Original Article

A bibliometric analysis of the research on preeclampsia in the first two decades of the twenty-first century

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Background: Preeclampsia still remains one of the leading causes of maternal and perinatal mortality worldwide. Despite the concerted efforts of researchers, only a little improvement has been seen. Clinical decision-making is based on the published literatures. With the explosive growth of medical documents in recent decades, a bibliometric method is essential for assessing the intellectual contributions, major components and potential trends.

Methods: Web of Science Core Collections was selected as the original database and datasets were retrieved consisting of literatures published from 2000 to 2020. Different bibliometric software were employed to visualize the co-authorship network, citation analysis and research theme detection.

Results: A total of 25497 articles and 3668 reviews were obtained. Despite the number of publications increased annually, the quantity of high-quality contributions did not elevate accordingly. Clinical practitioners should be alerted to the false bloom of achievements and the yield of improvement in future research. Nicolaides Kypros H was found to be the most productive and influential researcher. University of Pittsburgh was the most productive institution whereas Harvard University showed its leading academic status. America located at the central point in global collaboration and scholarship network. Reference citation analysis revealed the top landmark articles. Moreover, keywords co-occurrence analysis and burst detection certificated the lack of novel themes in this field, which needs further efforts.

Conclusion: This study provides the overall landscape of science mapping in recent two decades in the field of preeclampsia, with the aim of identifying evolution of research topics and promoting potential concentration or collaboration in the future.

Keywords: bibliographic coupling, bibliometric, BICOMB, CiteSpace, co-citation, co-occurrence, preeclampsia, VOSviewer

Abbreviations: ACOG, American College of Obstetricians and Gynecologists; MeSH, Medical Subject Headings

INTRODUCTION

Preeclampsia (previously referred to as toxaemia of pregnancy), one of the most serious hypertensive disorders of pregnancy, is uniquely challenging as the pathology and its therapeutic management simultaneously affect both mother and foetus, sometimes putting their well being into mutual contradiction with each other [1]. The classical definition of preeclampsia is new onset hypertension developing in the second half of pregnancy (after 20 weeks gestation) and resolving after delivery, accompanied by other maternal organ dysfunction (including liver, kidney, neurological) or haematological involvement, often associated with uteroplacental dysfunction, such as foetal growth restriction. The pathophysiology of preeclampsia still remains poorly understood, limiting earlier diagnosis and therapeutic interventions [2]. Mothers with preeclampsia simultaneously develop increased cardiometabolic health risks long after delivery [3].

To reduce both short-term and long-term disease burden across the life-course, a wide range of research has been conducted and huge amount of literatures have been published. As the features of this prodromal syndrome have been documented for almost 200 years [2], it seems quite impossible for healthcare practitioners to go through the original data and mine the main findings as the basis of subsequent decision. In view of aforesaid problems, bibliometric analysis becomes essential to summarize the trends of research and evaluate the previous research findings.

Bibliometric, or similarly scientometric methods [4], is the cross-disciplinary science of quantitative technique of all knowledge carriers by mathematical and statistical methods. It is commonly used to identify the development of a certain field for assessing research performance and topics [5]. Relying on bibliometric analytic tools and preferably visual representation, as well as an authoritative database of scientific literatures, a science map can be generated. The

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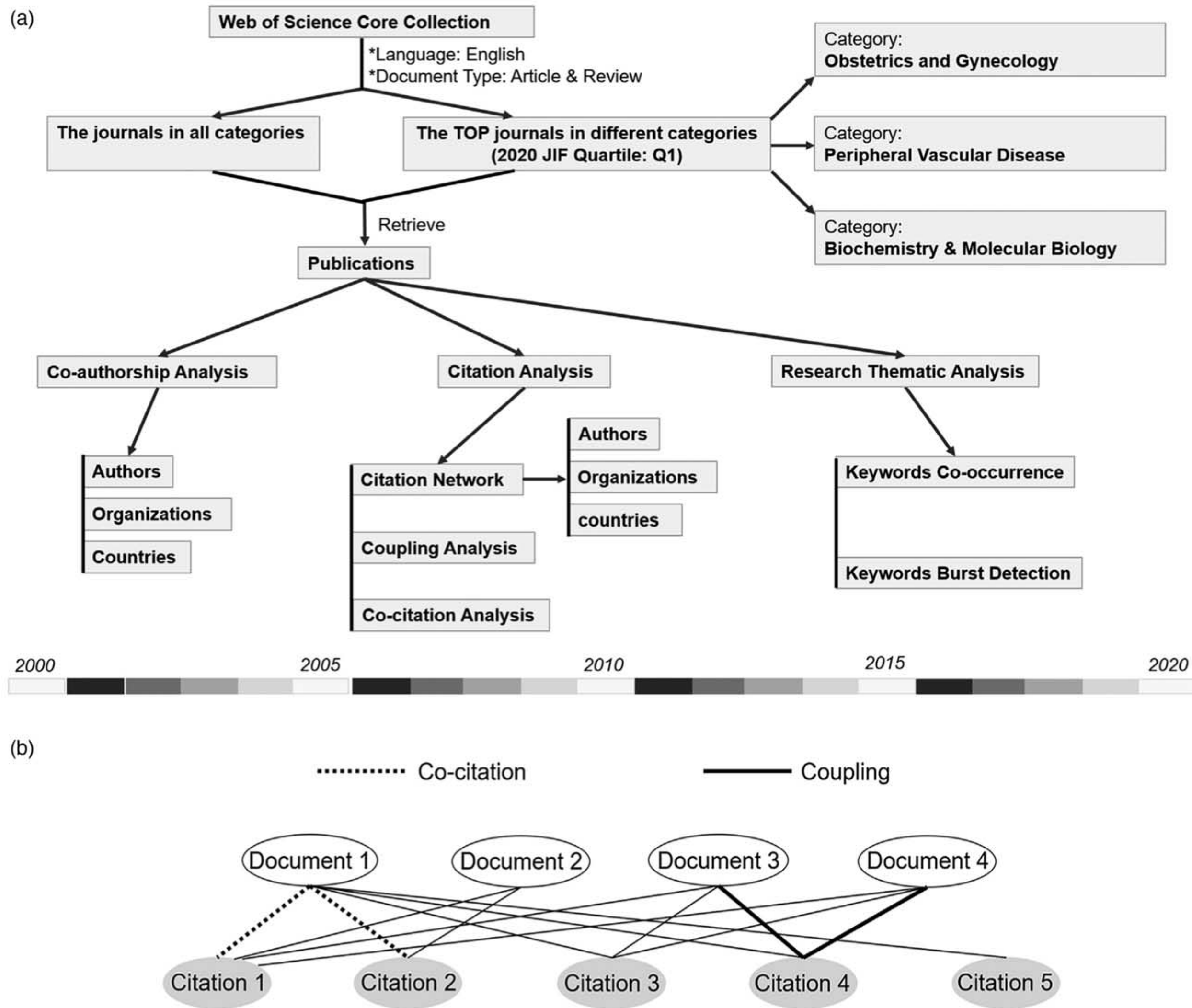

FIGURE 1 (a) Flow chart of this study. (b) Illustration of coupling and co-citation analysis.

units in science map are domains of scientific knowledge, which reflect an aggregated collection of intellectual contributions from scholars. The structure of the domain may experience constant and possibly revolutionary changes [6]. Researchers could even predict the underlying research trends on the basis of the map.

At present, only one previous study on bibliometric analysis has been performed relating to preeclampsia during recent two decades [7]. The purpose of this study is to describe the current global science map in this field from 2000 to 2020, and to provide reasonable references for future decision making and direction of further academic cooperation worldwide. Yet, long-term efforts are still required to step forward in the prevention and treatment of preeclampsia, to improve women's and offspring's health.

METHODS

Typical bibliometric analyses consist of steps of formulating questions, retrieving data, applying suitable bibliometric tools, and interpreting the results [8]. The flow chart of this study can be seen in Fig. 1a.

Data source and retrieval strategy

Web of Science Core Collections (WOSCC), the world's largest and most comprehensive database of scientific publications [9], was applied in this study to retrieve datasets. Journals in this database were classified into different categories and in each category, 'top journals' were defined as the journals ranking in the top quartile (Q1) according to the 2020 impact factor. We selected three categories to explore more detailed information: 'Obstetrics and Gynecology', 'Peripheral Vascular Disease' and 'Biochemistry Molecular Biology'. The first two were the top two categories with the most published articles and the last one was the category focusing on basic medicine. More information can be seen in Supplementary Data 1, http://links.lww.com/HJH/B902.

The following search strategy was applied in the WOSCC database: Topic = ∗eclamp∗; Document type = Articles OR Reviews, varied according to the research requirement; Language = English; Timespan = from 2000 to 2020, varied according to the requirement.

Keywords and MeSH term were combined to generate this search topic. The MeSH term 'preeclampsia' contains the previous indexing of 'Pregnancy Toxemias' (1966–1974). Although this time range was not included in our timespan and this description of the disease was abandoned, we searched the word 'Toxemia' from 1 January 2000 to 31 December 2020, no literature was found relating to preeclampsia, so we excluded the word 'toxemia' from our search strategy.

Bibliometric methods

Co-authorship networks revealed collaborations among authors, organizations and countries, the degree of relationships and the influence of different scholars or groups within the special research filed could be described [10].

In the case of citation relations, a further distinction can be made between direct citation relations, bibliographic coupling relations and co-citation relations [11]. Direct citation analysis gives a measure of the relative importance or impact of authors, institutions, countries or documents by counting the number of times cited by others. Bibliographic coupling occurs when two documents cite the same third document, measuring the similarity between publications. Co-citation appears when two documents receive a citation from the same third document, identifying scholarship that has received peer-recognition indicated by citation patterns, which enables identification of relevant literatures in scholarly communities [12]. After determining the relatedness of publications, clusters could be generated by statistical methods. (The illustration of coupling and co-citation analysis can be seen in Fig. 1b.)

The co-occurrence analysis of keywords, one category of co-word analysis, was conducted by producing frequency matrixes in which the elements of the matrix are co-occurrence words, and then clustering the keywords to different domains according to the frequency of occurrence, the clusters could be arranged by timeline to display the development of certain research theme [13]. Burst detection is a computational technique that has been used to identify abrupt changes of events and other types of information [6].

Applied bibliometric and related tools

VOSviewer (N.J. van Eck and L. Waltman, Leiden University, Leiden, The Netherlands, version 1.6.17), CiteSpace (Chaomei Chen, Drexel University, Philadelphia, Pennsylvania, USA, version 5.5.R2) and BICOMB (Lei Cui, China Medical University, Shenyang, China, version 2.0) were used as the bibliometric analysis tool. gCLUTO (Matt Rasmussen and George Karypis, University of Minnesota, Minnesota, USA, version 1.0) was a graphical cluster toolkit. By these visualizing quantitative metrics, science mapping can be generated according to the network containing an overview of all retrieved literatures [6,14]. GraphPad Prism (GraphPad Prism Software Inc., San Diego, California, USA) was used to make line charts and geographic information was provided by GeoDa (Luc Anselin, version 1.20).

The science maps consist of nodes and links. Different nodes in a map represent different elements, such as authors, institutions, countries, cited references and occurred keywords. The node size means the frequency of occurrence in the corresponding networks. Links between nodes represent the interrelationships. The different greyscale of nodes and links represent different clusters or published years.

To observe the overall science maps of the two decades in the early twenty-first century and to distinguish the differences between the two decades, time slicing was selected from 2000 to 2020, 2000 to 2010, 2010 to 2020, 2016 to 2020 and 2020, which varied according to the queries.

The parameters of CiteSpace were set as follows [15,16]: years per slice; term source: all selection; term type: burst detection was used to identify the abrupt changes of keywords citation; node type: choose 1 at a time; selection criteria: top 50; pruning: pathfinder; visualization: cluster view-static, show merged network. The parameters not mentioned were default setting.

RESULTS

The number of publications increased annually

A total of 25 497 research articles and 3668 reviews were retrieved from WOSCC, from 2000 to 2020 in English. Over the studied period, the number of publications increased annually as shown in Fig. 2a andSupplementary 2, http://links.lww.com/HJH/B903, especially in recent decade. Meanwhile, it was worth noting that the amount of publications was very stable when we referred to 'top journals' in categories of 'Obstetrics and Gynecology' and 'Peripheral Vascular Disease' (Fig. 2b and Supplementary 2, http://links.lww.com/HJH/B903).

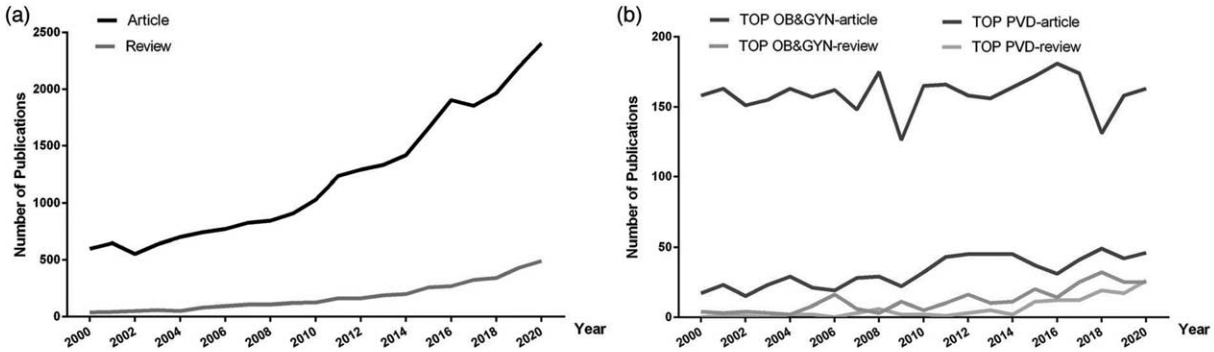

FIGURE 2 (a) Line graph of publications related to preeclampsia. (b) 'TOP OB&GYN-article' represents the publications in top journals with the category of 'Obstetrics and Gynecology', document type was 'article'. 'TOP PVD-review' was the similar way of naming the group with the category of 'Peripheral Vascular Disease'.

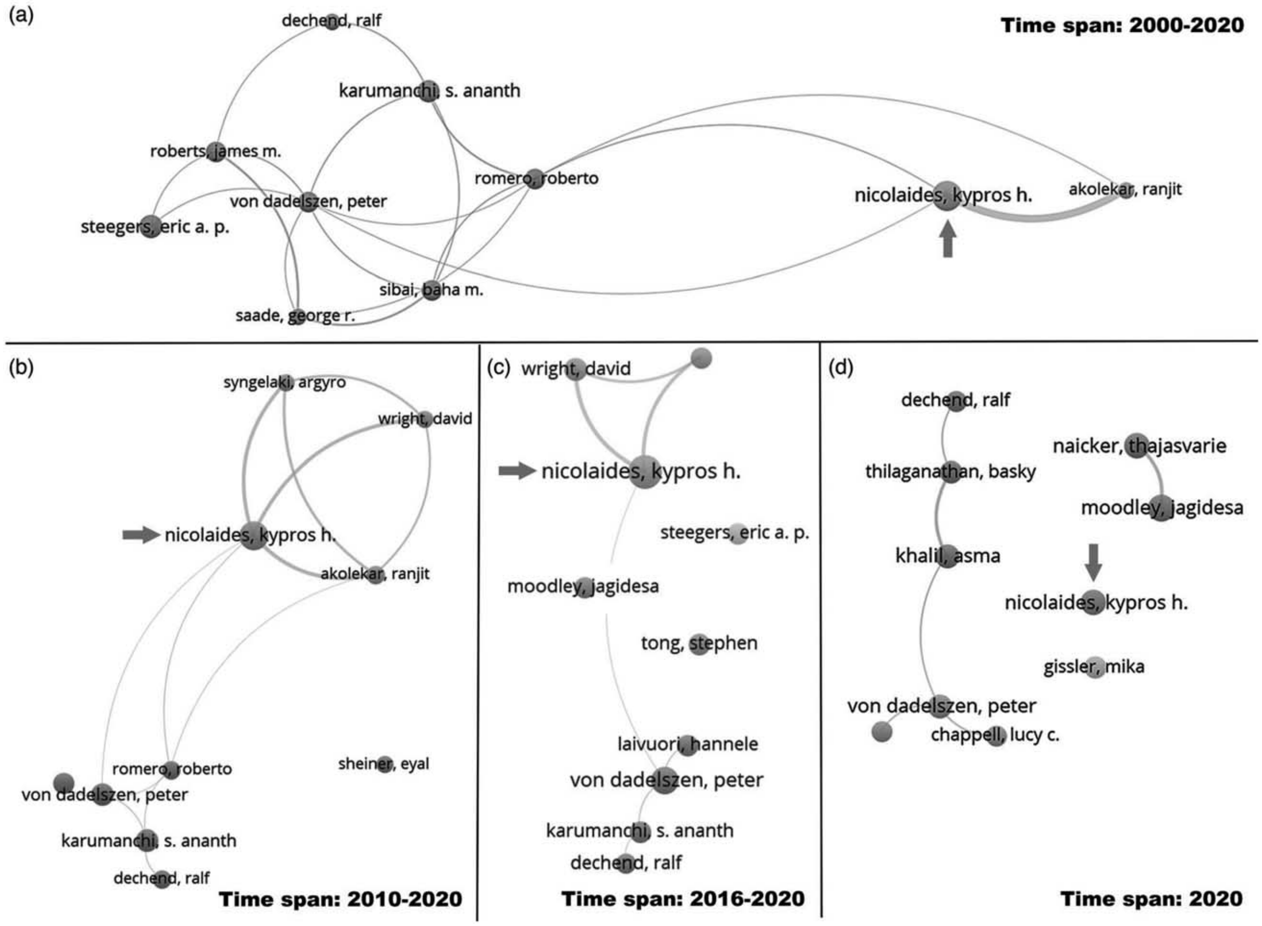

FIGURE 3 The arrows pointed to the most productive authors with the highest frequencies of co-authorship in certain timespan.

The evolution of academic collaboration network during the two decades

The co-authorship analysis only focused on the document type of 'article'. Figure 3 was the visualized expression of Table 1, they both illustrated the co-authorship networks of top 10 authors in four different timespans. Nicolaides Kypros H. was the most productive author with the highest frequencies of co-authorship whereas the composition of co-authorship clusters varied according to time. These collaborations between researcher communities led to collaborations between institutions.

Top 30 institutions' co-authorship network varied in different timespan, and some clusters merged by the increasing links over time. University of Pittsburgh was the most productive institution in two decades with the largest number of publications whereas University of Toronto was the most productive one in the recent decade. In 2020, under the pandemic situation, King's College London was the institution with the most frequencies of co-authorship (seen in Fig. 4 and Table 2).

The global collaboration pattern was mainly formed based on geographic location in two decades and the different areas with different greyscales on the maps provided intuitive geographic information of clusters, Fig. 5 and Table 3. America located at the central point in coauthorship network, which was the most productive one in the Top 50 countries. The images with more different shades of grey in 2020 indicated the more extensive cooperation worldwide transcended the geographical barriers.

High-impact academic contributions on preeclampsia in recent two decades

In this section, we also limited the research range of literatures to document type of 'article'.

Academic contributions evaluated by direct citation

We generated the networks of direct citation to describe the academic contribution of authors, institutions, countries and journals.

Nicolaides Kypros H. was the pioneer in the field of preeclampsia in these two decades with the most frequencies of direct citation. The two clusters of direct citation network indicated the two main research topics with the approval of researchers in form of citation and remained stable in recent 20 years. In the recent decade, Khalil Asma involved to bridge the two research groups (Fig. 6 and Table 4).

