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ORIGINAL ARTICLE BREAST SURGERY

The Evolution of Breast Reduction Publications: A Bibliometric Analysis

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Abstract

Objective This study aims to make a bibliometric analysis of the studies on breast reduction (BR) between the years 1980 and 2016 and identify important studies through trend topics as well as active authors, countries, universities, scientific journals, and citation and co-citation analyses about BR.

Background Although BR looks like one of the cosmetic surgeries performed in order to restore the woman's appearance, in fact it is a reconstructive surgery that eliminates back pain, stance disorder, headache, shoulder pain, back and cervical disk hernia, difficulty in breathing, hollowness caused by bra straps, hygiene problems under breasts (e.g., rash or fungal infections), and limitations in some daily activities. However, the related literature has little information about the publications on this issue.

Methods Bibliometric analysis was performed by downloading all the documents published between 1980 and 2016 from Thomson Reuters Web of Science (WoS; Thomson Reuters, New York, NY, USA), using the keywords including "breast reduction", "gigantomastia", "reduction mammaplasty", and "reduction mammoplasty".

Results There was a total of 1427 publications in the WoS database. Of these publications, 869 (60.90%) were research articles. The top three research areas of these publications were surgery with 1178 (82.55%) publications, oncology with 78 (5.47%) publications, and obstetrics gynecology with 67 (4.70%) publications. The top three countries that contributed to the literature most were the USA (515), England (147), and Turkey (83), respectively; the top university that contributed most was Harvard University, and the top two authors who contributed most were Drew PJ and Iwuagwu OC (13; 0.91%). The top-cited publication was "A Simplified Vertical Reduction Mammaplasty: Shortening the Learning Curve" written by Hall-Findlay, EJ in 1999. The journals with top numbers of publications were *Plastic and Reconstructive Surgery* (483; 33.85%), *Annals of Plastic Surgery* (164; 11.50%) and *Aesthetic Plastic Surgery* (147; 10.30%) respectively.

Conclusion Despite the fact that the BR literature is contributed by developed countries, developing countries, particularly Turkey and Brazil, also had significant contributions to the literature.

Level of Evidence V This journal requires that authors assign a level of evidence to each article. For a full description of these evidence-based medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Breast reduction · Gigantomastia · Reduction mammoplasty · Bibliometrics

Introduction

Although breast reduction looks like a cosmetic surgery performed to restore a woman's appearance, in fact it is a reconstructive surgery that eliminates back pain, stance disorder, headache, shoulder pain, back and cervical disk hernia, difficulty in breathing, hollowness caused by bra straps, hygiene problems under breasts (e.g., rash or fungal infections), and limitations in some daily activities.

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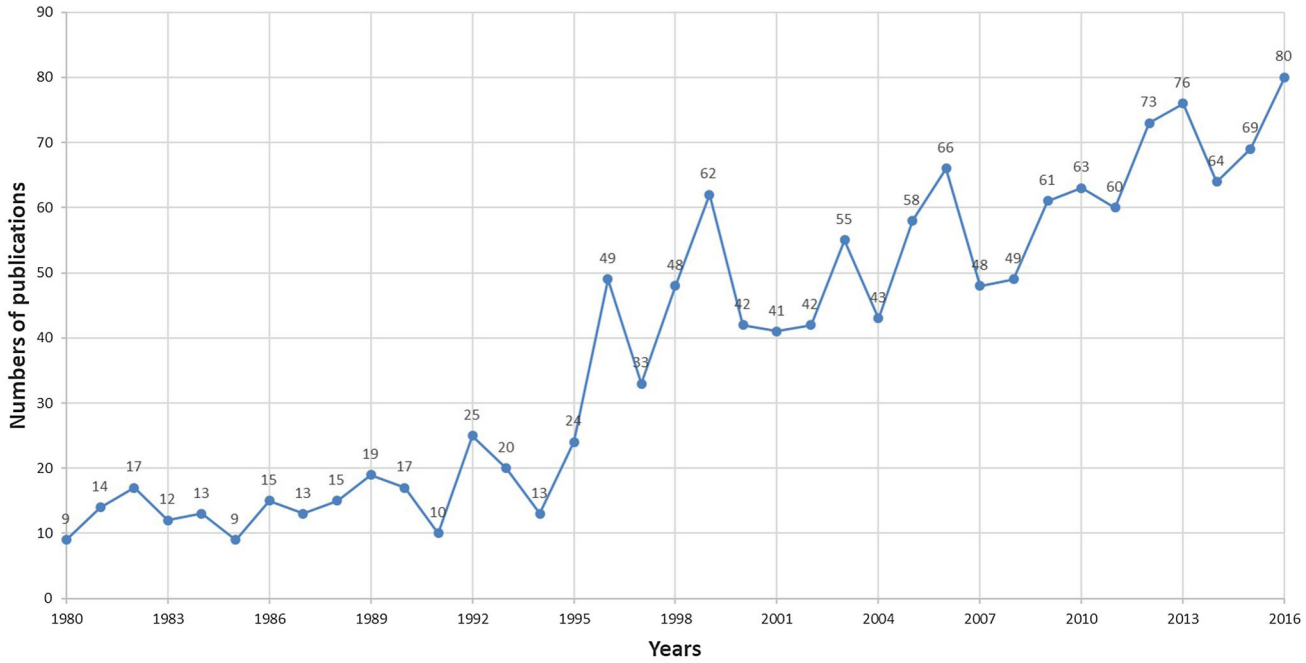

