Original Article

A bibliometric and social network analysis of pelvic organ prolapse during 2007−2016

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Abstract

Background: Pelvic organ prolapse (POP) seriously affects the life quality of old females. In the present work, we described the knowledge structure of POP in a macroscopic view, and summarized the recent research focus.
Methods: Candidates were identified through reading and screening publications from PubMed database with a MeSH term of "pelvic organ prolapse" during 2007−2016. Relevant journals and journal-affiliated countries were extracted, and essential information, such as the number of publication of each year, first authors and MeSH/subheading words, was analyzed with BICOMB. In addition, highly-frequent MeSH/subheading words were determined and classified, and co-occurrence matrices were produced accordingly. Finally, social network was utilized to analyze the knowledge structure.
Results: A total of 3294 publications of POP were retrieved from 364 journals. The publication of POP had a significant downward trend since the beginning of 2015. POP articles published in American and British journals were significantly more compared with other countries. The co-occurrence matrices of 37 × 37 and 55 × 55 were produced by the highly-frequent MeSH/subheading words, and then the social network analysis was performed based on them.
Conclusion: These publications on POP were mainly from the developed countries. Surgical treatment of POP was a hot topic of POP research in recent 10 years.

1. Introduction

As a common disease among women after parturition,[1] pelvic organ prolapse (POP) usually has symptoms, such as discomfort in vagina, leakage of urine, dysuria, dyschezia, vaginal bleeding, inflammation and so on, and some of patients have even no any symptoms. These symptoms cause social, psychological and sexual problems to female POP patients,[2] negatively influencing their daily activity and quality of life.[3] Therefore, more and more doctors and medical researchers have been involved in the POP study, and they have achieved fruitful results about this topic, including etiology and pathogenesis,[4−8] prevention and control,[9−12] diagnosis,[13] conservative treatment,[14] surgical treatment,[15−17] and postoperative complications.[18−20] These studies have greatly contributed to POP research and provided meaningful guidelines for the clinical decision-making of POP. The ultimate goal is to find the best individual treatment for every POP patient and improve their quality of life. In this study, we aimed to statistically analyze published articles of POP in the PubMed database in recent 10 years using bibliometric techniques and explain the hot topics of current research.

Bibliometric is a set of special research methods, which can be used to quantify the documents, authors, words, citation and co-citation by employing mathematics and statistics.[21,22] Co-word analysis is a one of methods that count and analyze the high frequency of keywords.[23,24] It can reveal the theme of the article, estimate the co-occurrence frequency of two words in the same paper and then form a co-word network by these relevant words, while the distance between the network nodes can reflect the theme of kinship. By this way, the essential information of these articles about the country, author, journal and the MeSH words can be traced, and a specific visual representation can be formed to summarize the contents, characteristics, internal relationship and scientific structure of the published literature in the POP field. Our data could provide the basis and guidelines of POP study for researchers, clinical doctors and educators.

2. Methods

Our study consisted of several steps as follows: 1) data collection; 2) extraction of major journals and journal-affiliated countries, including the number of publication of each year, first authors and the MeSH words, as well as the discovery of highly-frequent MeSH/subheading words; 3) establishment of a co-word matrix; and 4) social network analysis with co-word matrix.

2.1. Publication search

Our research materials were obtained from PubMed, which is an authoritative database well recognized by medical investigators and doctors worldwide. The MeSH word 'pelvic organ prolapse' was introduced into PubMed MeSH vocabulary in 2010, so such a keyword was employed to retrieve online data from January 1st, 2007 to December 31st, 2016 without any language restriction. News, letters, comments, editorials, repeated studies and other irrelevant literature were excluded through reading titles, abstracts, clinical cases and full texts of the articles by two independent reviewers.