Harvard University, even though it was not the most productive institution, showed its profound academic

TABLE 1. Top 10 authors with the highest frequencies of co-authorship in different timespans

(2000–2020)				(2010–2020)			
Author	**Documents**	**Citations**	**Cluster**	**Author**	**Documents**	**Citations**	**Cluster**
Steegers Eric A. P.	162	6653	1	Von Dadelszen Peter	114	4835	1
Karumanchi S. Ananth	136	9838	1	Karumanchi S. Ananth	108	5068	1
Romero Roberto	133	9410	1	Steegers Eric A. P.	97	4467	1
Sibai Baha M.	133	11233	1	Romero Roberto	82	2575	1
Von Dadelszen Peter	127	5407	1	Dechend Ralf	73	1874	1
Roberts James M.	124	8306	1	**Nicolaides Kypros H.**	**191**	**7752**	**2**
Dechend Ralf	84	2641	1	Akolekar Ranjit	74	4097	2
Saade George R.	83	4187	1	Syngelaki Argyro	66	4156	2
Nicolaides Kypros H.	**277**	**13975**	**2**	Wright David	63	3547	2
Akolekar Ranjit	84	4893	2	Sheiner Eyal	67	958	3
(2016–2020)				**(2020)**			
Author	**Documents**	**Citations**	**Cluster**	**Author**	**Documents**	**Citations**	**Cluster**
Von Dadelszen Peter	68	944	1	Khalil Asma	14	47	1
Karumanchi S. Ananth	43	1099	1	Thilaganathan Basky	12	45	1
Laivuori Hannele	40	495	1	Dechend Ralf	11	44	1
Dechend Ralf	37	356	1	Von Dadelszen Peter	13	35	2
Nicolaides Kypros H.	**98**	**3286**	**2**	Chappell Lucy C.	11	24	2
Wright David	48	2398	2	Li Jing	10	22	2
Syngelaki Argyro	41	2292	2	Moodley Jagidesa	17	33	3
Moodley Jagidesa	41	236	3	Naicker Thajasvarie	15	23	3
Steegers Eric A. P.	40	400	4	Gissler Mika	12	32	4
Tong Stephen	39	558	5	**Nicolaides Kypros H.**	**15**	**69**	**5**

The authors were ranked according to the number of publications in each cluster and the clusters were ranked by the number of items. The grey background of the table distinguished different clusters and the bold fonts indicated the most productive author. For the family names and given names of authors may display in different forms according to journals, and this variation cannot be identified by bibliometric software, we made the thesaurus list of authors, seen in Supplementary 3, http://links.lww.com/HJH/B904.

influence verified by the results of citation analysis lasting for two decades, the quantity could not represent quality obviously (Fig. 7 and Table 5). In the recent 5 years, King's College London got the first place in the list of institutions with the largest numbers of citations in area of preeclampsia and in 2020, Columbia University increased its presence.

America, demonstrated its central position again in citation analysis indisputably (Fig. 8 and Table 6). Throughout the two decades, citation relation still displayed its correlation with geographic location or even history, while when we focused on the recent 10 years, or 5 years, more specifically, the citation patterns were more unitive to form the dominant cluster with the largest number of countries, which may indicate the widespread acceptance of research achievement depending on more extensive academic exchange as the development of social economy. The result in 2020 might indicate the new tendency with more clusters, or might be altered that the clusters would merge to fewer ones over time.

Furthermore, the list of most impacted journals was also shown in Fig. 9 and Table 7. For briefness, we only displayed the top 10 journals. *American Journal of Obstetrics and Gynecology* was the most influential journal globally, whereas in 2020, *Journal of Maternal-Fetal & Neonatal Medicine* became the most prominent one. The reason to explain this alteration was assumed that the number of publications in the *Journal of Maternal-Fetal & Neonatal Medicine* was the largest during the recent decade and the citation could be affected by the publication amount, the more spread, the more impact.

Academic contributions evaluated by bibliographic coupling

Coupling networks of documents in different timespans were performed to evaluate the similarity of literatures in science maps. Figure 10a and Table 8 displayed the coupling analysis of top 30 documents during 2000–2020, all essential information to identify the documents was recorded. The documents were retrieved based on link strength of coupling, which meant if one document cited one citation, the link strength of the document would be counted for '1'. The clusters of documents were formed according to the coupling connection and ranked based on the number of documents it contained, whereas literatures in one cluster shared similar content. In the meanwhile, the results from 2016 to 2020 were shown in Fig. 10b and Table 9, providing up-to-date information, and the latest information of coupling network in 2020 was shown in Fig. 11a and Table 10.

Academic contributions evaluated by co-citation analysis

We performed the co-citation network analysis of the top 30 references, to clarify the research foundation, or the classification of knowledge domains in this field in two decades. From 2000 to 2020, the top 30 documents retrieved by the number of citations clustered into three groups based on the co-citation relationship, seen in Fig. 10c and Table 11. In the recent 5 years, the number of clusters in co-citation network remained three, whereas the representative literature transferred from a review [17] to an evidence-based guideline [18], seen in Fig. 10d and Table 12. In 2020, the

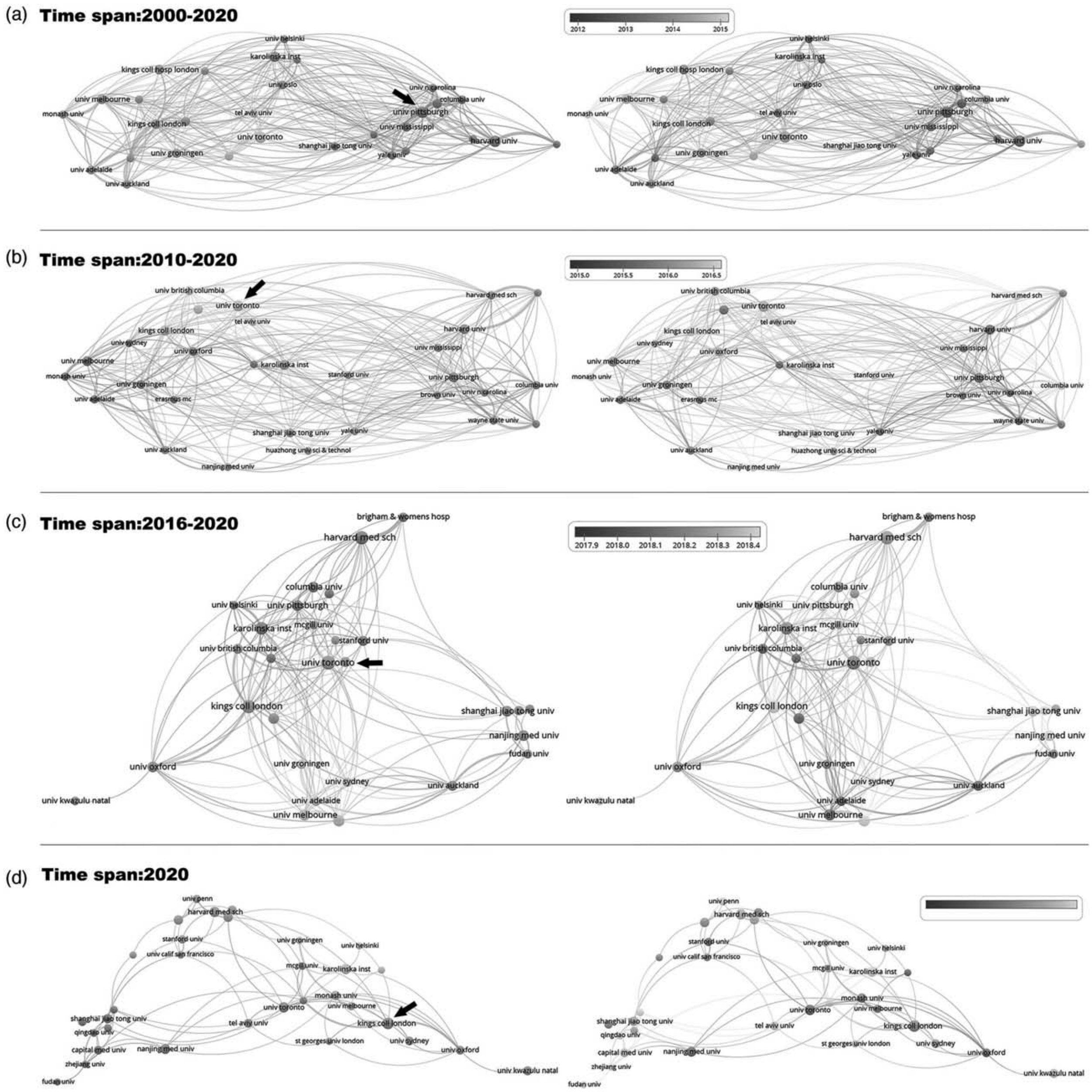

FIGURE 4 The arrows pointed to the most productive institution with the largest number of publications. The images on left which were identical compared with the images on right were distinguished based on timeline, according to the legends.

mentioned guideline still persisted its impact (Fig. 11b and Table 13). For a better visualized expression of the clustering process, we employed the BICOMB software to create the matrix of documents and gCLUTO software to generate the visualized three-dimensional clusters in this year (the reason why we selected this single year was that the computation time could be reduced significantly for the small size of data). As shown in Fig. 11d, the matrix was formed taking the top 30 documents as the horizontal and longitudinal axes, various shades of grey in the matrix indicated the different frequencies of citations, the darker the colour was, the higher the citation frequencies were. In Fig. 11c, the peaks formed according to the previous matrix data. The height of each peak on the plane was proportional to the internal similarity of the corresponding clusters. The volume of a peak was proportional to the number of objects within the cluster. Lastly, the different greyscale of a peak represented the internal standard deviation of documents in this cluster. Dark grey represented low deviation, whereas light grey represented high deviation. The images of matrix and peaks showed a more direct impression of the relationship between documents in one cluster and the relationship between clusters.

To get more precise results, we selected the documents in the top two categories separately, 'Obstetrics and Gynecology' and 'Peripheral Vascular Disease', to further explore the co-citation relationship. In the category of 'Obstetrics and Gynecology', top 30 documents retrieved according to

TABLE 2. The top 30 institutions with the largest number of publications in different timespans

2000–2020 Organization	Documents	Citations	Cluster
University of Pittsburgh	**374**	**18708**	**1**
Harvard University	370	27 393	1
Wayne State University	237	14 024	1
University of Mississippi	233	8492	1
Columbia University	227	9261	1
Yale University	218	9491	1
University of Washington	201	6358	1
University of North Carolina	195	7968	1
Shanghai Jiao Tong University	182	3177	1
University of California San Francisco	180	9040	1
Stanford University	174	5790	1
Brigham & Women's Hospital	172	6663	1
King's College London	282	10 204	2
King's College Hospital London	279	13 373	2
University of Melbourne	261	6096	2
University of Oxford	254	14 058	2
University of Groningen	233	6000	2
University of Adelaide	217	8056	2
University of Auckland	207	5508	2
University of Sydney	192	5812	2
University of Manchester	190	7528	2
Monash University	188	3400	2
University of Cambridge	180	11194	2
Karolinska Institutet	299	13 242	3
University of Oslo	214	8474	3
University of Helsinki	202	6693	3
University of Bergen	172	7828	3
University of Toronto	361	15 708	4
Tel Aviv University	214	7855	4
University of British Columbia	210	9958	4

2010–2020 Organization	Documents	Citations	Cluster
University of Melbourne	230	4980	1
University of Oxford	190	7496	1
University of Groningen	179	3688	1
University of Adelaide	163	5176	1
Monash University	161	2509	1
University of Oslo	149	3925	1
Erasmus MC	141	6223	1
University of Sydney	141	2917	1
Karolinska Institutet	227	5664	2
Shanghai Jiao Tong University	179	3142	2
University of Auckland	170	3741	2
Nanjing Medical University	153	3141	2
Stanford University	144	3553	2
Yale University	142	5044	2
Huazhong University of Science & Technology	138	1305	2
University of Pittsburgh	227	5815	3
Columbia University	173	4163	3
Wayne State University	167	5186	3
University of North Carolina	145	3338	3
NIH Eunice Kennedy Shriver National Institute of Child Health & Human Development (NICHD)	143	5155	3
Brown University	136	4414	3
University of Toronto	**284**	**7072**	**4**
King's College London	251	8508	4
King's College Hospital london	208	7639	4
University of British Columbia	181	7874	4
Tel Aviv University	146	2865	4
Harvard University	245	10 445	5
University of Mississippi	173	4507	5
Harvard Medical School	163	2675	5
Brigham & Women's Hospital	144	4390	5

(2016–2020) Organization	Documents	Citations	Cluster
Harvard Medical School	163	2675	1
Karolinska Institutet	146	2263	1
Columbia University	115	1584	1
University of Pittsburgh	107	1272	1
Stanford University	94	1611	1
University of Mississippi	88	1440	1
University of Cambridge	86	2023	1
Brigham & Women's Hospital	79	1500	1
University of Helsinki	77	986	1
University of Toronto	**181**	**2990**	**2**
King's College London	167	3028	2
King's College Hospital London	108	2954	2
University of British Columbia	99	1215	2
Tel Aviv University	95	886	2
Ben Gurion University	76	675	2
McGill University	76	825	2
Shanghai Jiao Tong University	114	1180	3
Nanjing Medical University	105	1339	3
University of Auckland	94	1222	3
Capital Medical University	81	347	3
Huazhong University of Science & Technology	78	559	3
Fudan University	77	665	3
University of Melbourne	125	2114	4
Monash University	118	1251	4
University of Adelaide	84	1159	4
University of Groningen	82	699	4
University of Sydney	81	834	4
University of Oxford	115	2361	5
University of Kwazulu Natal	77	424	5

(2020) Organization	Documents	Citations	Cluster
Nanjing Medical University	32	93	1
Shanghai Jiao Tong University	28	99	1
Capital Medical University	25	49	1
Huazhong University of Science & Technology	22	35	1
Southern Medical University	21	56	1
Qingdao University	20	21	1
Shandong University	19	60	1
Fudan University	18	26	1
Zhejiang University	18	37	1
Harvard Medical School	35	100	2
Columbia University	29	173	2
University of Pittsburgh	29	102	2
University of Mississippi	25	72	2
Stanford University	22	79	2
University of Pennsylvania	22	63	2
University of California San Francisco	19	53	2
China Medical University	18	72	2
King's College London	**46**	**131**	**3**
University of Toronto	35	146	3
Tel Aviv University	26	51	3
University of British Columbia	21	65	3
McGill University	19	45	3
St Georges University London	18	63	3
Karolinska Institutet	35	104	4
Lund University	18	66	4
University of Helsinki	18	65	4
University of Oxford	27	96	5
University of Kwazulu Natal	25	40	5
University of Sydney	25	47	5
Monash University	30	76	6
University of Melbourne	23	57	6
University of Groningen	18	36	6

The institutions were ranked according to the number of publications in each cluster. The bold fonts indicated the most productive institutions with the largest number of publications.

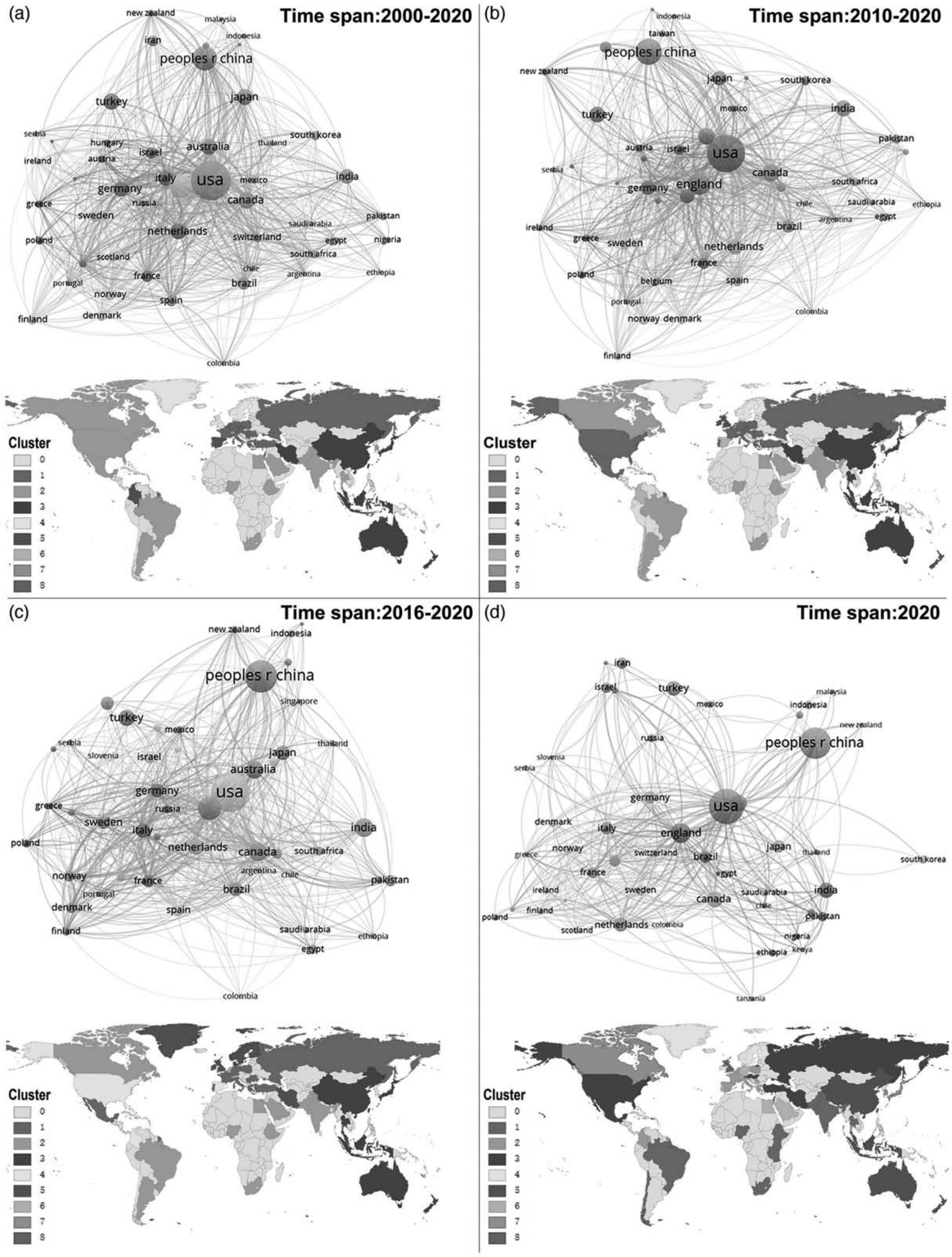

FIGURE 5 One greyscale represented one cluster both in the networks and on the maps according to the legend.

the citation frequencies and clustered into three domains whereas the matrix and mountain graphs elucidated the internal relation within each domain (Fig. 12 and Table 14). The results in this category were quite similar to the results including all kinds of categories. From another aspect, we selected the category of 'Peripheral Vascular Disease' to access more information (Fig. 13), and the results showed distinctive features with eleven new documents, which were not included in the top 30 list in category of 'Obstetrics and Gynecology' and were underlined in Table 15. These

TABLE 3. The top 50 countries with the largest number of publications in different timespans

2000–2020

Country	Documents	Citations	Cluster
Netherlands	1164	33 164	1
Turkey	1139	13 486	1
Germany	1085	33 591	1
Italy	1038	27 122	1
France	601	16157	1
Israel	587	18 327	1
Poland	302	4825	1
Austria	280	8718	1
Belgium	273	11 775	1
Greece	258	5944	1
Hungary	206	4875	1
Russia	163	1160	1
Portugal	106	2387	1
Serbia	94	836	1
Romania	84	671	1
Czech Republic	80	1599	1
USA	**6706**	**233432**	**2**
Canada	1294	50 446	2
India	922	9125	2
Brazil	656	10910	2
Switzerland	416	15 280	2
South Korea	400	6998	2
South Africa	339	6689	2
Pakistan	283	1992	2
Egypt	235	3263	2
Mexico	214	3779	2
Nigeria	171	1483	2
Saudi Arabia	144	2497	2
Argentina	127	4209	2
Thailand	102	5680	2
Ethiopia	77	523	2
Peoples R China	2558	38 931	3
Australia	1180	37312	3
Japan	1158	23 152	3
Iran	500	4059	3
New Zealand	242	6840	3
Taiwan-China	235	5351	3
Indonesia	130	1168	3
Malaysia	79	694	3
Singapore	76	1656	3
England	2415	101 628	4
Sweden	706	26 781	4
Norway	590	23 244	4
Denmark	427	13 663	4
Finland	406	12612	4
Scotland	302	14 932	4
Ireland	234	6289	4
Spain	507	16 342	5
Chile	157	6494	5
Colombia	97	1829	5