2.2. Information extraction and data analysis

Invented by Professor Cui Lei (China Medical University), Bibliographic Item Co-occurrence Matrix Builder (BICOMB) is a basic tool that can read and extract a large number of information as quickly as possible, generating a bibliographic data matrix. In this work, BICOMB was used to determine the distribution of the journals and journal-affiliated countries, the publication year, first authors and the MeSH/subheading words. Moreover, the highly-frequent MeSH/subheading words were determined by threshold value (T), which was calculated based on high-frequency and low-frequency keywords by Donohue formula[25]: $T = (1 + \sqrt{1 + 8i})/2$, where 'i' refers to the number of MeSH/subheading words appearing only once. According to their relationship and characteristics, the highly-frequent MeSH/subheading words were classified, and then a co-occurrence matrix[26] was produced with them.

Finally, social network analysis, as the last step, was performed with UCINET 6 software.

3. Results

3.1. Eligible articles, the number of major journals, the number of publication of each year, high-yield journal-affiliated countries and first authors

A total of 10,374 records were selected from the initial screening, and then some limited conditions were applied, leading to 3294 records for future analysis. Fig. 1 describes the detailed steps and results. We found that 364 journals published relevant articles about the field of POP, and journals publishing more than 50 articles were enrolled as the major journals, yielding 13 types of journals. The journal with the greatest contribution was International Urogynecology Journal (n = 571), and the remaining journals included International urogynecolgy journal and pelvic floor dysfunction, American Journal of Obstetrics and Gynecology, European Journal of Obstetrics & Gynecology and Reproductive Biology, Female Pelvic Medicine & Reconstructive Surgery, Obstetrics and Gynecology and so on (Fig. 2). Fig. 3 indicates that the publication of each year exhibited a gradual upward trend from 2007 (n = 268) to 2012 (n = 406), and then there was gradual downward trend in 2015 with only 233 articles. A total of 54 journal-affiliated countries were summarized, and 18 countries published more than 10 articles (Fig. 4). Articles published in American (n = 1102) and British (n = 1141) journals were significantly more compared with other countries. In addition, a total of 2101 first authors were recorded in this investigation. Fig. 5 lists the top 12 authors who published more than 10 articles in this field, as well as the countries from which they are were enrolled.

3.2. Highly-frequent MeSH/subheading words

In this study, the number of MeSH/subheading words appearing once was 1467 (i = 1467), and the threshold value was 54.66 (T = 54.66) based on the Donohue formula, suggesting that 33 highly-frequent MeSH/subheading words appeared more than 54.66 in these papers. However, such a value was too small to show the centrality of knowledge structure network or the research hotspots.[27,28] Therefore, the threshold value was decreased to 35, resulting in 55 identified words (Table 1). According to their relationships and characteristics, 55 highly-frequent MeSH/subheading words were divided into six categories (Table 2) as follows: "therapy, surgical treatment was the main location" (4797, 74.33%), "pathology and physiopathology" (443, 6.86%), "diagnosis and auxiliary examination" (337, 5.22%), "epidemiology" (241, 3.73%), "etiology" (171, 2.65%) and others (465, 7.20%).

3.3. Co-occurrence matrix and social network analysis of highly-frequent MeSH/subheading words

In order to test the necessity of reduction of the T value, better and more clearly reflect the research hotspots of this
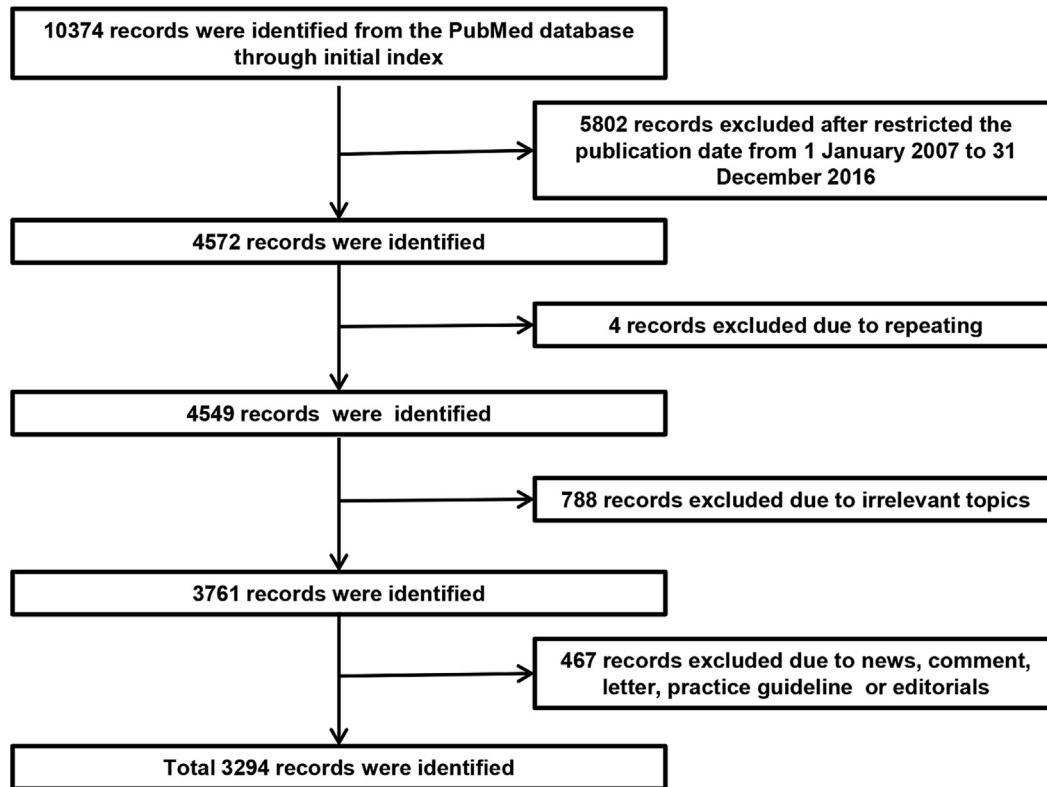
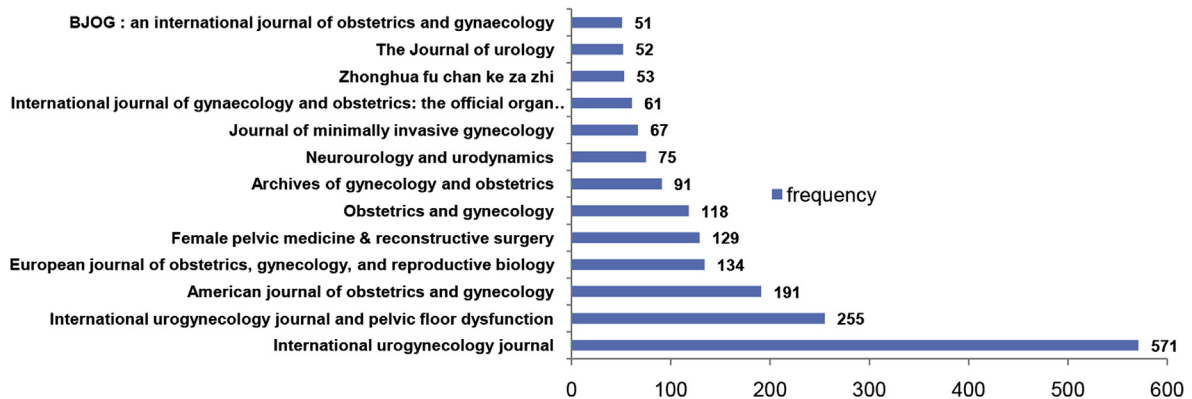Fig. 1. Flow graph of the study identification including inclusion criteria and the results of each step.