2010–2020

Country	Documents	Citations	Cluster
USA	**4668**	**103 742**	**1**
Turkey	844	6576	1
Italy	674	14 067	1
Germany	670	16 023	1
France	427	7894	1
Israel	398	7646	1
South Korea	302	3676	1
Poland	209	2677	1
Austria	188	5509	1
Greece	169	3800	1
Mexico	157	2052	1
Russia	146	773	1
Hungary	128	2589	1
Serbia	84	692	1
Portugal	82	1584	1
Romania	78	621	1
Czech Republic	62	1300	1
Canada	995	27215	2
India	828	6332	2
Brazil	550	7139	2
Pakistan	268	1585	2
Switzerland	267	7924	2
South Africa	229	2658	2
Egypt	199	1491	2
Nigeria	134	894	2
Saudi Arabia	119	1296	2
Argentina	91	1998	2
Ethiopia	75	497	2
Peoples R China	2380	30118	3
Australia	919	21 555	3
Japan	698	9837	3
Iran	449	3112	3
Taiwan-China	169	2573	3
Indonesia	112	448	3
Thailand	78	1252	3
Malaysia	65	437	3
Sweden	502	12 309	4
Norway	403	9937	4
Denmark	327	7668	4
Finland	233	5112	4
Scotland	188	5594	4
England	1631	48 400	5
New Zealand	190	4378	5
Ireland	179	4067	5
Spain	395	11832	6
Chile	111	3324	6
Colombia	77	952	6
Netherlands	802	20 006	7
Belgium	213	8346	7

2016–2020

Country	Documents	Citations	Cluster
Turkey	439	1813	1
Italy	351	5198	1
Germany	317	4630	1
France	252	2942	1
Poland	119	951	1
Russia	114	438	1
Mexico	92	584	1
Greece	77	2108	1
Serbia	52	375	1
Romania	51	375	1
Portugal	42	520	1

2020

Country	Documents	Citations	Cluster
England	191	580	1
India	116	186	1
Brazil	67	100	1
Pakistan	45	117	1
South Africa	36	60	1
Ethiopia	26	45	1
Nigeria	22	34	1
Thailand	14	32	1
Chile	13	98	1
Kenya	11	59	1
Tanzania	10	6	1

TABLE 3 (*Continued*)

2016–2020				2020			
Country	Documents	Citations	Cluster	Country	Documents	Citations	Cluster
India	570	2450	2	Netherlands	97	201	2
Canada	553	7412	2	Italy	73	162	2
Brazil	304	2272	2	France	62	166	2
Pakistan	215	579	2	Spain	57	271	2
Switzerland	152	2679	2	Poland	23	61	2
South Africa	145	1012	2	Belgium	16	31	2
Egypt	133	703	2	Greece	15	29	2
Nigeria	86	459	2	Colombia	14	24	2
Saudi Arabia	71	303	2	Serbia	14	46	2
Ethiopia	66	281	2	Slovenia	10	18	2
Argentina	46	489	2	**USA**	**592**	**1992**	**3**
Peoples R China	1664	13 982	3	Turkey	110	116	3
Australia	520	7002	3	Iran	58	92	3
Japan	361	2815	3	Israel	53	105	3
New Zealand	101	1268	3	Russia	33	39	3
Indonesia	98	258	3	Austria	23	77	3
Taiwan-China	94	660	3	Mexico	21	34	3
Thailand	54	442	3	Hungary	12	43	3
Malaysia	37	155	3	Sweden	63	219	4
Singapore	33	477	3	Denmark	40	131	4
USA	**2463**	**28 532**	**4**	Norway	38	137	4
Spain	240	5652	4	Finland	33	106	4
Israel	234	3036	4	Ireland	26	103	4
South Korea	162	1252	4	Scotland	25	107	4
Austria	105	1751	4	Peoples R China	483	1136	5
Chile	60	1206	4	Australia	137	410	5
Hungary	53	488	4	Indonesia	34	18	5
Colombia	40	295	4	Taiwan-China	26	57	5
Slovenia	32	278	4	New Zealand	14	34	5
England	880	15 283	5	Malaysia	13	22	5
Sweden	297	4629	5	Germany	73	142	6
Iran	277	1294	5	Egypt	28	38	6
Norway	202	3220	5	Saudi Arabia	28	63	6
Denmark	181	2565	5	Switzerland	26	67	6
Finland	135	1916	5	Portugal	9	23	6
Ireland	97	1356	5	Canada	124	363	7
Scotland	95	1389	5	Japan	73	126	7
Netherlands	397	4599	6	South Korea	36	50	7
Belgium	124	3257	6	Romania	11	20	

The countries were ranked according to the number of publications in each cluster. The bold fonts indicated the most productive countries.

underlined documents might trigger the interests of cardiologist more than obstetricians. The interested readers can explore more information depending on these software.

Research trends of preeclampsia in the two decades and recent cutting-edge knowledge

The summary of this section may indicate the evolution process and the present research hotspots.

The network of keyword co-occurrence analysis

The analysis of co-occurrence keywords produced a network of research themes. If the network was sorted chronologically, the evolution of keywords over time could be interpreted to trace the variation of research trends in the field of preeclampsia. The keywords in co-occurrence networks were retrieved by the occurrence frequencies and clustered according to co-occurrence relationship. Considering that the authors might optimize keywords with broad conception for possible inclusion, or employ the names of diseases as the keywords, which were useless to detect the research tendency, we deleted the overbroad keywords and names of diseases (the list can be seen in Supplementary Data 4, http://links.lww.com/HJH/B905). In the meanwhile, the retrieved aliases or different forms of abbreviation might share the identical meaning, we utilized one term to replace aliases or other variant spellings (Supplementary Data 5, http://links.lww.com/HJH/B906). The document type in this section was 'article'.

As shown in Fig. 14a and Table 16, the networks of keyword co-occurrence were sorted according to different timespan, respectively. The location of the keywords indicated the correlation with each other. In the overall two decades, the research topics could be divided into five clusters: Cluster 1: the cluster with the largest number of keywords. The keyword in central position with the highest frequencies of occurrences was 'placenta', indicating that this word didn't demonstrate tight link with other clusters. In this cluster, the aggregated keywords mainly depicted the early biological behaviours of trophoblast, aiming to explore the pathogenesis of this placenta-derived disease. Cluster 2: The theme of this cluster was about pregnancy

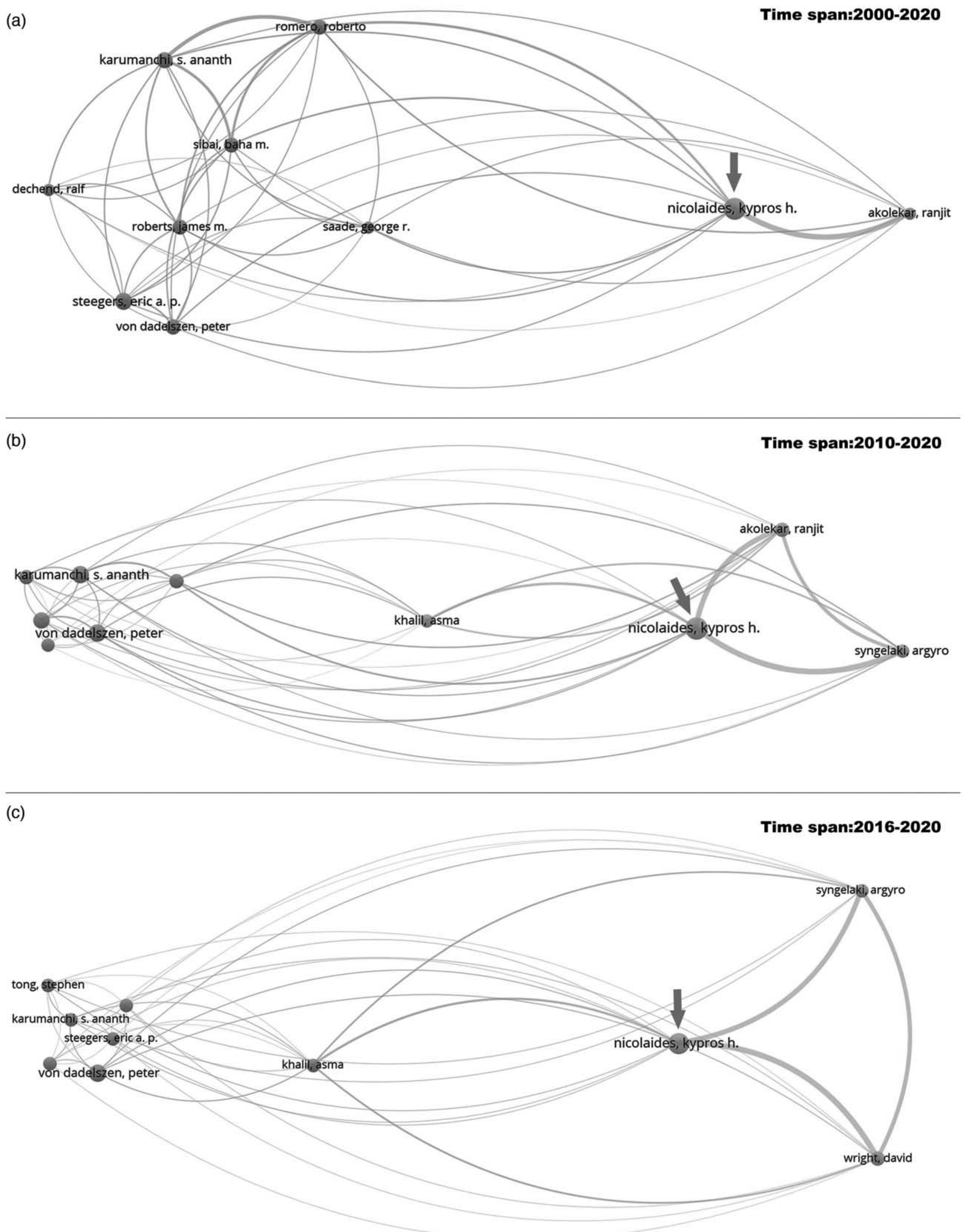

FIGURE 6 The arrows pointed to the most influential authors with the highest frequencies of citation in certain timespan.

TABLE 4. Top 10 authors with the highest frequencies of citation in different timespans

2000–2020				2010–2020			
Author	Documents	Citations	Cluster	Author	Documents	Citations	Cluster
Sibai, Baha M.	133	11233	1	Karumanchi, S. Ananth	108	5068	1
Karumanchi, S. Ananth	136	9838	1	Von Dadelszen, Peter	114	4835	1
Romero, Roberto	133	9410	1	Steegers, Eric A. P.	97	4467	1
Roberts, James M.	124	8306	1	Romero, Roberto	82	2575	1
Steegers, Eric A. P.	162	6653	1	Dechend, Ralf	73	1874	1
Von Dadelszen, Peter	127	5407	1	Sheiner, Eyal	67	958	1
Saade, George R.	83	4187	1	**Nicolaides, Kypros H.**	**191**	**7752**	**2**
Dechend, Ralf	84	2641	1	Syngelaki, Argyro	66	4156	2
Nicolaides, Kypros H.	**277**	**13975**	**2**	Akolekar, Ranjit	74	4097	2
Akolekar, Ranjit	84	4893	2	Khalil, Asma	66	1450	2
2016–2020				**2020s**			
Author	**Documents**	**Citations**	**Cluster**	**Author**	**Documents**	**Citations**	**Cluster**
Karumanchi, S. Ananth	43	1099	1	Khalil, Asma	14	47	1
Von Dadelszen, Peter	68	944	1	Thilaganathan, Basky	12	45	1
Khalil, Asma	44	735	1	Dechend, Ralf	11	44	1
Tong, Stephen	39	558	1	Von Dadelszen, Peter	13	35	2
Laivuori, Hannele	40	495	1	Li, Jing	10	22	2
Steegers, Eric A. P.	40	400	1	Moodley, Jagidesa	17	33	3
Moodley, Jagidesa	41	236	1	Naicker, Thajasvarie	15	23	3
Nicolaides, Kypros H.	**98**	**3286**	**2**	Chappell, Lucy C.	11	24	4
Wright, David	48	2398	2	Gissler, Mika	12	32	5
Syngelaki, Argyro	41	2292	2	**Nicolaides, Kypros H.**	**15**	**69**	**6**

The thesaurus list of authors also can be seen in Supplementary 3, http://links.lww.com/HJH/B904. The authors were ranked according to the number of citations in each cluster and the bold fonts indicated the most influential ones.

complications. The word ‘preterm’ with the most frequent occurrences located at the edge of the cluster and linked closely to the cluster 3 focusing on prenatal care. As one of the serious complications of preeclampsia, the problems of preterm might be relieved by improving the quality of prenatal care. Cluster 3: prediction and prevention. ‘Aspirin’ was the only drug displayed on the network, which did not possess a dominant position, indicating more research is still needed to verify the effectiveness. Cluster 4: the main components of this cluster were biomarkers bridging cluster 1 and cluster 3, in other words, original researches and clinical practices. Cluster 5: this cluster related to HELLP syndrome dismissed over time compared with the network in recent decade, partially because of the lack of ongoing researches depending on reliable experimental models. While referring to the network in the recent decade, the disappointing situation was that there was no prominent emergence of new themes. As to the network in recent 5 years, the cluster 3 and cluster 4 merged, indicating that the combined detection with ultrasonic Doppler indexes and serum biomarkers was the tendency, actually for lack of other effective options.

For more information, we explored the networks of keywords in documents published in top journals in categories mentioned above: ‘Obstetrics and Gynecology’, ‘Peripheral Vascular Disease’ and ‘Biochemistry Molecular Biology’, Fig. 14b-d and Table 17. In the category of ‘Obstetrics and Gynecology’, the result in two decades were quite similar to the result of all categories, whereas Cluster 1 and Cluster 2 were reversed, indicating the main focus on clinical practice in this category. In the recent 5 years, the preventive role of aspirin raised concern and generated the independent cluster 4 (Fig. 14b). In categories of ‘Peripheral Vascular Disease’ and ‘Biochemistry Molecular Biology’, the retrieved keywords were unique compared with the keywords in category of ‘Obstetrics and Gynecology’, which were listed in bold font in Table 17. These words might reveal the interdisciplinary distinction, or might be the consequence of insufficient intercommunication.

The keyword co-occurrence analysis displayed in timeline

Furthermore, we employed the CiteSpace to generate clusters of keywords under chronological order, with the document type of both ‘article’ and ‘review’. Considering the outcome of keywords co-occurrence analysis in recent decade was quite similar to the result in two decades, while the diversity of the first decade was obvious and interesting, we only included the images of clusters from 2000 to 2020 (Fig. 15a) and from 2000 to 2010 (Fig. 15b).

The crosses on the cluster lines represented the keywords, similar as nodes, and the links represented the interrelationship. All the crosses could be dragged to other places for the convenience of annotation and we noted most recent keywords to facilitate interpretation. The dotted portion of cluster lines indicated that the clustered keywords did not appear in this period, in another words, the theme research was interrupted or has not been initiated yet. It could be figured out that the majority of crosses located on the left side of the timeline, providing numerous connections with other keywords, indicating accumulation

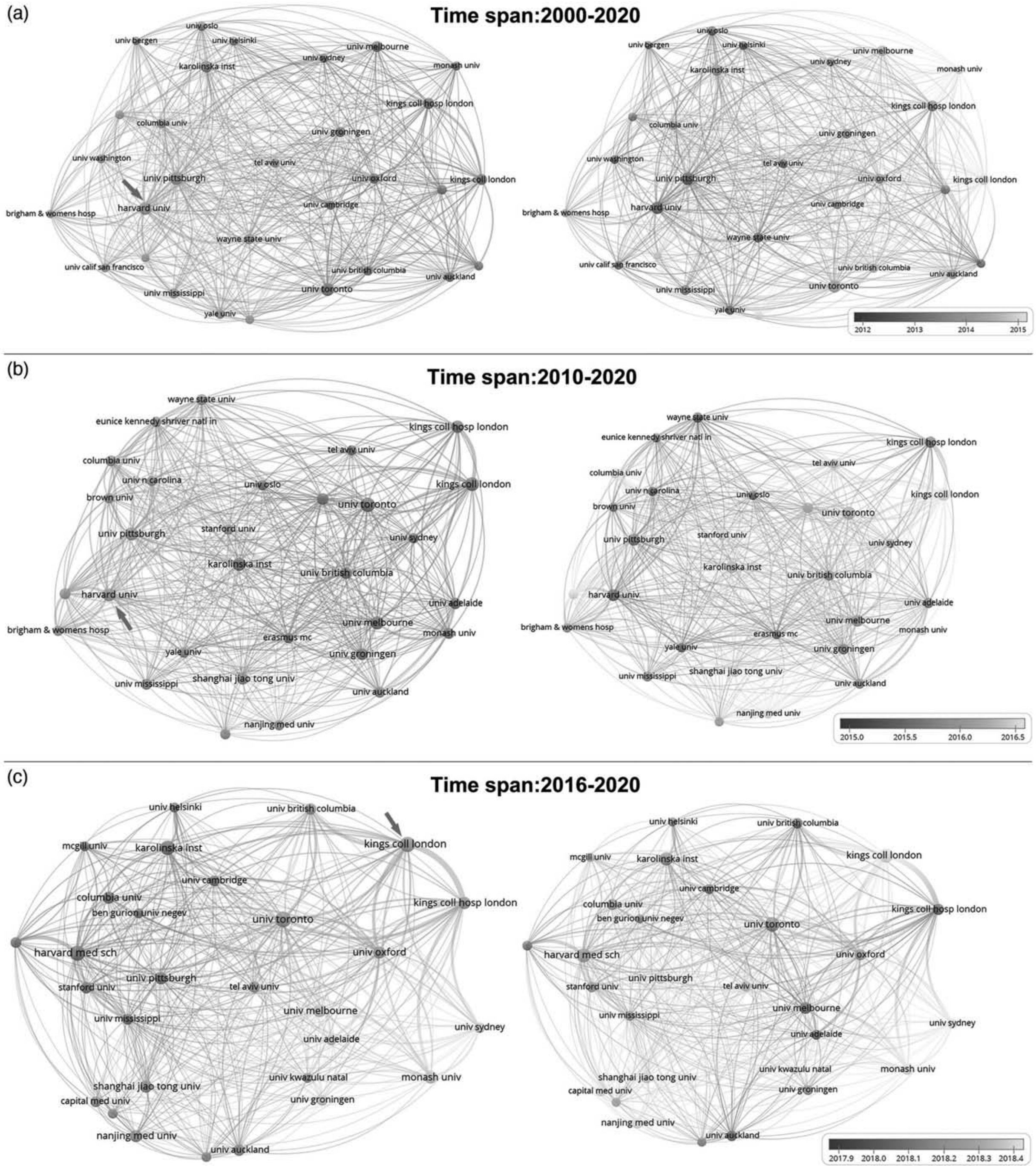

FIGURE 7 The arrows pointed to the most influential institutions with the highest frequencies of citation in certain timespan. The images on left showed the evolution based on time.

related to time. The comparison between clusters in different timespans could reveal the evolution of research direction in preeclampsia, with the influences from other relating disciplines.

Though the 'Cluster 0' in Fig. 15a and b shared the same topic, placenta, the content was quite different. In the first decade, the keywords in late period was placental growth factor, soluble endoglin, circulating angiogenic factor, VEGF (vascular endothelial growth factor) and so on, the biomarkers related to ischemic placenta or injured endothelia. Nowadays, the novel targets focused were cellular signal pathway, DNA methylation, microRNA, regulatory T cell, and so forth.