Fig. 2. The major journals which published more than 50 articles during 2007−2016 were enrolled.
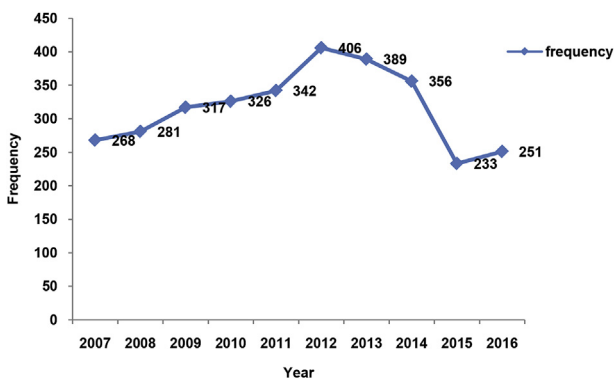
Fig. 3. The number of articles published per year ranging from 2007 to 2016.

field. A 33 × 33 (T = 54.66) and a 55 × 55 (T = 35) co-occurrence matrices were generated, and their co-occurrence frequencies were 1024 and 3,025, respectively. Subsequently, two network knowledge structure diagrams were also created based on them (Figs. 6 and 7).

Centrality of keywords and network centralization were used to analyze the knowledge network structure. Fig. 6 reveals that the mean value of betweenness centrality of MeSH/subheading words was 6.424 ± 5.594, the minimum value was 0.703, the maximum value was 22.456, the network centralization index was 3.33%, and the network centralization was 36.09%. Fig. 7 exhibits that the mean value of betweenness centrality of MeSH/subheading words was 14.491 ± 14.449,

The high-yield journal-country

Fig. 4. The journal-affiliated countries which published more than 10 articles during 2007−2016 were enrolled.

The first authors and countries

Fig. 5. The first authors who published more than 9 articles during 2007−2016 were enrolled.

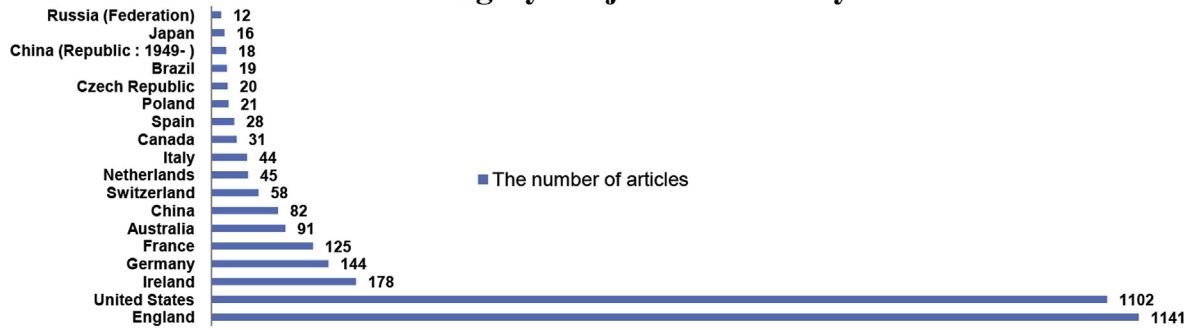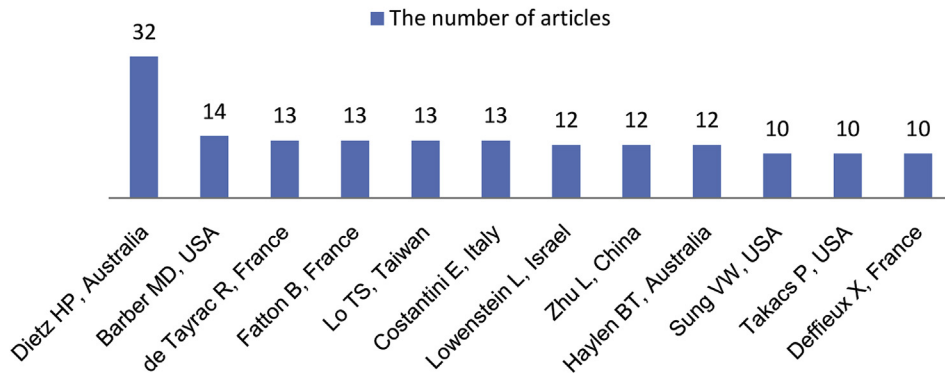the minimum value was 0.130, the maximum value was 64.188, the network centralization index was 3.54%, and the network centralization was 43.89%. Based on above-mentioned data, the more new MeSH/subheading words, the better centrality of network nodes (MeSH/subheading words) and centralization of knowledge network structure.