Nitric oxide (NO), the topic of 'Cluster 1', is a strong vasorelaxant and anticoagulant factor. The dotted line latterly indicates the interruption of researches, for the described adverse effects during supplementation of NO donors [19]. The similar situation happened to the researches of thrombophilia (cluster 2, Fig. 15b). Application of antithrombotic drugs did not alleviate the situation

TABLE 5. Top 30 institutions with the highest frequencies of citation in different timespans

2000–2020				2010–2020			
Organization	Documents	Citations	Cluster	Organization	Documents	Citations	Cluster
University of Toronto	361	15 708	1	King's College London	251	8508	1
University of Oxford	254	14 058	1	University of British Columbia	181	7874	1
King's College Hospital London	279	13 373	1	King's College Hospital london	208	7639	1
University of Cambridge	180	11194	1	University of Oxford	190	7496	1
King's College London	282	10 204	1	University of Toronto	284	7072	1
University of British Columbia	210	9958	1	Erasmus MC	141	6223	1
University of Adelaide	217	8056	1	Karolinska Institutet	227	5664	1
University of Manchester	190	7528	1	University of Adelaide	163	5176	1
University of Melbourne	261	6096	1	University of Melbourne	230	4980	1
University of Groningen	233	6000	1	University of Oslo	149	3925	1
University of Sydney	192	5812	1	University of Groningen	179	3688	1
University of Auckland	207	5508	1	University of Sydney	141	2917	1
Monash University	188	3400	1	Tel Aviv University	146	2865	1
Harvard University	**370**	**27 393**	**2**	Monash University	161	2509	1
University of Pittsburgh	374	18 708	2	**Harvard University**	**245**	**10445**	**2**
Wayne State University	237	14 024	2	University of Pittsburgh	227	5815	2
Yale University	218	9491	2	Wayne State University	167	5186	2
Columbia University	227	9261	2	NIH Eunice Kennedy Shriver National Institute of Child Health & Human Development (NICHD)	143	5155	2
University of California San Francisco	180	9040	2	Brown University	136	4414	2
University of Mississippi	233	8492	2	Brigham & Women's Hospital	144	4390	2
University of North Carolina	195	7968	2	Columbia University	173	4163	2
Tel Aviv University	214	7855	2	Stanford University	144	3553	2
Brigham & Women's Hospital	172	6663	2	University of North Carolina	145	3338	2
University of Washington	201	6358	2	Harvard Medical School	163	2675	2
Stanford University	174	5790	2	Yale University	142	5044	3
Shanghai Jiao Tong University	182	3177	2	University of Mississippi	173	4507	3
Karolinska Institutet	299	13 242	3	University of Auckland	170	3741	3
University of Oslo	214	8474	3	Shanghai Jiao Tong University	179	3142	3
University of Bergen	172	7828	3	Nanjing Medical University	153	3141	3
University of Helsinki	202	6693	3	Huazhong University of Science & Technology	138	1305	3

2016–2020				2020			
Organization	Documents	Citations	Cluster	Organization	Documents	Citations	Cluster
Harvard Medical School	163	2675	1	Shanghai Jiao Tong University	28	99	1
Karolinska Institutet	146	2263	1	Nanjing Medical University	32	93	1
University of Cambridge	86	2023	1	China medical university	18	72	1
Stanford University	94	1611	1	Tel Aviv University	26	51	1
Columbia University	115	1584	1	Capital Medical University	25	49	1
Brigham & Women's Hospital	79	1500	1	Zhejiang University	18	37	1
University of Mississippi	88	1440	1	Qingdao University	20	21	1
University of Pittsburgh	107	1272	1	Karolinska Institutet	35	104	2
University of Helsinki	77	986	1	Monash University	30	76	2
McGill University	76	825	1	St Georges University London	18	63	2
Ben Gurion University	76	675	1	University of California San Francisco	19	53	2
King's College London	**167**	**3028**	**2**	University of Groningen	18	36	2
University of Toronto	181	2990	2	King's College London	46	131	3
King's College Hospital london	108	2954	2	University of Oxford	27	96	3
University of Oxford	115	2361	2	Lund University	18	66	3
University of British Columbia	99	1215	2	University of British Columbia	21	65	3
Tel Aviv University	95	886	2	University of Toronto	35	146	4
University of Kwazulu Natal	77	424	2	Harvard Medical School	35	100	4
Nanjing Medical University	105	1339	3	University of Mississippi	25	72	4
University of Auckland	94	1222	3	McGill University	19	45	4
Shanghai Jiao Tong University	114	1180	3	**Columbia University**	**29**	**173**	**5**
Fudan University	77	665	3	University of Pittsburgh	29	102	5
Huazhong University of Science & Technology	78	559	3	University of Pennsylvania	22	63	5
Capital Medical University	81	347	3	Southern Medical University	21	56	5

TABLE 5 (*Continued*)

2016–2020				2020			
Organization	Documents	Citations	Cluster	Organization	Documents	Citations	Cluster
University of Melbourne	125	2114	4	Shandong University	19	60	6
Monash University	118	1251	4	University of Sydney	25	47	6
University of Adelaide	84	1159	4	Fudan University	18	26	6
University of Sydney	81	834	4	Huazhong University of Science & Technology	22	35	7
University of Groningen	82	699	4	Stanford University	22	79	8
				University of Helsinki	18	65	9
				University of Kwazulu Natal	25	40	10
				University of Melbourne	23	57	11

of disease actually, though the original researches reported the expecting effects [20]. After the ACOG's hypertension 2013 task force [1] revising the definition of preeclampsia, to include the presence of severe features with or without proteinuria and to exclude degree of proteinuria as a criterion of severe features, the cluster 4, proteinuria, (Fig. 15a), remained the dotted line. The 'gestational diabetes mellitus' cluster and Obesity' cluster depicted the correlated high risks of preeclampsia and the protective therapeutics.

The detection of keyword burst

Burst detection of keyword is a computational technique that has been used to identify abrupt emerging trends or research frontier topics according to citation frequency. Keywords with strong values in 'Strength' column tend to be significantly active research area [6]. The output of burst detection in the recent decade was shown in Table 18. The time span of keywords with the burst detected were distinguished by different grayscale in the column for better visualization. 'Meta-analysis' was the active area lasting for recent five years and the 'migration' of trophoblast, with the strongest strength value, was the core issue of preeclampsia pathogenesis.

DISCUSSION

The main purpose of this research is to describe the landscape of previous science map in the recent two decades, consisting of the intellectual contributions, major components and potential trends, as a reference for present decision-making in the field of preeclampsia. As a matter of fact, depicting the preexisting academic accumulation was not a complicated work while predicting a convincing trend was not always easy. According to the novel keywords appeared recently, it could be figured out that the combination of basic medicines and clinical medicines was tighter in recent decade and the translational medicines were vital to assist clinical practice, as the development of genomics and proteomics. Meanwhile, computer-assisted machine deep learning and medical big data research were prompting to predict the disease in early stage. However, the quantitative bibliometric analysis is a secondary use of the bibliographic databases and the major purpose of bibliometric exercises is transforming something intangible into a manageable entity. The pronouncements will be doubtful if the bibliometric methods are used for any predictions about the research program in long-term as the societal impact of a research program cannot be captured by its quantitative nature [21].

It is important to recognize the limitation of bibliometric indicators, Take the metric of citation frequency as an example, documents are cited for multiple reasons, such as negative citation of disputing results or theories. There is no perfect method to evaluate the research quality, so does the bibliometric analysis, biases should be taken into consideration whenever using these assessments. The combined application of different bibliometric tools and indicators, as well as the integration of other nonmeasurable characteristics, like peer review, should be recommended to provide an accurate depiction of research status [22]. Meanwhile, our datasets are solely from the database of WOSCC, with the original purpose of selecting high-quality publications, which may also omit important information.

It is worth noting that the flourish publications we depicted may still not properly address the clinical dilemma with burden, especially in developing countries. The researchers from developed countries may neglect the fact that, there is even no word for 'preeclampsia' in local languages in low-income countries and unawareness of this disease prevents the clinical practitioners from observing and reporting [23]. It is indisputable that academics from developing countries are still numerically underrepresented as authors and editorial board members in scientific journals [24]. Insufficient English language education and scientific research training, as well as lacking of financial support, these are all insurmountable obstacles to restrain academics from being an author, let alone an editorial board member, which indicates the recognition as a specialty expert. It can be figure out that the contribution of the editorial board, author-editorial cooperation demonstrate a strong positive effect on the author's publications [25,26]. Despite the proportion of editorial board members from developing countries has improved over time, opportunities likely exist to improve further.

Though this research was expected to be a references for future research decision, there is concern about the false boom in medical research nowadays. It was revealed that an increase in the number of publications, while the number of studies from high-impact journals remained stable. Low-quality studies may exacerbate uncertainties

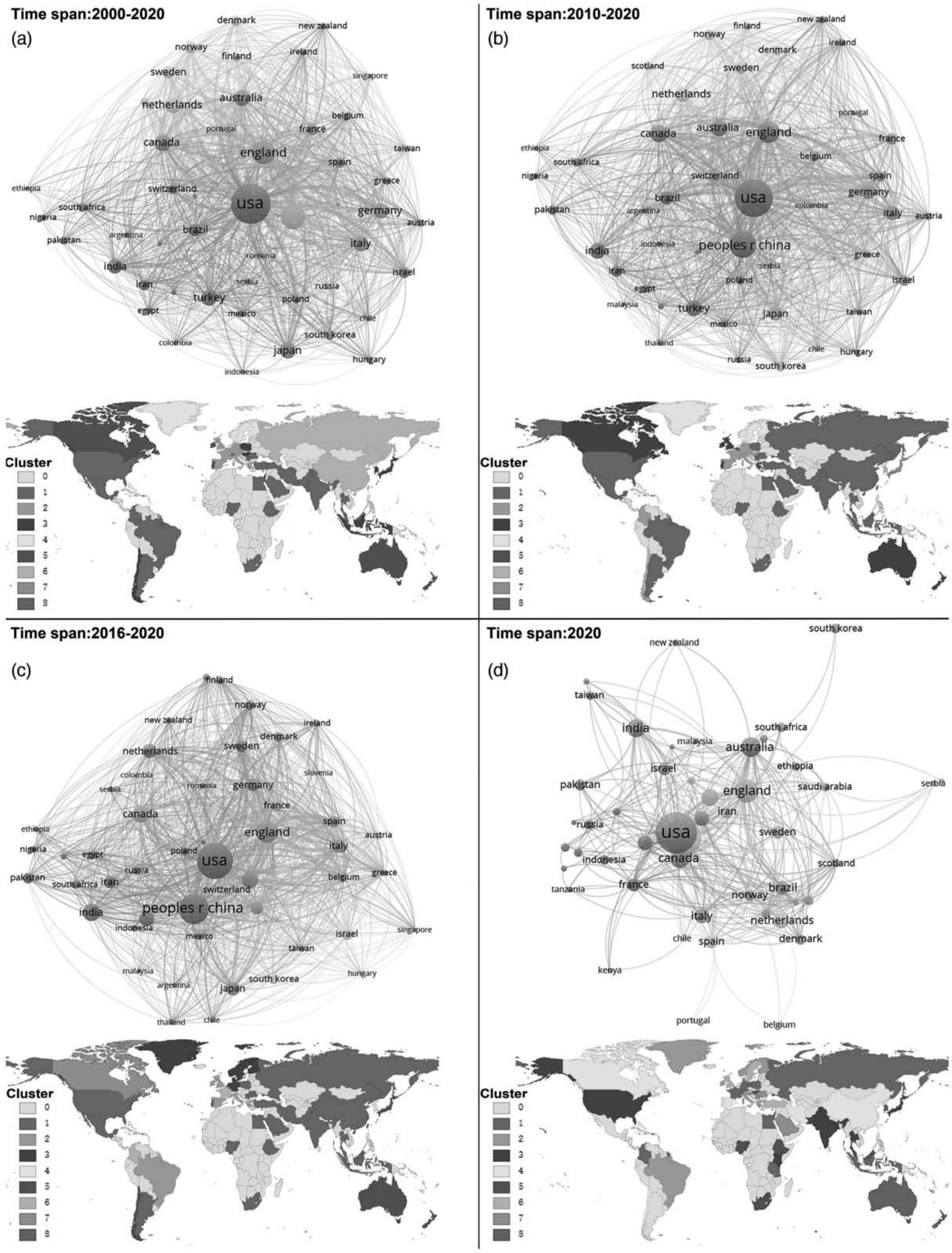

FIGURE 8 One greyscale represented one cluster both in the networks and on the maps according to the legend.

and cause pollution within the scientific literatures, rather than adding value and ensuring progress. Unreliable clinical research has consequences for clinical decision-making, wasting clinical resources and having negative impacts on patients' health. Clinicians should critically appraise research articles to avoid making misguided medical decisions. Future research goals should aim to enhance the quality of published literatures, being aware of the improvement of gestation and long-term health outcomes [7].

TABLE 6. Top 50 countries with the highest frequencies of citation in different timespans

2000–2020				2010–2020			
Country	Documents	Citations	Cluster	Country	Documents	Citations	Cluster
USA	**6706**	**233432**	**1**	**USA**	**4668**	**103 742**	**1**
Switzerland	416	15 280	1	Peoples R China	2380	30118	1
Turkey	1139	13 486	1	Brazil	550	7139	1
Brazil	656	10910	1	Turkey	844	6576	1
India	922	9125	1	India	828	6332	1
South Africa	339	6689	1	Iran	449	3112	1
Thailand	102	5680	1	Poland	209	2677	1
Argentina	127	4209	1	South Africa	229	2658	1
Iran	500	4059	1	Mexico	157	2052	1
Mexico	214	3779	1	Argentina	91	1998	1
Egypt	235	3263	1	Pakistan	268	1585	1
Saudi Arabia	144	2497	1	Egypt	199	1491	1
Pakistan	283	1992	1	Saudi Arabia	119	1296	1
Colombia	97	1829	1	Thailand	78	1252	1
Nigeria	171	1483	1	Nigeria	134	894	1
Serbia	94	836	1	Russia	146	773	1
Malaysia	79	694	1	Serbia	84	692	1
Romania	84	671	1	Romania	78	621	1
Ethiopia	77	523	1	Ethiopia	75	497	1
England	2415	101 628	2	Indonesia	112	448	1
Germany	1085	33 591	2	Malaysia	65	437	1
Italy	1038	27 122	2	Germany	670	16 023	2
Spain	507	16 342	2	Italy	674	14 067	2
France	601	16157	2	Spain	395	11832	2
Belgium	273	11 775	2	Switzerland	267	7924	2
Austria	280	8718	2	France	427	7894	2
Greece	258	5944	2	Israel	398	7646	2
Singapore	76	1656	2	Austria	188	5509	2
Czech Republic	80	1599	2	Hungary	128	2589	2
Japan	1158	23 152	3	Czech Republic	62	1300	2
Israel	587	18 327	3	Colombia	77	952	2
South Korea	400	6998	3	England	1631	48 400	3
Chile	157	6494	3	Canada	995	27215	3
Hungary	206	4875	3	Australia	919	21 555	3
Poland	302	4825	3	New Zealand	190	4378	3
Indonesia	130	1168	3	Ireland	179	4067	3
Netherlands	1164	33 164	4	Portugal	82	1584	3
Sweden	706	26 781	4	Netherlands	802	20 006	4
Norway	590	23 244	4	Sweden	502	12 309	4
Scotland	302	14 932	4	Norway	403	9937	4
Denmark	427	13 663	4	Denmark	327	7668	4
Finland	406	12612	4	Scotland	188	5594	4
Canada	1294	50 446	5	Finland	233	5112	4
Australia	1180	37312	5	Belgium	213	8346	5
New Zealand	242	6840	5	Greece	169	3800	5
Ireland	234	6289	5	Taiwan-China	169	2573	5
Portugal	106	2387	5	South Korea	302	3676	6
Peoples R China	2558	38 931	6	Chile	111	3324	6
Taiwan-China	235	5351	6	Japan	698	9837	7
Russia	163	1160	6				

2016–2020				2020			
Country	Documents	Citations	Cluster	Country	Documents	Citations	Cluster
USA	**2463**	**28 532**	**1**	France	62	166	1
Peoples R China	1664	13 982	1	Germany	73	142	1
India	570	2450	1	Switzerland	26	67	1
Turkey	439	1813	1	Poland	23	61	1
Iran	277	1294	1	Russia	33	39	1
South Africa	145	1012	1	Egypt	28	38	1
Poland	119	951	1	Colombia	14	24	1
Egypt	133	703	1	Indonesia	34	18	1
Mexico	92	584	1	Slovenia	10	18	1
Pakistan	215	579	1	Tanzania	10	6	1
Portugal	42	520	1	Italy	73	162	2

TABLE 6 (*Continued*)

2016–2020				2020			
Country	Documents	Citations	Cluster	Country	Documents	Citations	Cluster
Argentina	46	489	1	Norway	38	137	2
Nigeria	86	459	1	Denmark	40	131	2
Thailand	54	442	1	Scotland	25	107	2
Russia	114	438	1	Finland	33	106	2
Romania	51	375	1	Ireland	26	103	2
Serbia	52	375	1	Brazil	67	100	2
Saudi Arabia	71	303	1	Greece	15	29	2
Ethiopia	66	281	1	**USA**	**592**	**1992**	**3**
Indonesia	98	258	1	Canada	124	363	3
Malaysia	37	155	1	India	116	186	3
England	880	15 283	2	Japan	73	126	3
Spain	240	5652	2	Pakistan	45	117	3
Italy	351	5198	2	Kenya	11	59	3
Belgium	124	3257	2	Taiwan-China	26	57	3
Brazil	304	2272	2	Thailand	14	32	3
Greece	77	2108	2	Peoples R China	483	1136	4
Ireland	97	1356	2	Spain	57	271	4
Taiwan-China	94	660	2	Netherlands	97	201	4
Singapore	33	477	2	Chile	13	98	4
Germany	317	4630	3	Iran	58	92	4
Sweden	297	4629	3	Belgium	16	31	4
Netherlands	397	4599	3	Portugal	9	23	4
Norway	202	3220	3	Israel	53	105	5
Denmark	181	2565	3	South Africa	36	60	5
Finland	135	1916	3	Ethiopia	26	45	5
Scotland	95	1389	3	Hungary	12	43	5
Israel	234	3036	4	Nigeria	22	34	5
Switzerland	152	2679	4	Malaysia	13	22	5
Austria	105	1751	4	England	191	580	6
South Korea	162	1252	4	Sweden	63	219	6
Hungary	53	488	4	Turkey	110	116	6
Slovenia	32	278	4	Austria	23	77	6
Australia	520	7002	5	Saudi Arabia	28	63	7
Japan	361	2815	5	Serbia	14	46	7
New Zealand	101	1268	5	Romania	11	20	7
Chile	60	1206	5	Australia	137	410	8
France	252	2942	6	South Korea	36	50	8
Colombia	40	295	6	New Zealand	14	34	8
Canada	553	7412	7	Mexico	21	34	

The bold fonts indicated the most influential countries.

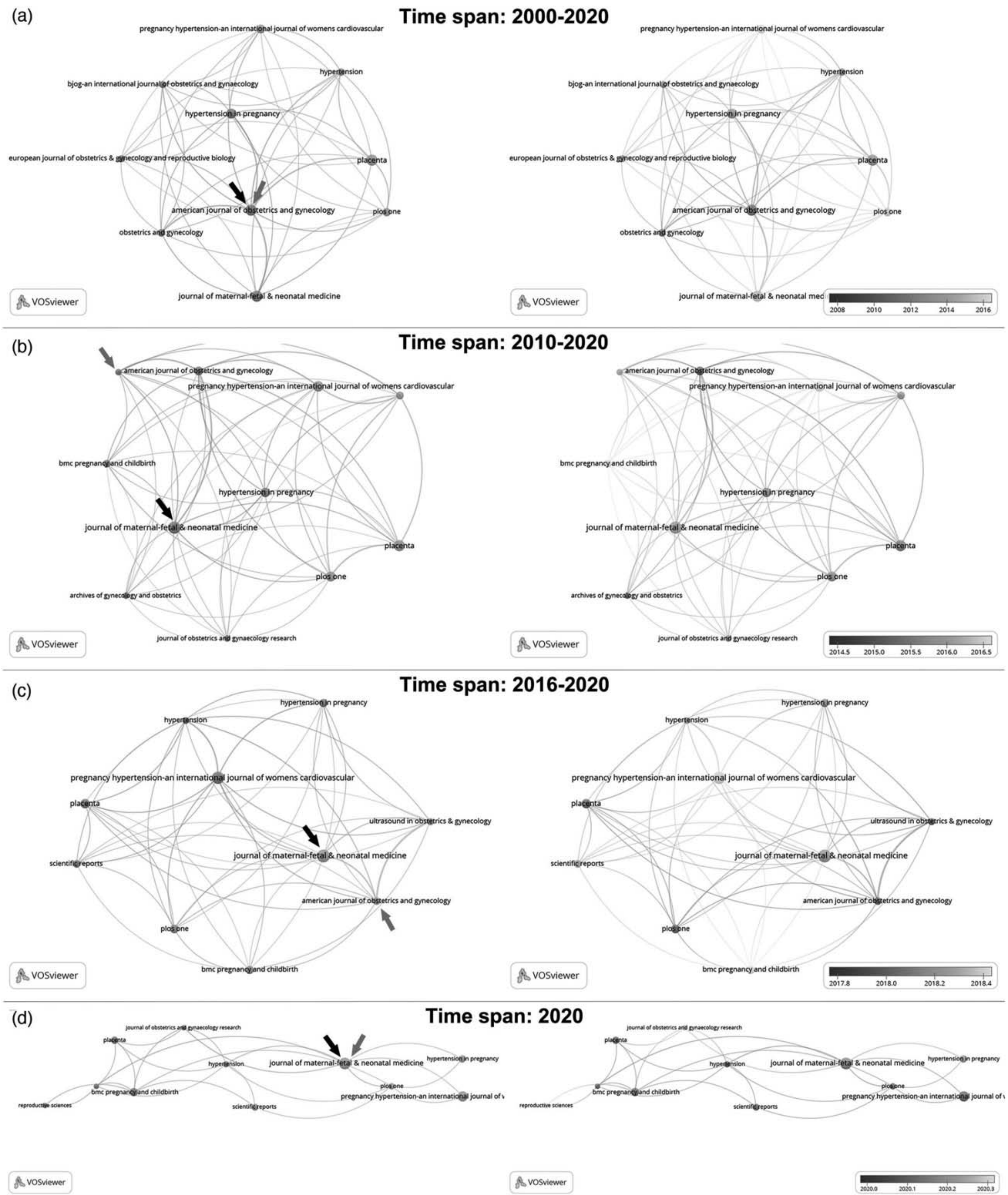

FIGURE 9 The grey arrows pointed to the most influential journals with the highest frequencies of citation while the black arrows pointed to the most productive journals with the largest number of publications.

TABLE 7. Top 10 journals with the highest frequencies of citation in different timespans

2000–2020			
Source	**Documents**	**Citations**	**Cluster**
American Journal of Obstetrics And Gynecology	**945**	**46250**	**1**
Obstetrics And Gynecology	479	27 262	1
BJOG-An International Journal of Obstetrics And Gynaecology	384	14 967	1
Hypertension In Pregnancy	727	11037	1
Journal of Maternal-Fetal & Neonatal Medicine	893	9909	1
European Journal of Obstetrics & Gynecology and Reproductive Biology	357	6075	1
Placenta	930	29 553	2
Hypertension	461	23 826	2
Plos One	551	13 252	2
Pregnancy Hypertension-An International Journal of Women's Cardiovascular	589	3938	2
2010–2020			
Source	**Documents**	**Citations**	**Cluster**
American Journal of Obstetrics and Gynecology	**422**	**14464**	**1**
Journal of Maternal-Fetal & Neonatal Medicine	807	7546	1
Ultrasound In Obstetrics & Gynecology	242	6438	1
BMC Pregnancy and Childbirth	334	4828	1
Hypertension In Pregnancy	465	4164	1
Archives of Gynecology and Obstetrics	242	2884	1
Journal of Obstetrics and Gynaecology Research	245	2565	1
Placenta	634	13 546	2
Hypertension	328	12 932	2
Plos One	540	12812	2
Pregnancy Hypertension-An International Journal of Women's Cardiovascular	589	3975	2
2016–2020			
Source	**Documents**	**Citations**	**Cluster**
Hypertension	164	3234	1
Placenta	281	3202	1
Pregnancy Hypertension-An International Journal of Women's Cardiovascular	456	2507	1
Scientific Reports	170	1794	1
Hypertension In Pregnancy	214	1146	1
American Journal of Obstetrics and Gynecology	**168**	**4138**	**2**
Ultrasound In Obstetrics & Gynecology	145	2769	2
Journal of Maternal-Fetal & Neonatal Medicine	483	2590	2
Plos One	235	2425	3
BMC Pregnancy and Childbirth	220	1731	3
2020			
Source	**Documents**	**Citations**	**Cluster**
American Journal of Obstetrics and Gynecology	31	178	1
BMC Pregnancy and Childbirth	71	112	1
Placenta	53	112	1
Reproductive Sciences	31	48	1
Journal of Obstetrics and Gynaecology Research	32	44	1
Journal of Maternal-Fetal & Neonatal Medicine	**136**	**282**	**2**
Pregnancy Hypertension-An International Journal of Women's Cardiovascular	109	186	2
Plos One	43	67	2
Hypertension In Pregnancy	56	51	2
Hypertension	42	181	3
Scientific Reports	46	72	3

The bold fonts indicated the most influential journals.

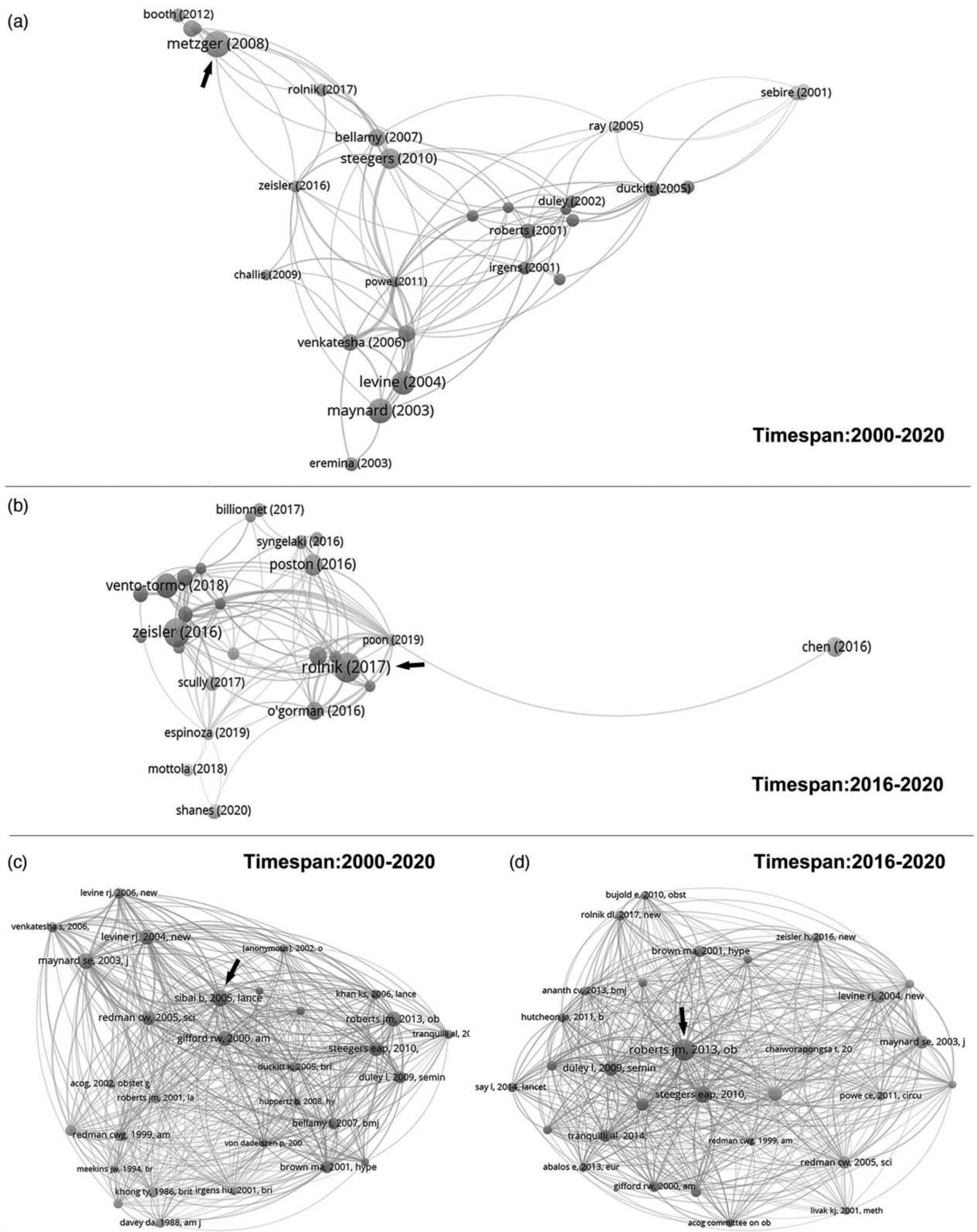

FIGURE 10 (a and b) Coupling network of documents. The documents were displayed as the first author and the published year. The black arrows pointed to the most influential documents with the largest number of citations. (c) and (d) Co-citation relationship of documents. The items only displayed the first 20 characters for concise graphic data-showing.

TABLE 8. Coupling analysis of top 30 documents from 2000 to 2020

Document	Title	Source	Citations	Cluster
Duckitt (2005)	Risk factors for preeclampsia at antenatal booking: systematic review of controlled studies	*British Medical Journal* 330(7491), 565-567	967	1
Roberts (2001)	Pathogenesis and genetics of preeclampsia	*Lancet,*357(9249), 53-56	921	1
Duley (2002)	Do women with preeclampsia, and their babies, benefit from magnesium sulphate? The magpie trial: a randomised placebo-controlled	Lancer 359(9321), 1877-1890	780	1
Jackson (2004)	Perinatal outcomes in singletons following in vitro fertilization: a meta-analysis	*Obstetrics and Gynecology,*103(3), 551 -563	777	1
Irgens (2001)	Long term mortality of mothers and fathers after preeclampsia: population based cohort study	*British Medical Journal,*3237323), 1213-1216	765	1
Hiby (2004)	Combinations of maternal KIR and fetal HLA-C genes influence the risk of preeclampsia and reproductive success	*Journal of Experimental Medicine,*200(8), 957-965	742	1
Smith (2001)	Pregnancy complications and maternal risk of ischaemic heart disease: a retrospective cohort study of 129,290 births	*Lancet,*357(9273), 2002-2006	673	1
Jauniaux (2000)	Onset of maternal arterial blood flow and placental oxidative stress-a possible factor in human early pregnancy failure	*American Journal of Pathology,*157(6), 2111 -2122	665	1
Askie (2007)	Antiplatelet agents for prevention of preeclampsia: a meta-analysis of individual patient data	*Lancet,*369(9575), 1791-1798	576	1
Anonymous (2002)	Diagnosis and management of preeclampsia and eclampsia	*Obstetrics and Gynecology,*99(1), 159-166	543	1
Metzger (2008)	**Hyperglycemia and adverse pregnancy outcomes**	***New England Journal of Medicine,*358(19), 1991 -2002**	**3015**	**2**
Steegers (2010)	Preeclampsia	*Lancet,*376(9741), 631-644	1801	2
Bellamy (2007)	Preeclampsia and risk of cardiovascular disease and cancer in later life: systematic review and meta-analysis	*BMJ-British Medical Journal,*335(7627), 974-977	1459	2
Landon (2009)	A multicenter, randomized trial of treatment for mild gestational diabetes.	*New England Journal of Medicine,*361(14), 1339-1348	1206	2
Booth (2012)	Lack of exercise is a major cause of chronic diseases	*Comprehensive Physiology,*2(2), 1143–1211	868	2
Rolnik (2017)	Aspirin versus placebo in pregnancies at high risk for preterm preeclampsia	*New England Journal of Medicine,*377(7), 613-622	686	2
Zeisler (2016)	Predictive value of the sfit-1:PLGF ratio in women with suspected preeclampsia	*New England Journal of Medicine,*374(1), 13-22	607	2
Catalano (2012)	The hyperglycemia and adverse pregnancy outcome study associations of GDM and obesity with pregnancy outcomes	*Diabetes Care,*35(4), 780-786	535	2
Maynard (2003)	Excess placental soluble fms-like tyrosine kinase 1(sflt-1) may contribute to endothelial dysfunction, hypertension and proteinuria in preeclampsia	*Journal of Clinical Investigation,*111(5), 649-658	2651	3
Levine (2004)	Circulating angiogenic factors and the risk of preeclampsia	*New England Journal of Medicine,*350(7), 672-683	2356	3
Venkatesha (2006)	Soluble endoglin contributes to the pathogenesis of preeclampsia	*Nature Medicine,*12(6), 642-649	1234	3
Levine (2006)	Soluble endoglin and other circulating antiangiogenic factors in preeclampsia	*New England Journal of Medicine,*355(10), 992-1005	1232	3
Eremina (2003)	Glomerular-specific alterations of VEGF-a expression lead to distinct congenital and acquired renal diseases	*Journal of Clinical Investigation,*111(5), 707-716	897	3
Powe (2011)	Preeclampsia, a disease of the maternal endothelium the role of antiangiogenic factors and implications for later cardiovascular disease	*Circulation,*123(24), 2856-2869	574	3
Sebire (2001)	Maternal obesity and pregnancy outcome: a study of 287 213 pregnancies in London	*International Journal of Obesity,*25(8), 1175-1182	1026	4
Cedergren (2004)	Maternal morbid obesity and the risk of adverse pregnancy outcome	*Obstetrics and Gynecology,*103(2), 219-224	781	4
Weiss (2004)	Obesity, obstetric complications and cesarean delivery rate-a populationbased screening study	*American Journal of Obstetrics and Gynecology,*190(4), 1091-1097	553	4
Ray (2005)	Cardiovascular health after maternal placental syndromes (champs): population-based retrospective cohort study	*Lancet,*366(9499), 1797-1803	590	4
Challis (2009)	Inflammation and pregnancy	*Reproductive Sciences,*16(2), 206-215	546	5
Dragovic (2011)	Sizing and phenotyping of cellular vesicles using nanoparticle tracking analysis	*Nanomedicine-Nanotechnology Biology and Medicine,*7(6), 780-788	692	6

The bold fonts indicated the reference with the most citations.

TABLE 9. Coupling analysis of top 30 documents from 2016 to 2020

Document	Title	Source	Citations	Cluster
Vento-Tormo (2018)	Single-cell reconstruction of the early maternal-fetal interface in humans	*Nature,* 563(7731), 347	468	1
De Goffau (2019)	Human placenta has no microbiome but can contain potential pathogens	*Nature,* 572(7769), 329	214	1
Harmon (2016)	The role of inflammation in the pathology of preeclampsia	*Clinical Science,* 130(6), 409-419	190	1
Rana (2019)	Preeclampsia pathophysiology, challenges, and perspectives	*Circulation Research,* 124(7), 1094-1112	195	1
Ilekis (2016)	Placental origins of adverse pregnancy outcomes: potential molecular targets: an executive workshop summary of the Eunice Kennedy Shriver National Institute of Child Health and Human Development	*American Journal of Obstetrics and Gynecology,* 215(1), S1-S46	117	1
Brownfoot (2016)	Metformin as a prevention and treatment for preeclampsia: effects on soluble fms-like tyrosine kinase 1 and soluble endoglin secretion and endothelial dysfunction	*American Journal of Obstetrics and Gynecology,* 214(3)	111	1
Poston (2016)	Preconceptional and maternal obesity: epidemiology and health consequences	*Lancet Diabetes & Endocrinology,* 4(12), 1025-1036	331	2
Syngelaki (2016)	Metformin versus placebo in obese pregnant women without diabetes mellitus	*New England Journal of Medicine,* 374(5), 434-443	152	2
Billionnet (2017)	Gestational diabetes and adverse perinatal outcomes from 716,152 births in France in 2012	*Diabetologia,* 60(4), 636-644	144	2
Voerman (2019)	Association of gestational weight gain with adverse maternal and infant outcomes	*JAMA-Joumal of The American Medical Association,* 321 (17), 1702-1715	120	2
Salomon (201 6)	Gestational diabetes mellitus is associated with changes in the concentration and bioactivity of placenta-derived exosomes in maternal circulation across gestation	*Diabetes,* 65(3), 598-609	117	2
Rolnik (2017)	**Aspirin versus placebo in pregnancies at high risk for preterm preeclampsia**	***New England Journal of Medicine,* 377(7), 613-622**	**689**	**3**
Bartsch (2016)	Clinical risk factors for preeclampsia determined in early pregnancy: systematic review and meta-analysis of large cohort studies	*BMJ-British Medical Journal,* 353	274	3
O'gorman (2016)	Competing risks model in screening for preeclampsia by maternal factors and biomarkers at 11 – 13 weeks gestation	*American Journal of Obstetrics and Gynecology,* 214(1)	253	3
O'gorman (2017b)	Accuracy of competing-risks model in screening for preeclampsia by maternal factors and biomarkers at 11 – 13 weeks' gestation	*Ultrasound In Obstetrics & Gynecology,* 49(6), 751-755	133	3
O'gorman (2017a)	Accuracy of competing-risks model in screening for preeclampsia by maternal factors and biomarkers at 11 – 13 weeks' gestation	*Ultrasound In Obstetrics & Gynecology,* 49(6), 751-755	112	3
Shanes (2020)	Placental pathology in COVID-19	*American Journal of Clinical Pathology,* 154(1), 23-32	176	4
Hosier (2020)	SARS-COV-2 infection of the placenta	*Journal of Clinical Investigation,* 130(9), 4947-4953	132	4
Espinoza (201 9)	Gestational hypertension and preeclampsia	*Obstetrics and Gynecology,* 133(1), El–E25	128	4
Mottola (201 8)	2019 Canadian guideline for physical activity throughout pregnancy	*British Journal of Sports Medicine,* 52(21), 1339–1346	127	4
Zeisler (2016)	Predictive value of the sflt-1: PLGF ratio in women with suspected preeclampsia	*New England Journal of Medicine,* 374(1), 13-22	616	5
Zhang (2017)	Genetic associations with gestational duration and spontaneous preterm birth	*New England Journal of Medicine,* 377(12), 1156-1 167	135	5
Thadhani (2016)	Removal of soluble fms-like tyrosine kinase-1 by dextran sulfate apheresis in preeclampsia	*Journal of the American Society of Nephrology,* 27(3), 903-913	133	5
Chen (2016)	Fresh versus frozen embryos for infertility in the polycystic ovary syndrome	*New England Journal of Medicine,* 375(6), 523-533	297	6
Poon (2019)	The international federation of gynecology and obstetrics(FIGO) initiative on preeclampsia: a pragmatic guide for first-trimester screening and prevention	*International Journal of Gynecology & Obstetrics,* 145, 1–33	118	6
Wei (2019)	Frozen versus fresh single blastocyst transfer in ovulatory women: a multicentre, randomised controlled trial	*Lancet,* 393(10178), 1310–1318	118	6
Scully (2017)	Consensus on the standardization of terminology in thrombotic thrombocytopenic purpura and related thrombotic microangiopathies	*Journal of Thrombosis and Haemostasis,* 15(2), 312-322	175	7
Schreiber (2018)	Antiphospholipid syndrome	*Nature Reviews Disease Primers,* 4	130	7
Gomez-Arango (2016)	Increased systolic and diastolic blood pressure is associated with altered gut microbiota composition and butyrate production in early pregnancy	*Hypertension,* 68(4), 974-981	139	8
Ananth (2017)	Confounding, causality, and confusion: the role of intermediate variables in interpreting observational studies in obstetrics	*American Journal of Obstetrics and Gynecology,* 217(2), 167-175	115	9

The bold fonts indicated the reference with the most citations.