In the map of knowledge network structure, the nodes represent the subject words. Node size and location determine the decisive role of a word. Links represent the connection between two words, while the number or thickness of the lines represents the co-occurrence frequency about highly-frequent MeSH/subheading words. In Fig. 6, the node "gynecologic surgical procedures/methods" was the largest one, which was located in the center of the network with the thickest network lines, followed by three nodes "pelvic organ prolapsed/surgery", "quality of life" and "vagina/surgery". All these nodes were around the node "gynecologic surgical procedures/methods", and their network lines were also thicker. In Fig. 7, three new nodes "uterine prolapsed/surgery", "surgical mesh", "pelvic floor/surgery" were added to the above-mentioned five nodes around it. Network lines around these main nodes were the thickest. At the edge of the network, words "pelvic organ prolapsed/metabolism" and "pelvic organ prolapse/ultrasonography" were the most distant from the center of the

network, which had "6" and "11" network lines, respectively. Through a comparison between Figs. 6 and 7, we found that the biggest node located in the center of the network was also "gynecologic surgical procedures/methods", and nodes of POP surgery around this node. If these nodes were removed, the network structure would be greatly changed.

4. Discussion

Through the statistical analysis with BICOMB software, the number of articles published in International Urogynecology Journal was much higher than other journals. This journal is the official journal of the International Urogynecological Association (IUGA), and its publication covers all aspects of this field in an interdisciplinary fashion. Since 2007, articles of pop published has gradually increased every year and reached its peak in 2012. In spite of some fluctuations, the number of articles published in each year remained relatively stable from 2012 to 2014. In 2015 and 2016, the number was significantly decreased, which might be interpreted by that old research topics about POP have been gradually refined, whereas new topics have not been popular. Moreover, our analysis revealed that most of the high-yield journal-affiliated countries were the developed countries. In particular, the

Table 1
The frequency and percentage of the 55 highly-frequent MeSH/subheading words in the POP field during the period of January 1st 2007 to December 31st 2016.

rank	MeSH/subheading words	Frequency n (%)	rank	MeSH/subheading words	Frequency n (%)
1	Pelvic Organ Prolapse/surgery	929 (7.2641)	28	Postoperative Complications/etiology	62 (0.4848)
2	Uterine Prolapse/surgery	752 (5.8801)	29	Surveys and Questionnaires	61 (0.4770)
3	Gynecologic Surgical Procedures/methods	429 (3.3544)	30	Pelvic Organ Prolapse/etiology	60 (0.4692)
			31	Uterine Prolapse/etiology	57 (0.4457)
4	Surgical Mesh	365 (2.8540)	32	Uterine Prolapse/physiopathology	56 (0.4379)
5	Vagina/surgery	201 (2.5006)	33	Uterine Prolapse/complications	55 (0.4301)
6	Surgical Mesh/adverse effects	265 (2.0721)	34	Laparoscopy	54 (0.4222)
7	Urinary Incontinence, Stress/surgery	202 (1.5795)	35	Postoperative Complications/etiology	54 (0.4222)
8	Laparoscopy/methods	147 (1.1494)	36	Uterine Prolapse/epidemiology	53 (0.4144)
9	Cystocele/surgery	139 (1.0869)	37	Gynecologic Surgical Procedures	53 (0.4144)
10	Suburethral Slings	136 (1.0634)	38	Uterine Prolapse/pathology	51 (0.3988)
11	Quality of Life	124 (0.9696)	39	Uterine Prolapse/therapy	48 (0.3757)
12	Gynecologic Surgical Procedures/adverse effects	121 (0.9461)	40	Hysterectomy/adverse effects	47 (0.3675)
			41	Robotics	47 (0.3675)
13	Pelvic Organ Prolapse/therapy	112 (0.8758)	42	Hysterectomy/methods	46 (0.3597)
14	Pelvic Organ Prolapse/diagnosis	107 (0.8367)	43	Vagina/pathology	44 (0.3440)
15	Pelvic Floor/physiopathology	105 (0.8210)	44	Patient Satisfaction	43 (0.3362)
16	Pelvic Floor/surgery	104 (0.8132)	45	Pessaries	42 (0.3284)
17	Pelvic Organ Prolapse/epidemiology	87 (0.6803)	46	Polypropylenes	40 (0.3128)
18	Pelvic Organ Prolapse/physiopathology	80 (0.6255)	47	Urinary Incontinence, Stress/epidemiology	39 (0.3049)
19	Uterine Prolapse/diagnosis	77 (0.6021)	48	Urodynamics	39 (0.3049)
20	Pelvic Organ Prolapse/complications	75 (0.5864)	49	Pelvic Floor/pathology	38 (0.2971)
21	Ligaments/surgery	72 (0.5630)	50	Severity of Illness Index	37 (0.2893)
22	Urinary Incontinence/surgery	71 (0.5552)	51	Pelvic Floor/ultrasonography	36 (0.2815)
23	Urologic Surgical Procedures/methods	71 (0.5552)	52	Pelvic Organ Prolapse/psychology	35 (0.2737)
24	Suburethral Slings/adverse effects	70 (0.5473)	53	Colposcopy/methods	35 (0.2737)
25	Pelvic Organ Prolapse/pathology	69 (0.5395)	54	Pelvic Organ Prolapse/metabolism	35 (0.2737)
26	Gynecologic Surgical Procedures/instrumentation	64 (0.5004)	55	Pelvic Organ Prolapse/ultrasonography	35 (0.2737)
27	Reconstructive Surgical Procedures/methods	62 (0.4848)			