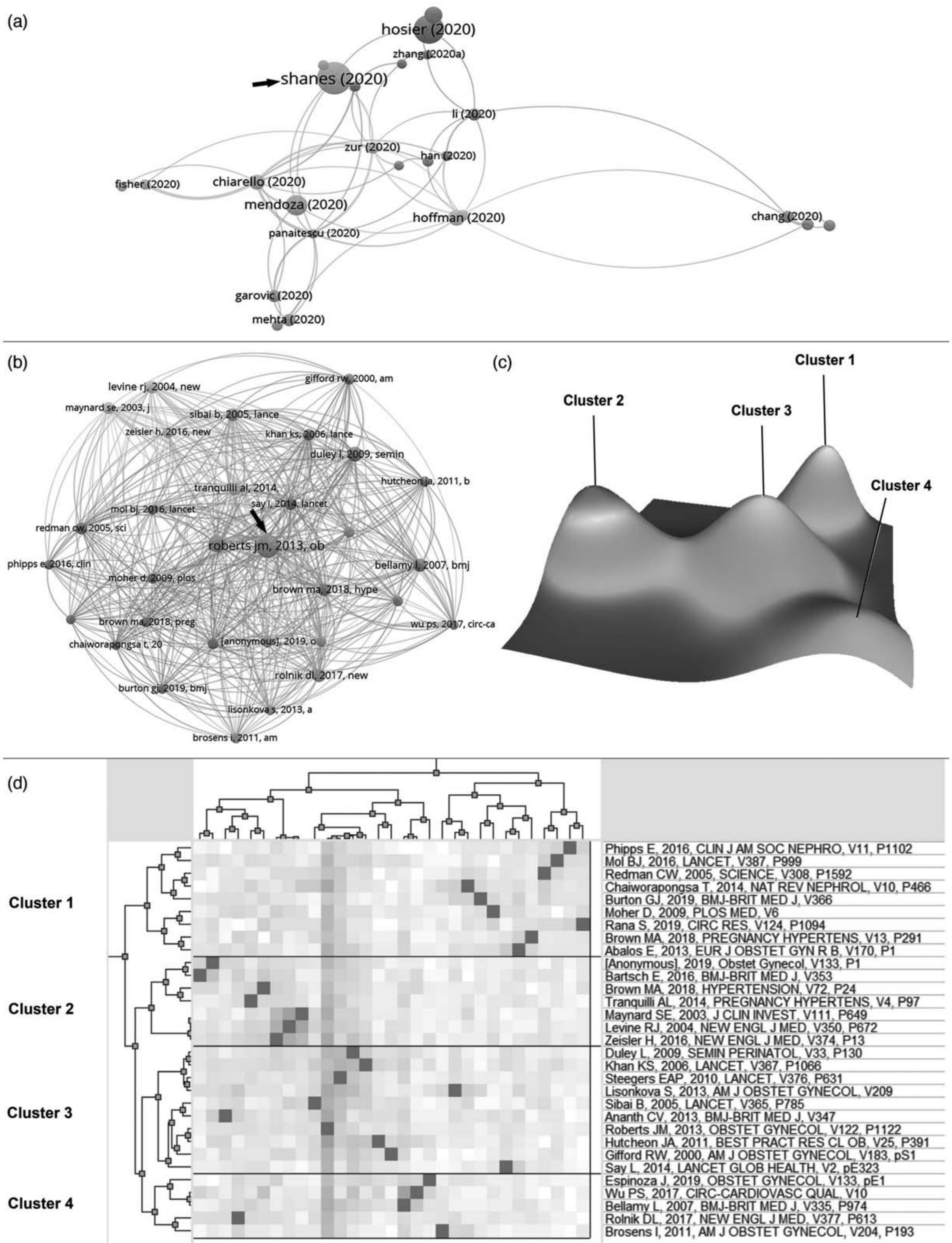

FIGURE 11 (a) Coupling network of documents in 2020. (b) Co-citation relationship of documents in 2020. (c) and (d) The peaks and matrix to reveal the relationship of documents based on co-citation analysis in 2020.

TABLE 10. Coupling analysis of Top 30 documents in 2020

Document	Title	Source	Citations	Cluster
Hosier (2020)	SARS-COV-2 infection of the placenta	*Journal of Clinical Investigation,* 130(9), 4947-4953	132	1
Kayem (2020)	Snapshot of the COVID-19 pandemic among pregnant women in France	*Journal of Gynecology Obstetrics and Human Reproduction,* 49(7)	45	1
Meinhardt (2020)	Pivotal role of the transcriptional co-activator YAP in trophoblast sternness of the developing human placenta	*Proceedings of the National Academy of Sciences of the United States,* 117(24), 13562-13570	18	1
Lokossou (2020)	Endogenous retrovirus-encoded synoytin-2 contributes to exosome-mediated immunosuppression of T cells	*Biology of Reproduction,* 102(1), 185-198	16	1
Zhang (2020a)	Upregulation of PUML expression in preeclampsia impairs trophoblast invasion by negatively regulating the expression of the lncRNA	*Molecular Therapy,* 28(2), 631–641	16	1
Garovic (2020)	Incidence and long-term outcomes of hypertensive disorders of pregnancy	*Journal of The American College of Cardiology,* 75(18), 2323-2334	26	2
Mehta (2020)	Cardiovascular considerations in caring for pregnant patients: a scientific statement from the American Heart Association	*Circulation,* 141(23), E884-E903	24	2
Agarwala (2020)	The use of sex-specific factors in the assessment of women's cardiovascular risk	*Circulation,* 1417), 592-599	18	2
Panaitescu (2020)	E LABE LA plasma concentrations are increased in women with late-onset preeclampsia	*Journal of Maternal-Fetal & Neonatal Medicine,* 33(1), 5-15	16	2
Li (2020)	Unique microRNA signals in plasma exosomes from pregnancies complicated by preeclampsia	*Hypertension,* 75(3), 762-771	25	3
Han (2020)	Placenta-derived extracellular vesicles induce preeclampsia in mouse models	*Haematologica,* 105(6), 1686-1694	18	3
Williamson (2020)	l-(+)-ergothioneine significantly improves the clinical characteristics of preeclampsia in the reduced uterine perfusion pressure rat model	*Hypertension,* 75(2), 561-568	17	3
Illsley (2020)	Human placental glucose transport in fetoplacental growth and metabolism	*Biochimica Et Biophysics Acta-Molecular Basis of Disease,* 1866(2)	16	3
Hoffman (2020)	Low-dose aspirin for the prevention of preterm delivery in nulliparous women with a singleton pregnancy (aspirin);a randomised, double-blind, placebo-controlled trial	*Lancet,* 395(10220), 285-293	43	4
Zur (2020)	The placental basis of fetal growth restriction	*Obstetrics and Gynecology Clinics of North America,* 47(1),81	24	4
Ahmed (2020)	Pravastatin for early-onset preeclampsia: a randomised, blinded, placebo-controlled trial	*BJOG-An International Journal of Obstetrics and Gynaecology,* 127(4), 478-488	23	4
Chang (2020)	Short-chain fatty acids accompanying changes in the gut microbiome contribute to the development of hypertension in patients with preeclampsia	*Clinical Science,* 134(2), 289-302	24	5
Chen (2020)	Gut dysbiosis induces the development of preeclampsia through bacterial translocation	*Gut,* 69(3), 513-522	23	5
Harper (2020)	Early gestational diabetes screening in obese women: a randomized controlled trial	*American Journal of Obstetrics and Gynecology,* 222(5)	21	5
Chiarello (2020)	Oxidative stress: normal pregnancy versus preeclampsia	*Biochimica Et Biophysica Acta-Molecular Basis of Disease,* 1866(2)	38	6
Fisher (2020)	Placental mitochondria and reactive oxygen species in the physiology and pathophysiology of pregnancy	*Clinical and Experimental Pharmacology and Physiology.* 47(1), 176-184	19	6
Zhang (2020b)	MiR-30−5p-mediated ferroptosis of trophoblasts is implicated in the pathogenesis of preeclampsia	*Redox Biology,* 29	16	6
Shanes (2020)	**Placental pathology in COVID-19**	***American Journal of Clinical Pathology,* 154(1), 23-32**	**176**	**7**
Mendoza (2020)	Preeclampsia-like syndrome induced by severe COVID-19:a prospective observational study	*BJOG-An International Journal of Obstetrics And Gynaecology,* 127(11), 1374-1380	67	7
Antoun (2020)	Maternal COVID-19 infection, clinical characteristics, pregnancy, and neonatal outcome: a prospective cohort study	*European Journal of Obstetrics and Gynecology and Reproductive Biology,* 252, 559-562	18	7
Adhikari (2020)	Pregnancy outcomes among women with and without severe acute respiratory syndrome coronavirus 2 infection	*JAMA Network Open,* 3(11)	37	8
Aljary (2020)	Pregnancy outcomes in women with rheumatoid arthritis: a retrospective population-based cohort study	*Journal of Maternal-Fetal & Neonatal Medicine,* 33(4), 618-624	17	9

TABLE 10 (*Continued*)

Document	Title	Source	Citations	Cluster
Aziz (2020)	Telehealth for high-risk pregnancies in the setting of the COVID-19 pandemic	*American Journal of Perinatology,*37(08), 800-808	38	10
Wan (2020)	Laser induced self-N-doped porous graphene as an electrochemical biosensor for femtomolar miRNA detection	*Carbon,*163, 385-394	19	11
Xie (2020)	Effectiveness of telemedicine for pregnant women with gestational diabetes mellitus: an updated meta-analysis of 32 randomized Title: controlled trials with trial sequential analysis	*BMC Pregnancy And Childbirth*$_t$ 20(1)	16	12
Yang (2020)	Predicting fetal loss in severe acute pancreatitis during pregnancy: a 5-year single-tertiary-center retrospective analysis	*Postgraduate Medicine,*132(5), 473-478	22	13

The bold fonts indicated the reference with the most citations.

TABLE 11. Co-citation analysis of top 30 documents from 2000 to 2020

Author	Year	Source	DOI	Citations	Cluster
Sibai B	**2005**	***Lancet,* v365, p785**	**10.1016/s0140-6736(05)71003-5**	**1633**	**1**
Roberts JM	2013	*Obstet Gynecol,*v122, p1122	10.1097/01 .aog.0000437382.03963.88	1448	1
Gifford RW	2000	*Am J Obstet Gynecol,*v183, ps1	10.1067/mob.2000.107928	1426	1
Steegers EAP	2010	*Lancet,*v376, p631	10.1016/s0140-6736(10)60279-6	1229	1
Brown MA	2001	*Hypertens Pregnancy,*v20, pix	10.1081/prg-100104165	951	1
Duley L	2009	*Semin Pennatol,*v33, p130	10.1053/j.semperi.2009.02.010	899	1
Bellamy L	2007	*BMJ-Brit Med J,*v335, p974	10.1136/bmj. 39335.385301 .be	814	1
Duckitt K	2005	*Brit Med J.*v330, p565	10.1136/bmj. 38380.674340. eO	580	1
Khan Ks	2006	*Lancet,*v367, p1066	10.1016/s0140-6736(06)68397-9	575	1
Tranquilli Al	2014	*Pregnancy Hypertens,*v4, p97	[10.1016/j.preghy.2014.02.001 10.1016/j.preghy. 2014.04.017 10.1016/j.preghy.2014.04.007]	462	1
ACOG Committee on Obstetric Practice	2002	*Int J Gynaecol Obstet,*v77, p67		447	1
Sibai BM	2003	*Obstet Gynecol,*v102, p181	10.1016/s0029-7844(03)00475-7	400	1
[Anonymous]	2002	*Obstet Gynecol,*v99, p159		393	1
Bujold E	2010	*Obstet Gynecol,*v116, p402	10.1097/aog. Ob013e3181 e9322a	378	1
Von Dadelszen P	2003	*Hypertens Pregnancy,*v22, p143	10.1081/prg-120021060	378	1
Huppertz B	2008	*Hypertension,*v51, p970	10.1161/hypertensionaha. 107.107607	365	1
Redman CWG	1999	*Am J Obstet Gynecol,*v180, p499	10.101 6/50002-9378(99)70239-5	826	2
Roberts JM	1989	*Am J Obstet Gynecol,*vl 61, p1200	10.101 6/0002-9378(89)90665-0	731	2
Roberts JM	2001	*Lancet,*V357, P53	10.101 6/s0140-6736(00)03577-7	661	2
Khong TY	1986	*Brit J Obstet Gynaec, v93,*pW49	10.1111/j. 1471 -0528.1986.tb07830.x	597	2
Davey DA	1988	*Am J Obstet Gynecol,*vl 58, p892	10.101 6/0002-9378(88)90090-7	511	2
Roberts JM	1993	*Lancet,*v341, p1447	10.101 6/0140-6736(93)90889-0	508	2
ACOG	2002	*Obstet Gynecol,*v99, p869		494	2
Irgens HU	2001	*Brit Med J*$_t$ v323, p1213	10.1136/bmj.323.7323.1213	460	2
Meekins JW	1994	*Brit J Obstet Gynaec,*vl 01, p669	10.1111/j. 1471 -0528.1994.tb13182.x	383	2
Maynard SE	2003	*J Clin Invest,*v111, p649	10.1172/jci200317189	1464	3
Levine RJ	2004	*New Engl J Med,*v350, p672	10.1056/nejmoa031884	1422	3
Redman CW	2005	*Science,*v308, p1592	10.1126/science.1111726	1199	3
Levine RJ	2006	*New Engl J Med,*v355, p992	10.1056/nejmoa055352	722	3
Venkatesha S	2006	*Nat Med,*v12, p642	10.1038/nm1429	628	3

The bold fonts indicated the reference with the most citations.

TABLE 12. Co-citation analysis of top 30 documents from 2016 to 2020

Author	Source	DOI	Year	Citations	Cluster
Roberts JM	***Obstet Gynecol*, v122, p1122**	**10.1097/01.aog.0000437382.03963.88**	**2013**	**1303**	**1**
Steegers EAP	*Lancet,*v376, p631	10.1016/s0140-6736(10)60279-6	2010	769	1
Duley L	*Semin Pennatol,*v33, p130	10.1053/j.semperi.2009.02.010	2009	578	1
Tranquilli AL	*Pregnancy Hypertens,*v4, p97	[10.1016/j.preghy.2O14.04.017 10.1016/j.preghy.2014.02.001 10.1016/j.preghy.2O14.04.007]	2014	443	1
Bellamy L	*BMJ-Brit Med J.*v335, p974	10.1136/bmj. 39335.385301 .be	2007	431	1
Gifford RW	*Am J Obstet Gynecol,*v183, ps1	10.1067/mob.2000.107928	2000	349	1
Mol BJ	*Lancet,*v387, p999	10.1016/s0140-6736(15)00070-7	2016	310	1
Khan KS	*Lancet,*v367, p1066	10.1016/s0140-6736(06)68397-9	2006	306	1
Say L	*Lancet Glob Health,*v2, pe323	10.1016/s2214-109x(14)70227-x	2014	272	1
Hutcheon JA	*Best Pract Res Cl Ob,*v25, p391	10.1016/j.bpobgyn.2011.01.006	2011	233	1
Duckitt K	*Brit Med J,*v330, p565	10.1136/bmj. 38380.67434O.eO	2005	225	1
Abalos E	*Eur J Obstet Gyn R B,*v170, p1	10.1016/j.ejogrb.2013.05.005	2013	224	1
Ananth CV	*BMJ-Brit Med J.*v347	10.1136/bmj. f6564	2013	208	1
ACOG Committee On Obstetric Practice	*Int J Gynaecol Obstet,*v77, p67		2002	187	1
Sibai B	*Lancet,*v365, p785	10.101 6/s0140-6736(05)71003-5	2005	545	2
Maynard SE	*J Clin Invest,*vili, p649	10.1172/jci200317189	2003	501	2
Levine RJ	*New Engl J Med,*v350, p672	10.1056/nejmoa031884	2004	496	2
Zeisler H	*New Engl J Med,*v374, pl 3	10.1056/nejmoa1414838	2016	288	2
Chaiworapongsa T	*Nat Rev Nephrol,*v10, p466	10.1038/nrneph.2014.102	2014	275	2
Powe CE	*Circulation,*v123, p2856	10.1161/circulationaha. 109.853127	2011	252	2
Levine RJ	*New Engl J Med,*v355, p992	10.1056/nejmoa055352	2006	231	2
Venkatesha S	*Nat Med,*v12, p642	10.1038/nm1429	2006	200	2
Livak KJ	*Methods,*v25, p402	10.1006/meth.2001.1262	2001	191	2
Redman CWG	*Am J Obstet Gynecol,*v180, p499	10.101 6/50002-9378(99)70239-5	1999	190	2
Redman CW	*Science,*v308, p1592	10.1126/science.1111726	2005	411	3
Brown MA	*Hypertens Pregnancy,*v20, pix	10.1081/prg-100104165	2001	372	3
Rolnik DL	*New Engl J Med,*v377, p613	10.1056/nej moa 1704559	2017	276	3
Bujold E	*Obstet Gynecol,*v116, p402	10.1097/aog,0b013e3181 e9322a	2010	212	3
Brosens I	*Am J Obstet Gynecol,*v204, p193	10.1016/j.ajog.2010.08.009	2011	206	3
Li son kova S	*Am J Obstet Gynecol,*v209	10.1016/j.ajog.2013.08.019	2013	202	3

The bold fonts indicated the reference with the most citations.

TABLE 13. Co-citation analysis of top 30 documents in 2020

Author	Year	Source	DOI	Citations	Cluster
Say L	2014	*Lancet Glob Health,*v2, pe323	10.1016/s2214-109x(14)70227-x	88	1
Redman CW	2005	*Science,*v308, p1592	10.1126/science.1111726	80	1
Abalos E	2013	*Eur J Obstet Gyn* R B, v170, p1	10.1016/j.ejogrb.2013.05.005	77	1
Mol BJ	2016	*Lancet,*v387, p999	10.1016/s0140-6736(15)00070-7	68	1
Brown MA	2018	*Pregnancy Hypertens,*v13, p291	10.1016/j.preghy.2018.05.004	67	1
Moher D	2009	*PLos Med,*v6	10.1371/journal, pmed. 1000097	67	1
Chaiworapongsa T	2014	*Nat Rev Nephrol,*v10, p466	10.1038/nrneph.2014.102	59	1
Phipps E	2016	*Clin J Am Soc Nephrol,*v11, p1102	10.2215/cjn.12081115	58	1
Rana S	2019	*Circ Res,* v124, p1094	10.1161/circresaha.118.313276	56	1
Burton GJ	2019	*BMJ-Brit Med J.*v366	10.1136/bmj. 12381	53	1
Roberts JM	**2013**	***Obstet Gynecol,* v122, p1122**	**10.1097/01 .aog.0000437382.03963.88**	**334**	**2**
Steegers EAP	2010	*Lancet,*v376, p631	10.1016/s0140-6736(10)60279-6	184	2
Rolnik DL	2017	*New Engl J Med,*v377, p613	10.1056/nejmoa1 704559	110	2
Sibai B	2005	*Lancet,*v365, p785	10.1016/s0140-6736(05)71003-5	91	2
[Anonymous]	2019	*Obstet Gynecol,*v133, p1	10.1097/aog. 0000000000003018	89	2
Ananth CV	2013	*BMJ-Brit Med J.*v347	1 0.1136/bmj.f6564	73	2
Brosens 1	2011	*Am J Obstet Gynecol,*v204, p193	1 0.1016/j.ajog.2010.08.009	64	2
Bartsch E	2016	*BMJ-Brit Med* J, v353	1 0.1136/bmj.i1753	62	2
Li son kova S	2013	*Am J Obstet Gynecol,*v209	10.1016/j.ajog.2013.08.019	57	2
Duley L	2009	*Semin Perinatol,*v33, p130	10.1053/j.semperi.2009.02.010	134	3
Bellamy L	2007	*BMJ-Brit Med J.*v335, p974	10.1136/bmj. 39335.385301 .be	110	3
Brown MA	2018	*Hypertension,*v72, p24	10.1161/hypertensionaha. 117.10803	99	3
Khan KS	2006	*Lancet,*v367, p1066	10.1016/s0140-6736(06)68397-9	83	3
Gifford RW	2000	*Am J Obstet Gynecol,*v183, ps1	10.1067/mob.2000.107928	73	3
Espinoza J	2019	*Obstet Gynecol,*v133, pel	10.1097/aog. 0000000000003018	62	3
Hutcheon JA	2011	*Best Pract Res* Cl Ob, v25, p391	10.1016/j.bpobgyn.2011.01.006	60	3
Wu PS	2017	*Circ-Cardiovasc Qual,*v10	10.1161/circoutcomes.116.003497	53	3
Tranquilli AL	2014	*Pregnancy Hypertens,*v4, p97	10.1016/j.preghy.2O14.04.017 10.1016/j.preghy.2O14.02.001 10.1016/j.preghy.2O14.04.007]	116	4
Levine RJ	2004	*New Engl J Med,*v350, p672	10.1056/nejmoa031884	91	4
Maynard SE	2003	*J Clin Invest,*V111, P649	10.1172/jci200317189	87	4
Zeisler H	2016	*New Engl J Med,*V374, P13	10.1056/nejmoa1414838	83	4

The bold fonts indicated the reference with the most citations.

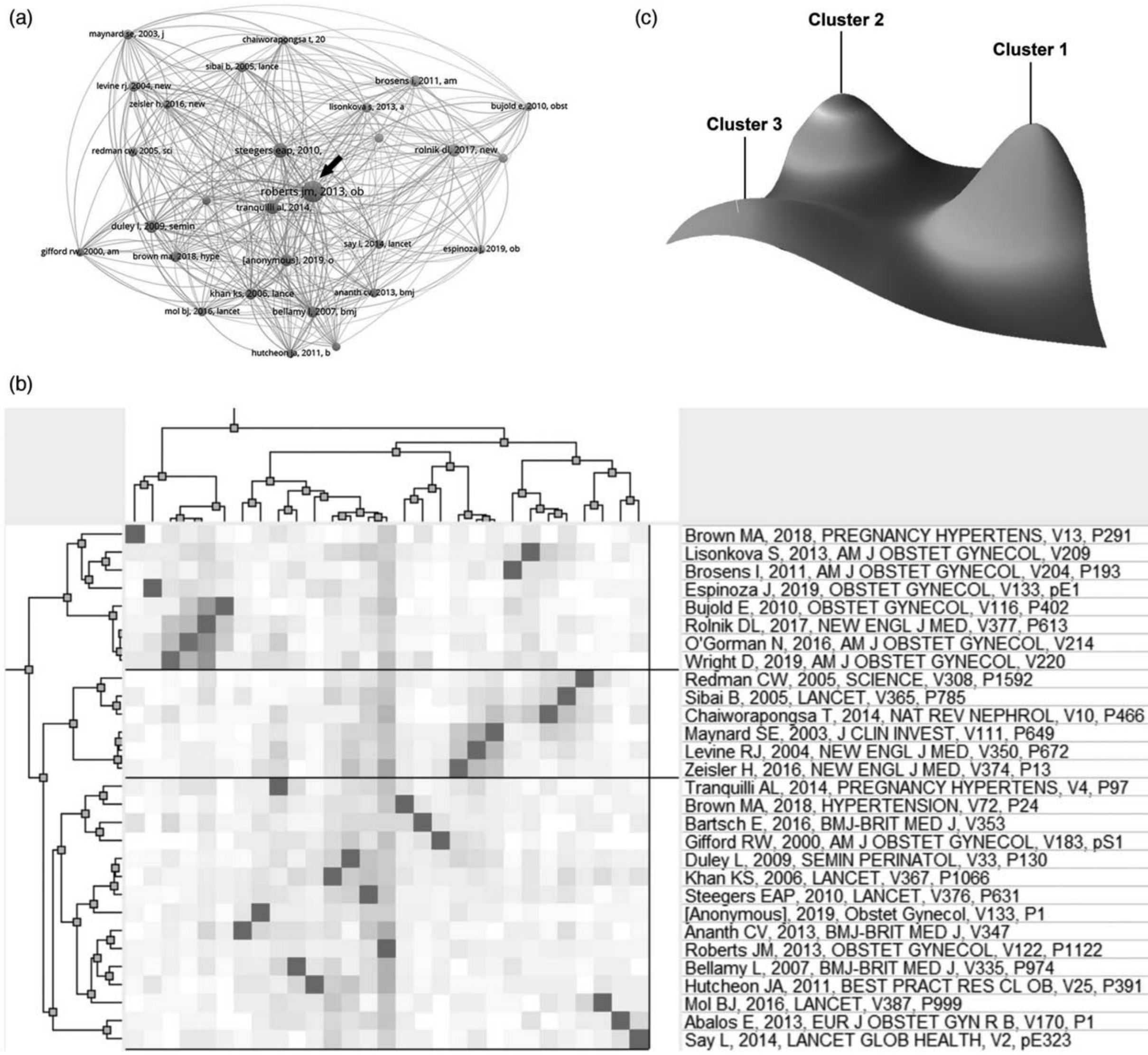

FIGURE 12 (a) The clusters of top 30 documents in category of 'Obstetrics and Gynecology' in 2020, based on co-citation analysis. (b) and (c) The matrix and peak graphs formed according to the aforesaid analysis.

TABLE 14. Co-citation analysis of top 30 documents in category of 'Obstetrics and Gynecology', in 2020

Author	Year	Source	Doi	Citations	Cluster
Roberts JM	**2013**	***Obstet Gynecol,* v122, p1122**	**10.1097/01.aog.0000437382.03963.88**	**167**	**1**
Steegers EAP	2010	*Lancet,*v376, p631	10.1016/s0140-6736(10)60279-6	77	1
Duley L	2009	*Semin Pennatol,*v33, p130	10.1053/j.semperi.2009.02.010	57	1
Tranquilli AL	2014	*Pregnancy Hypertens,*v4, p97	10.1016/j.preghy.2O14.02.001 10.1016/j.preghy.2014.04.007 10.1016/j.preghy.2O14.04.017]	56	1
[Anonymous]	2019	*Obstet Gynecol,*v133, p1	10.1097/aog.0000000000003018	49	1
Bellamy L	2007	*BMJ-Brit Med J.*v335, p974	10.1136/bmj.39335.385301 .be	46	1
Khan KS	2006	*Lancet,*v367, p1066	10.1016/s0140-6736(06)68397-9	46	1
Brown MA	2018	*Hypertension,*v72, p24	10.1161/hypertensionaha. 117.10803	40	1
Say L	2014	*Lancet Glob Health,*v2, pe323	10.1016/S2214-109x(14)70227-x	32	1
Mol BJ	2016	*Lancet,*v387, p999	10.1016/s0140-6736(15)00070-7	29	1
Ananth CV	2013	*BMJ-Brit Med J.*v347	10.1136/bmj.f6564	28	1
Hutcheon JA	2011	*Best Pract Res Cl Ob,*v25, p391	10.1016/j.bpobgyn.2011.01.006	27	1
Gifford RW	2000	*Am J Obstet Gynecol,*v183, ps1	10.1067/mob.2000.107928	26	1
Bartsch E	2016	*BMJ-Brit Med J.*v353	10.1136/bmj.i1753	25	1
Abalos E	2013	*Eur J Obstet Gyn R B,*v170, p1	10.1016/j.ejogrb.2013.05.005	24	1
Rolnik DL	2017	*New Engl J Med,*v377, p613	10.1056/nejmoa1704559	57	2
Brosens I	2011	*Am J Obstet Gynecol,*v204, pl 93	10.1016/j.ajog.2010.08.009	44	2
Li son kova S	2013	*Am J Obstet Gynecol,*v209	10.1016/j.ajog.2013.08.019	34	2
Brown MA	2018	*Pregnancy Hypertens,*v13, p291	10.1016/j.preghy.2O18.05.004	28	2
O'gorman N	2016	*Am J Obstet Gynecol,*v214	10.1016/j.ajog.2015.08.034	28	2
Bujold E	20W	*Obstet Gynecol,*vl 16, p402	10.1097/aog.0b013e3181 e9322a	27	2
Espinoza J	2019	*Obstet Gynecol,*v133, pel	10.1097/aog.000000000000301 8	27	2
Levine RJ	2004	*New Engl J Med,*v350, p672	10.1056/nejmoa031884	41	3
Sibai B	2005	*Lancet,*v365, p785	10.1016/s0140-6736(05)71003-5	40	3
Maynard SE	2003	*J Clin Invest,*v111, p649	10.1172/jci200317189	36	3
Redman CW	2005	*Science,*v308, p1592	10.1126/science.1111726	36	3
Zeisler H	2016	*New Engl J Med,*v374, p13	10.1056/nejmoa1414838	32	3
Chaiworapongsa T	2014	*Nat Rev Nephrol,*v10, p466	10.1038/nrneph.2014.102	27	3

The bold fonts indicated the reference with the most citations.

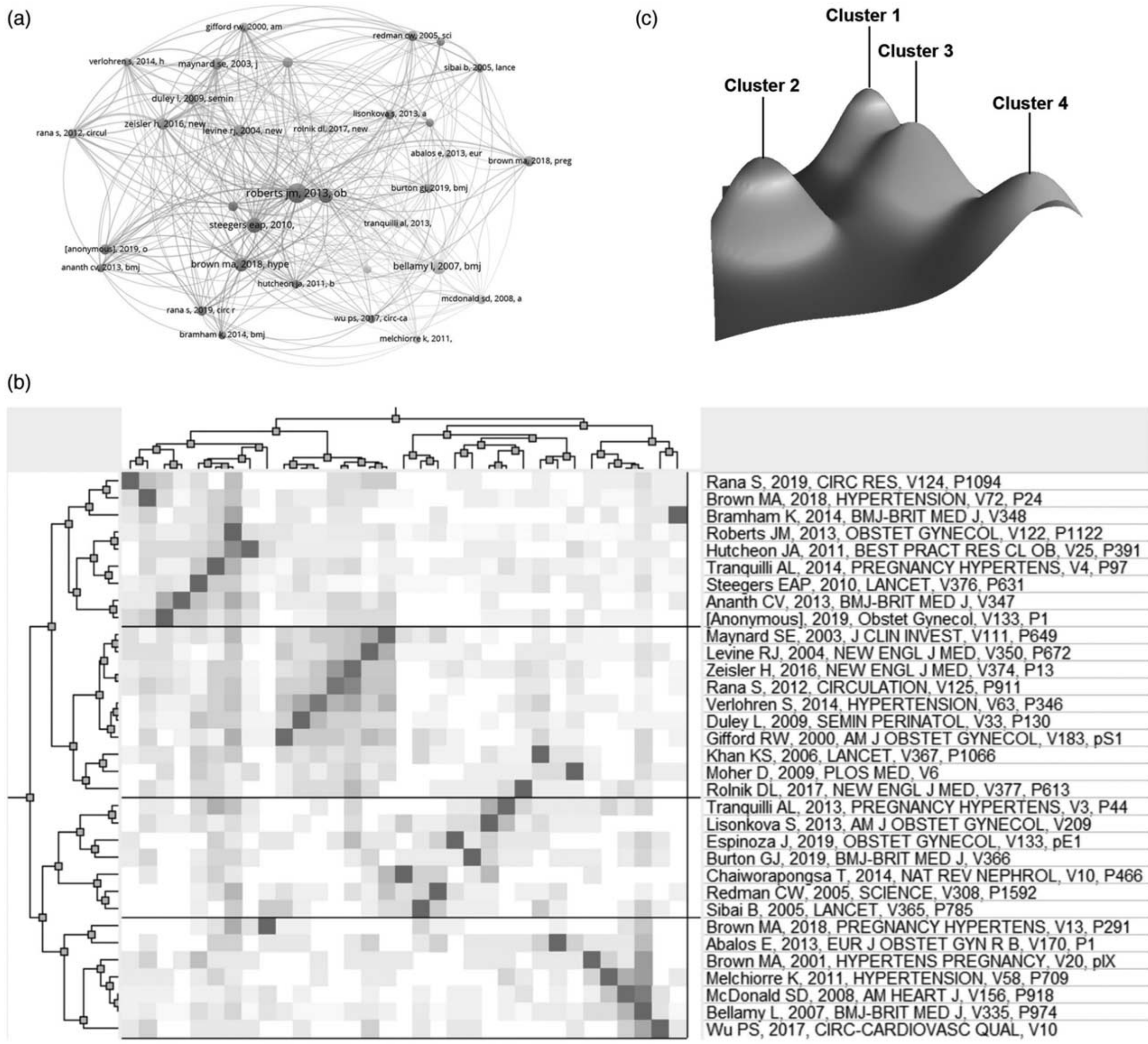

FIGURE 13 (a) The clusters of top 30 documents in category of 'Peripheral Vascular Disease' in 2020, based on co-citation analysis. (b) and (c) The matrix and peak graph generated.

TABLE 15. Co-citation analysis of top 30 documents in category of 'Peripheral Vascular Disease', in 2020

Author	Year	Source	DOI	Citations	Cluster
Roberts JM	**2013**	***Obstet Gynecol*, v122, p1122**	**10.1097/01.aog.0000437382.03963.88**	**59**	**1**
Steegers EAP	2010	*Lancet*,v376, p631	10.1016/s0140-6736(10)60279-6	34	1
Tranquilli AL	2014	*Pregnancy Hypertens*,v4, p97	[10.1016/j.preghy.2014.02.001 10.1016/j.preghy. 2014.04.00710.1016/j.preghy.2014.04.017]	30	1
Brown MA	2018	*Hypertension*,v72, p24	10.1161/hypertensionaha. 117.10803	28	1
[Anonymous]	2019	*Obstet Gynecol*,v133, p1	10.1097/aog.0000000000003018	17	1
Moher D	2009	*Plos Med*,v6	10.1371/journal.pmed. 1000097	14	1
Rana S	2019	*Circ Res*,v124, p1094	10.1161/circresaha. 118.313276	14	1
Hutcheon JA	2011	*Best Pract Res Cl Ob*,v25, p391	10.1016/j.bpobgyn.2011.01.006	11	1
Ananth CV	2013	*BMJ-Brit Med J*.v347	10.1136/bmj.f6564	10	1
Bramham K	2014	*BMJ-Brit Med J*.v348	10.1136/bmj.g2301	10	1
Wu PS	2017	*Circ-Cardiovasc Qual*,v10	10.1161/circoutcomes.116.003497	10	1
Levine RJ	2004	*New Engl J Med*,v350, p672	10.1056/nejmoa031884	21	2
Zeisler H	2016	*New Engl J Med*,v374, pl 3	10.1056/nejmoa1414838	21	2
Maynard SE	2003	*J Clin Invest*,vili, p649	10.1172/jci200317189	20	2
Duley L	2009	*Semin Perinatol*,v33, pl 30	1 0.1053/j.semperi.2009.02.010	19	2
Khan KS	2006	*Lancet*,v367, pW66	10.1016/s0140-6736(06)68397-9	17	2
Gifford RW	2000	*Am J Obstet Gynecol*,v183, psi	10.1067/mob.2000.107928	15	2
Rana S	2012	*Circulation*,v125, p91 1	10.1161/circulationaha. 111.054361	15	2
Verlohren S	2014	*Hypertension*,v63, p346	10.1161/hypertensionaha. 113.01787	11	2
Brown MA	2018	*Pregnancy Hypertens*,v13, p291	10.1016/j.preghy.2018.05.004	17	3
Redman CW	2005	*Science*,v308, p1592	10.1126/science.1111726	16	3
Lisonkova S	2013	*Am J Obstet Gynecol*,v209	10.1016/j.ajog.2013.08.019	14	3
Sibai B	2005	*Lancet*,v365, p785	10.1016/s0140-6736(05)71003-5	13	3
Burton GJ	2019	*BMJ-Brit Med J*.v366	10.1136/bmj. 12381	12	3
Chaiworapongsa T	2014	*Nat Rev Nephrol*,v10, p466	10.1038/nrneph.2014.102	10	3
Espinoza J	2019	*Obstet Gynecol*,v133, pel	10.1097/aog.0000000000003018	10	3
Bellamy L	2007	*BMJ-Brit Med J*.v335, p974	1 0.1136/bmj.39335.385301.be	33	4
Mcdonald SD	2008	*Am Heart J*,vl 56, p918	10.1016/j.ahj.2008.06.042	14	4
Rolnik DL	2017	*New Engi J Med*,v377, p613	10.1056/nejmoa 1704559	13	4
Abalos E	2013	*Eur J Obstet Gyn R B*,v1 70, pl	1 0.1016/j.ejogrb.2013.05.005	10	4
Brown MA	2001	*Hypertens Pregnancy*,v20, pix	10.1081/prg-100104165	10	4
Melchiorre K	2011	*Hypertension*,v58, p709	10.1161/hypertensionaha.11 1.176537	10	4
Tranquilli AL	2013	*Pregnancy Hypertens*,v3, p44	[10.1016/j.preghy.2012.11.001 10.1016/j.preghy.2O13.04.006]	10	4

The bold fonts indicated the reference with the most citations.

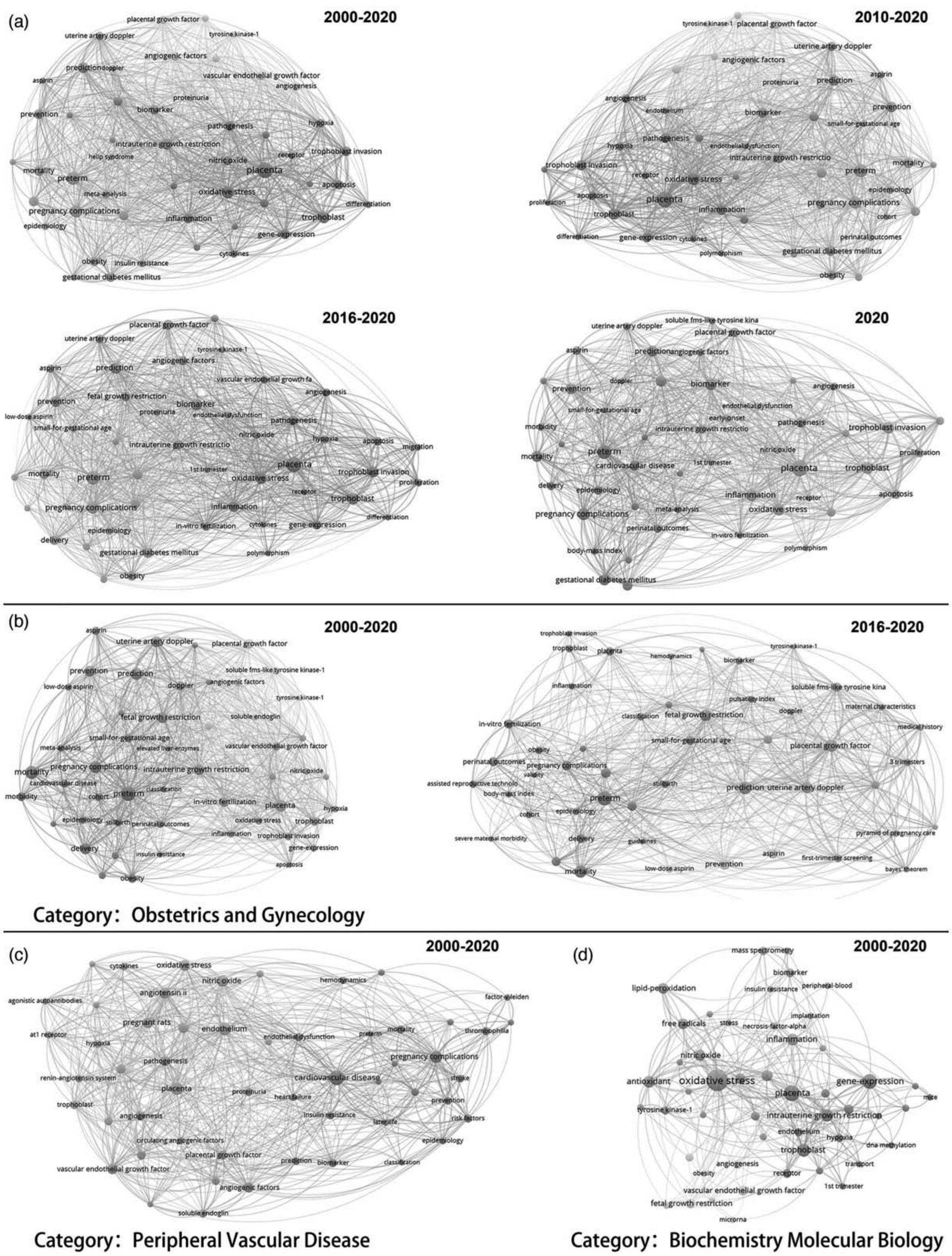

FIGURE 14 Keyword co-occurrence analysis in different categories and timespans.