Table 2
Detailed classification of all the highly-frequent MeSH/subheading words.

Groups	The serial number of highly-frequent MeSH/subheading words	Total frequency of highly-frequent MeSH/subheading words, n (%)
Therapy	Pelvic Organ Prolapse/surgery, Uterine Prolapse/surgery, Surgical Mesh, Gynecologic Surgical Procedures/methods, Vagina/surgery, Stress/surgery, Surgical Mesh/adverse effects, Urinary Incontinence, Suburethral Slings, Laparoscopy/methods, Pelvic Organ Prolapse/therapy, Pessaries, Cystocele/surgery, Gynecologic Surgical Procedures/adverse effects, Pelvic Floor/surgery, Ligaments/surgery, Urinary Incontinence/surgery, Urologic Surgical Procedures/methods, Uterine Prolapse/therapy, Reconstructive Surgical Procedures/methods, Laparoscopy, Robotics, Gynecologic Surgical Procedures/instrumentation, Polypropylenes, Gynecologic Surgical Procedures, Hysterectomy/methods, Hysterectomy/adverse effects, Suburethral Slings/adverse effects,	4797 (74.33)
Pathology and physiopathology	Pelvic Floor/physiopathology, Pelvic Organ Prolapse/physiopathology, Pelvic Organ Prolapse/pathology, Pelvic Floor/pathology, Uterine Prolapse/physiopathology, Vagina/pathology, Uterine Prolapse/pathology,	443 (6.86)
Diagnosis and auxiliary examination	Pelvic Organ Prolapse/diagnosis, Uterine Prolapse/diagnosis, Urodynamics, Pelvic Floor/ultrasonography, Colposcopy/methods, Pelvic Organ Prolapse/ultrasonography	337 (5.22)
Epidemiology	Pelvic Organ Prolapse/epidemiology, Uterine Prolapse/epidemiology, Postoperative Complications/epidemiology, Urinary Incontinence, Stress/epidemiology	241 (3.73)
Etiology	Pelvic Organ Prolapse/etiology, Uterine Prolapse/etiology, Postoperative Complications/etiology,	171 (2.65)
others	Surveys and Questionnaires, Pelvic Organ Prolapse/metabolism, Patient Satisfaction, Severity of Illness Index, Quality of Life, Pelvic Organ Prolapse/complications, Uterine Prolapse/complications, Pelvic Organ Prolapse/psychology	465 (7.20)

number of articles published in the journals of England and the United States was significantly higher compared with other countries, which was consistent with the bibliometric results of other fields.[23,29] This could be explained by that the first language is English in these two countries, which greatly contributes to their publications.

According to the co-word analysis and social network analysis in this study in recent 10 years, the study of POP was mainly related to surgical treatment, including the methods of operation,[30–32] complications,[33–35] the materials of surgical equipment and other relevant aspects of surgery.[36–38] Almost half of the multipara is diagnosed as prolapse based on POP-
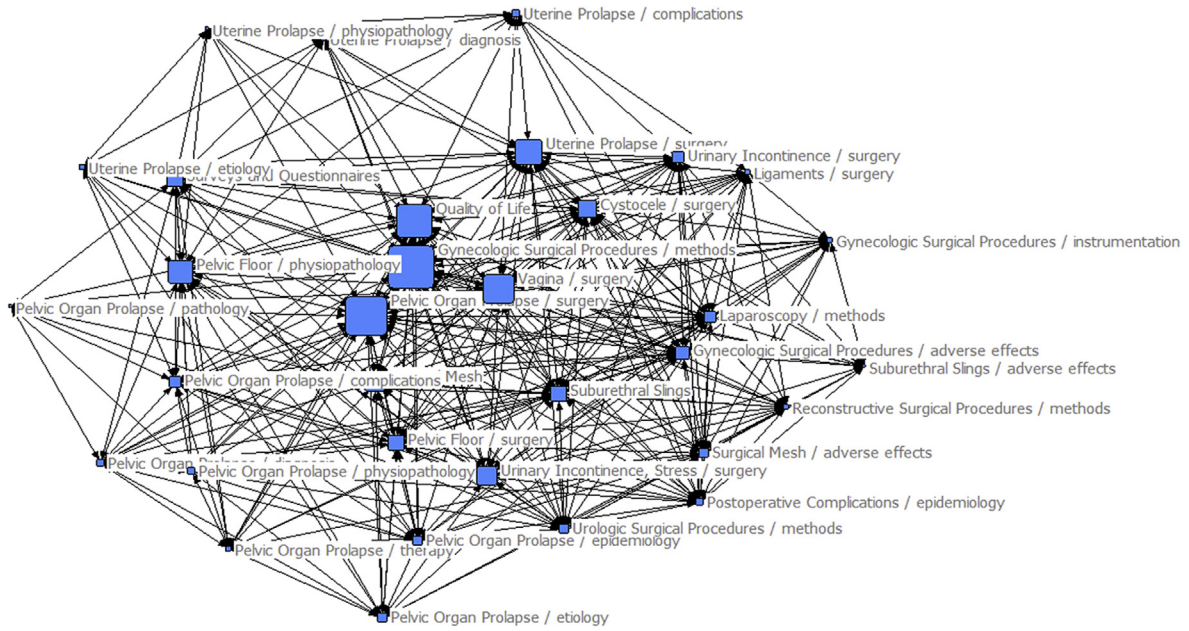
Fig. 6. **The network structure map for highly-frequent MeSH/subheading words (T = 54.66) of POP research.** Nodes represent MeSH/subheading words, while note size and location determine the centrality of a word in the network structure map. Links represent the connection between two words, and the number or thickness of the lines represents the co-occurrence frequency about highly-frequent MeSH/subheading words.