TABLE 16. Top 50 keywords with the most frequent occurrences in different timespans

2000–2020			2010–2020		
Keyword	Occurrences	Cluster	Keyword	Occurrences	Cluster
Placenta	2152	1	Placenta	1597	1
Oxidative stress	1373	1	Oxidative stress	976	1
Trophoblast	1137	1	Trophoblast	805	1
Gene-expression	838	1	Inflammation	664	1
Trophoblast invasion	830	1	Trophoblast invasion	659	1
Pathogenesis	813	1	Pathogenesis	610	1
Inflammation	782	1	Gene-expression	606	1
Apoptosis	704	1	Apoptosis	515	1
Nitric oxide	687	1	Angiogenesis	482	1
In-vitro fertilization	669	1	In-vitro fertilization	451	1
Hypoxia	598	1	Nitric oxide	419	1
Endothelium	497	1	Hypoxia	407	1
Cytokines	447	1	Receptor	302	1
Receptor	429	1	Endothelial dysfunction	288	1
Polymorphism	417	1	Differentiation	281	1
Endothelial dysfunction	403	1	Proliferation	281	1
Differentiation	393	1	Cytokines	280	1
Necrosis-factor-alpha	349	1	Polymorphism	270	1
Human placenta	345	1	Endothelium	258	1
Preterm	1418	2	Migration	250	1
Pregnancy complications	1272	2	Preterm	1130	2
Mortality	860	2	Pregnancy complications	961	2
Delivery	769	2	Mortality	675	2
Obesity	730	2	Cardiovascular disease	613	2
Cardiovascular disease	706	2	Obesity	611	2
Gestational diabetes mellitus	693	2	Gestational diabetes mellitus	603	2
Meta-analysis	528	2	Delivery	555	2
Insulin resistance	506	2	Meta-analysis	475	2
Epidemiology	430	2	Epidemiology	355	2
Body-mass index	419	2	Body-mass index	350	2
Morbidity	346	2	Insulin resistance	334	2
Intrauterine growth restriction	1024	3	Perinatal outcomes	303	2
Prediction	960	3	Morbidity	278	2
Prevention	817	3	Cohort	256	2
Biomarker	799	3	Prediction	795	3
Fetal growth restriction	703	3	Intrauterine growth restriction	733	3
Uterine artery doppler	653	3	Biomarker	716	3
Doppler	372	3	Prevention	676	3
Aspirin	367	3	Fetal growth restriction	569	3
Small-for-gestational age	343	3	Uterine artery doppler	550	3
Vascular endothelial growth factor	744	4	Aspirin	312	3
Angiogenic factors	675	4	Small-for-gestational age	290	3
Angiogenesis	633	4	1st trimester	258	3
Placental growth factor	598	4	Angiogenic factors	615	4
Soluble endoglin	445	4	Placental growth factor	549	4
Soluble fms-like tyrosine kinase-1	430	4	Vascular endothelial growth factor	518	4
Proteinuria	420	4	Soluble endoglin	377	4
Tyrosine kinase-1	353	4	Soluble fms-like tyrosine kinase-1	374	4
Elevated liver-enzymes	367	5	Proteinuria	305	4
HELLP syndrome	363	5	Tyrosine kinase-1	275	4

2000–2020			2010–2020		
Keyword	Occurrences	Cluster	Keyword	Occurrences	Cluster
Placenta	883	1	Preterm	162	1
Oxidative stress	502	1	Pregnancy complications	128	1
Trophoblast	459	1	Mortality	103	1
Trophoblast invasion	421	1	Gestational diabetes mellitus	101	1
Inflammation	405	1	Cardiovascular disease	87	1
Pathogenesis	342	1	Obesity	84	1
Gene-expression	320	1	Epidemiology	67	1
Apoptosis	289	1	Perinatal outcomes	62	1
Angiogenesis	239	1	Delivery	60	1
In-vitro fertilization	230	1	Classification	53	1
Vascular endothelial growth factor	221	1	Morbidity	44	1

TABLE 16 (*Continued*)

2000–2020			2010–2020		
Keyword	**Occurrences**	**Cluster**	**Keyword**	**Occurrences**	**Cluster**
Hypoxia	198	1	Meta-analysis	43	1
Proliferation	197	1	Body-mass index	42	1
Nitric oxide	193	1	**Diabetes mellitus**	42	1
Migration	181	1	In-vitro fertilization	39	1
Differentiation	158	1	Maternal mortality	39	1
Endothelial dysfunction	150	1	**Guidelines**	38	1
Receptor	148	1	Proteinuria	34	1
Polymorphism	141	1	Placenta	220	2
Cytokines	138	1	Trophoblast	128	2
Preterm	693	2	Trophoblast invasion	120	2
Pregnancy complications	530	2	Inflammation	112	2
Mortality	404	2	Oxidative stress	111	2
Gestational diabetes mellitus	387	2	Pathogenesis	90	2
Cardiovascular disease	370	2	Apoptosis	79	2
Obesity	358	2	Proliferation	70	2
Meta-analysis	327	2	Gene-expression	65	2
Delivery	318	2	Migration	59	2
Epidemiology	221	2	Angiogenesis	54	2
Perinatal outcomes	211	2	Nitric oxide	48	2
Body-mass index	192	2	**Early-onset**	43	2
Classification	172	2	Hypoxia	43	2
Morbidity	167	2	Polymorphism	36	2
Proteinuria	166	2	Endothelial dysfunction	34	2
Cohort	145	2	Receptor	34	2
Maternal mortality	145	2	Vascular endothelial growth factor	34	2
Prediction	463	3	Biomarker	113	3
Biomarker	458	3	Prediction	107	3
Prevention	432	3	Fetal growth restriction	104	3
Fetal growth restriction	361	3	Prevention	103	3
Intrauterine growth restriction	345	3	Placental growth factor	75	3
Placental growth factor	331	3	Intrauterine growth restriction	65	3
Angiogenic factors	316	3	Aspirin	64	3
Uterine artery doppler	267	3	Angiogenic factors	53	3
Aspirin	226	3	Uterine artery doppler	50	3
Soluble fms-like tyrosine kinase-1	199	3	Low-dose aspirin	42	3
Small-for-gestational age	166	3	Soluble fms-like tyrosine kinase-1	40	3
1st trimester	162	3	1st trimester	38	3
Low-dose aspirin	155	3	Doppler	37	3
Tyrosine kinase-1	141	3	Small-for-gestational age	37	3

TABLE 17. Top 50 keywords with the most frequent occurrences in different categories and timespans

2000–2020 Category: obstetrics and gynecology		
Keyword	**Occurrences**	**Cluster**
Preterm	215	1
Mortality	169	1
Pregnancy complications	151	1
Delivery	122	1
Morbidity	84	1
Obesity	75	1
Cardiovascular disease	68	1
Cohort	62	1
Epidemiology	55	1
Perinatal outcomes	55	1
Gestational diabetes mellitus	54	1
Stillbirth	54	1
Body-mass index	52	1
Meta-analysis	51	1
Insulin resistance	39	1
Classification	38	1
Smoking	37	1
Placenta	146	2
In-vitro fertilization	104	2
Trophoblast	84	2
Oxidative stress	65	2
Vascular endothelial growth factor	64	2
Trophoblast invasion	61	2
Inflammation	51	2
Gene-expression	50	2
Angiogenesis	49	2
Nitric oxide	47	2
Pathogenesis	47	2
Hypoxia	43	2
Apoptosis	39	2
Endothelium	37	2
Prediction	154	3
Uterine artery doppler	128	3
Intrauterine growth restriction	126	3
Fetal growth restriction	119	3
Prevention	117	3
Small-for-gestational age	83	3
Doppler	81	3
Aspirin	73	3
Low-dose aspirin	54	3
Elevated liver-enzymes	41	3
Human chorionic-gonadotropin	41	3
First trimester	40	3
Intrauterine growth-retardation	37	3
Placental growth factor	100	4
Biomarker	72	4
Angiogenic factors	68	4
Soluble fms-like tyrosine kinase-1	60	4
Soluble endoglin	44	4
Tyrosine kinase-1	37	4

2016–2020 Category: obstetrics and gynecology		
Keyword	**Occurrences**	**Cluster**
Preterm	113	1
Mortality	77	1
Pregnancy complications	51	1
Cardiovascular disease	49	1
Morbidity	46	1
Meta-analysis	45	1
Perinatal outcomes	45	1
Delivery	43	1
In-vitro fertilization	43	1
Placenta	36	1
Assisted reproductive technology	31	1
Obesity	31	1
Stillbirth	30	1
Cohort	27	1
Trophoblast	25	1
Gestational diabetes mellitus	23	1
Body-mass index	21	1
Epidemiology	21	1
Inflammation	21	1
Trophoblast invasion	20	1
Guidelines	17	1
Severe maternal morbidity	16	1
Validity	16	1
Placental growth factor	81	2
Uterine artery doppler	67	2
Soluble fms-like tyrosine kinase-1	42	2
Angiogenic factors	38	2
Mean arterial pressure	37	2
First-trimester screening	33	2
3 trimesters	30	2
Maternal characteristics	24	2
Medical history	23	2
Pyramid of pregnancy care	22	2
Bayes' theorem	19	2
Survival model	17	2
Tyrosine kinase-1	16	2
Prediction	85	3
Fetal growth restriction	71	3
Small-for-gestational age	46	3
Biomarker	32	3
Classification	32	3
Intrauterine growth restriction	28	3
Pulsatility index	25	3
Doppler	22	3
Hemodynamics	18	3
Cardiac output	17	3
Prevention	65	4
Aspirin	54	4
Low-dose aspirin	29	4

2000–2020 Category: peripheral vascular disease		
Keyword	**Occurrences**	**Cluster**
Cardiovascular disease	81	1
Pregnancy complications	52	1
Thrombophilia	27	1
Biomarker	26	1
Endothelial dysfunction	26	1
Mortality	25	1
Risk factors	24	1
Insulin resistance	23	1
Prevention	22	1
Ischemic-heart-disease	21	1
Prediction	21	1

2000–2020 Category: biochemistry and molecular biology		
Keyword	**Occurrences**	**Cluster**
Placenta	23	1
Gene-expression	19	1
Trophoblast	15	1
Intrauterine growth restriction	14	1
Differentiation	8	1
Receptor	7	1
Endothelium	6	1
Human chorionic-gonadotropin	6	1
Hypoxia	6	1
Cholesterol	5	1
Human placenta	5	1

TABLE 17 (*Continued*)

2000–2020 Category: peripheral vascular disease		
Keyword	**Occurrences**	**Cluster**
Stroke	21	1
Heart failure	20	1
Hemodynamics	18	1
Later life	17	1
Epidemiology	16	1
Factor-V-Leiden	16	1
Fetal growth restriction	16	1
Meta-analysis	16	1
Classification	15	1
Metabolic syndrome	15	1
Obesity	15	1
Preterm	15	1
Venous thromboembolism	15	1
Placenta	59	2
Endothelium	57	2
Nitric oxide	49	2
Angiotensin II	46	2
Pregnant rats	44	2
Oxidative stress	43	2
Inflammation	42	2
Pathogenesis	39	2
Gene-expression	31	2
Trophoblast	25	2
Receptor	24	2
Hypoxia	23	2
Renin-angiotensin system	23	2
Cytokines	21	2
AT1 receptor	19	2
Nitric-oxide synthase	19	2
Agonistic autoantibodies	16	2
Intrauterine growth restriction	16	2
Necrosis-factor-alpha	16	2
Uterine perfusion-pressure	15	2
Angiogenic factors	41	3
Vascular endothelial growth factor	41	3
Angiogenesis	34	3
Placental growth factor	28	3
Soluble fms-like tyrosine kinase-1	28	3
Proteinuria	26	3
Soluble endoglin	25	3
Tyrosine kinase-1	21	3
Circulating angiogenic factors	18	3
Antiangiogenic factors	15	3

2000–2020 Category: biochemistry and molecular biology		
Keyword	**Occurrences**	**Cluster**
1st trimester	4	1
Dna methylation	4	1
Metabolism	4	1
Methylation	4	1
Mice	4	1
Transport	4	1
Inflammation	13	2
Biomarker	7	2
Mass spectrometry	6	2
Proteomics	5	2
Implantation	4	2
Insulin resistance	4	2
Necrosis-factor-alpha	4	2
Peripheral-blood	4	2
Stress	4	2
Transcription factors	4	2
Oxidative stress	42	3
Antioxidant	13	3
Nitric oxide	12	3
Endothelial dysfunction	10	3
Free radicals	10	3
Lipid-peroxidation	10	3
Pathogenesis	7	3
Tyrosine kinase-1	6	3
Angiogenic factors	4	3
NADPH oxidase	4	3
Vascular endothelial growth factor	9	4
Fetal growth restriction	8	4
Angiogenesis	6	4
Cardiovascular disease	6	4
Pregnancy complications	5	4
In-vivo	4	4
microRNA	4	4
Obesity	4	4
Apoptosis	11	5
Proliferation	5	5
Mitochondria	4	5
Pregnant rats	4	5
Superoxide	4	5

The bolder terms within one period of time or one category were the unique keywords compared to the words in other periods or categories.

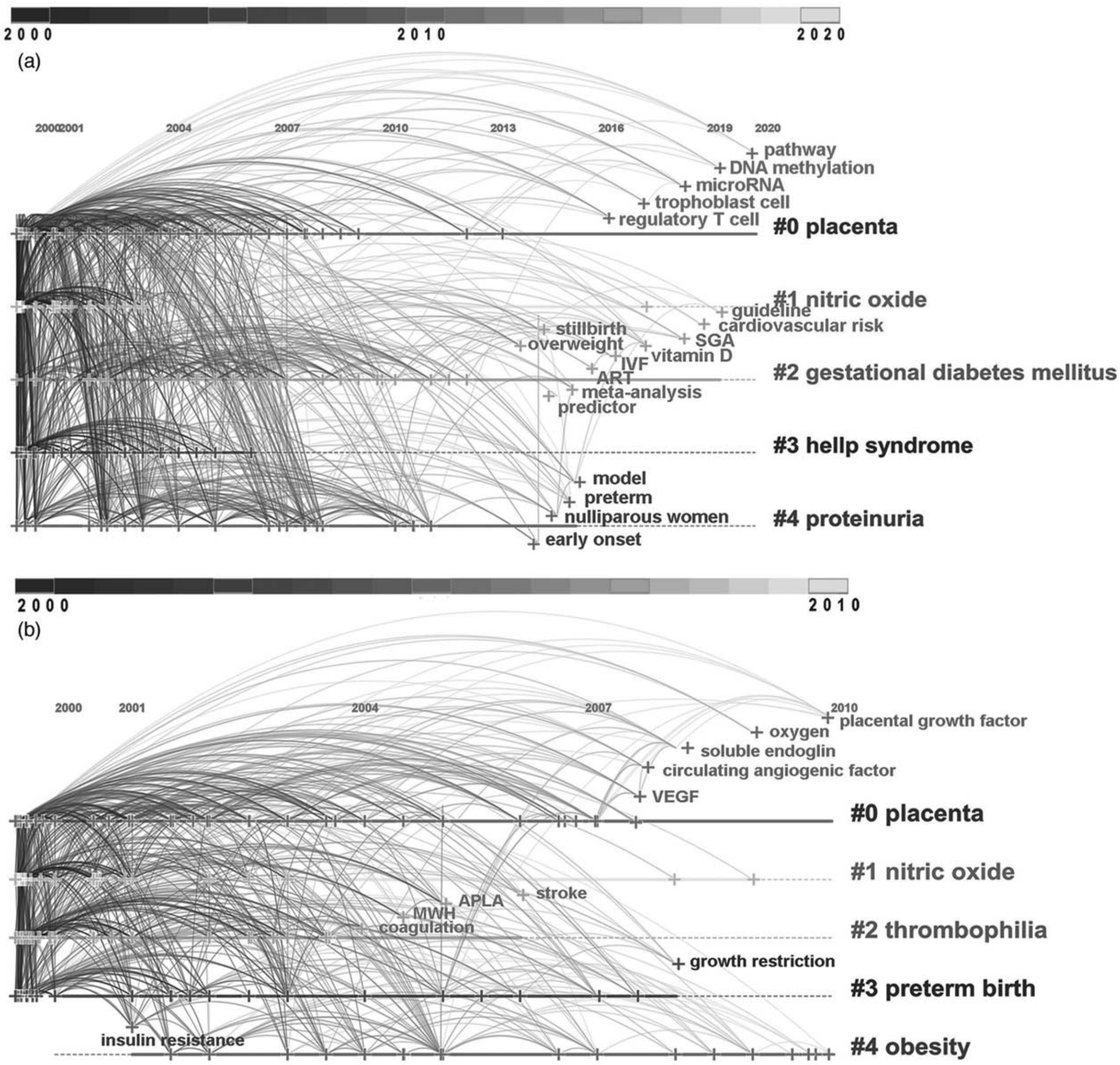

FIGURE 15 The keyword co-occurrence analysis displayed in timeline, from 2000 to 2020 (a), and 2000 to 2010 (b).

TABLE 18. Top 28 burst keywords detected by CiteSpace from 2010 to 2020

Keywords	Year	Strength	Begin	End	2010–2020
Lipid Peroxidation	2010	27.3	2010	2012	
Circulating Angiogenic Factor	2010	34.6	2010	2013	
Endothelial Cell	2010	23.8	2010	2015	
Magnesium Sulfate	2010	4.0	2010	2011	
Elevated Liver Enzyme	2010	29.0	2010	2013	
Insulin Resistance	2010	9.7	2010	2011	
Soluble Endoglin	2010	15.2	2010	2013	
Necrosis Factor Alpha	2010	30.4	2011	2015	
VEGF	2010	29.9	2011	2013	
Identification	2010	30.6	2011	2013	
Nitric Oxide Synthase	2010	32.5	2011	2013	
Amniotic Fluid	2010	21.8	2011	2012	
Therapy	2010	17.7	2012	2013	
Human Chorionic Gonadotropin	2010	19.9	2013	2014	
In Vitro Fertilization	2010	31.7	2015	2016	
Model	2010	15.5	2015	2017	
Natural Killer Cell	2010	7.6	2016	2017	
Regulatory T Cell	2010	22.2	2016	2017	
Cohort	2010	17.9	2016	2018	
Meta-analysis	2010	31.0	2016	2020	
Vitamin D	2010	30.4	2017	2018	
Randomized Controlled Trial	2010	26.1	2017	2018	
Early Onset	2010	28.5	2018	2020	
Aspirin	2010	31.6	2018	2020	
Migration	2010	44.6	2018	2020	
MicroRNA	2010	40.6	2018	2020	
Death	2010	28.0	2018	2020	
Stillbirth	2010	23.1	2018	2020	

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Conflicts of interest

There are no conflicts of interest.

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