Fig. 7. **The network structure map for highly-frequent MeSH/subheading words (T = 35) of POP research.** Nodes represent MeSH/subheading words, while note size and location determine the centrality of a word in the network structure map. Links represent the connection between two words, and the number or thickness of the lines represents the co-occurrence frequency about highly-frequent MeSH/subheading words.
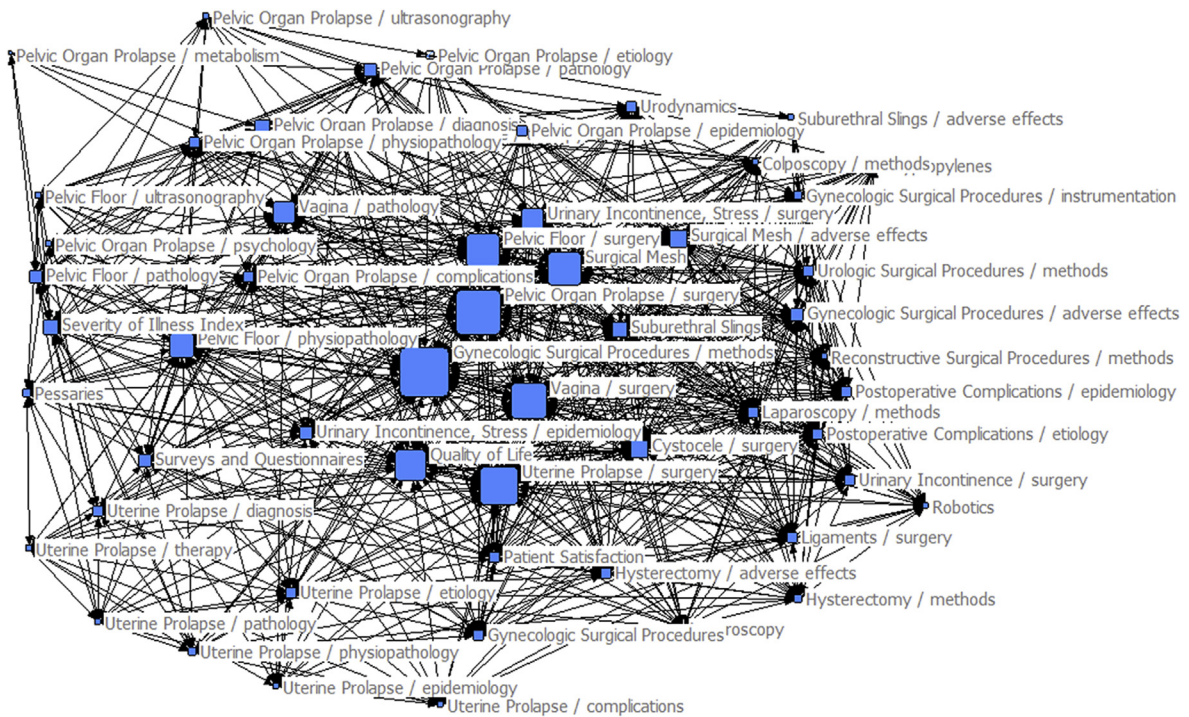
Q,[39] but most of them have no clinical manifestation. Generally speaking, POP patients experience symptoms once the lowest point of prolapse reaches or exceeds the level of hymen (POP-Q ≥ll stage), This greatly reduces the rate of early treatment, which often requires surgical intervention in order to improve the quality of life, leading to more research data about the surgery.

However, our study has some limitations mainly in the following three aspects. The first one is about the high-yield authors of the research. In the present study, we aimed to

find the active authors. However, the corresponding authors were not included, and usually these authors have an equal contribution to the study. In addition, these authors probably changed the work place during the period of this study, so the authors' institutions were not listed. The second drawback is about the data extraction. Our analysis was only performed based on the PubMed database, and literature in other sources were not analyzed. This problem could be solved by improving the literature mining skills of researchers. The third one is the inclusion or exclusion criteria of literature. If the review and clinical trial articles are included in the bibliometric and co-word analyses together, the materials may contain some repeated studies. If the review articles are excluded and only clinical trial articles are included, there may be a chance to lose some research hotspots. These limitations need to be solved in the future research.

Taken together, Despite the research of POP currently exhibited a downward trend, Surgical treatment of POP was a hot topic in recent 10 years. Most of publications were from the developed countries with English as the first language. In conclusion, bibliometrics is a set of macroscopic and novel methods for the research of hot topics. However, it only reflects the current research hotspots and can not predict the potential developmental trend.[40]

Acknowledgments

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