Fig. 1 Numbers of publications according to years on breast reduction

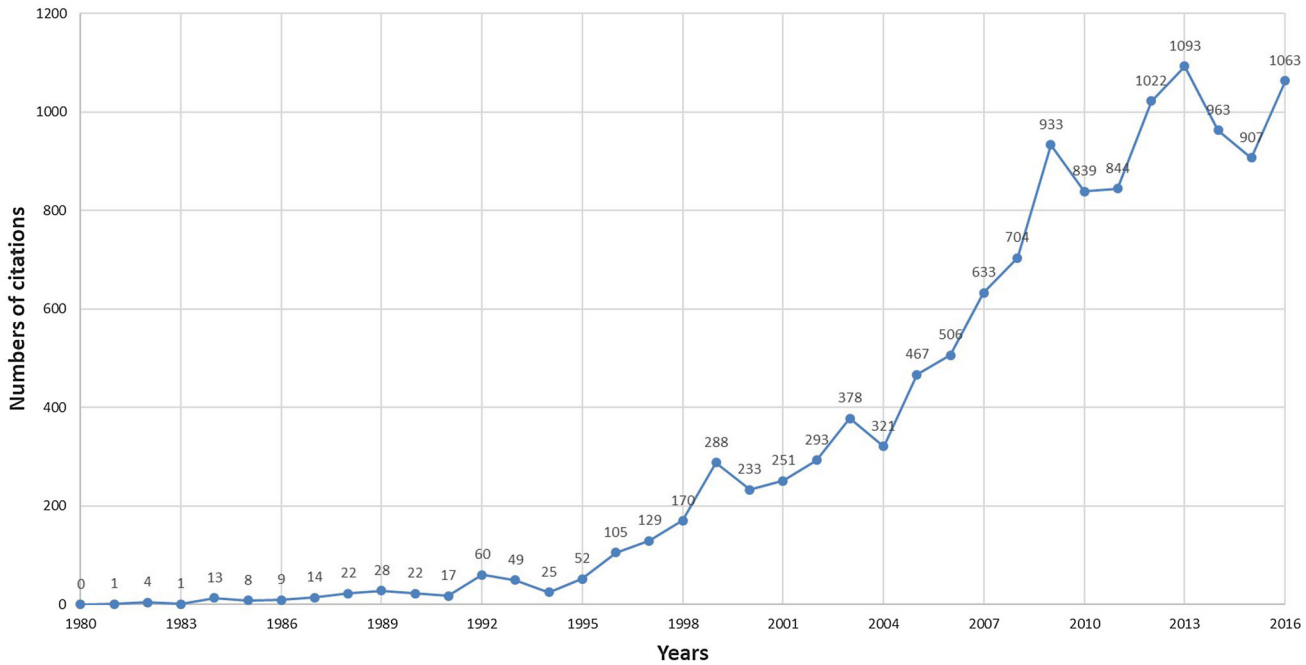

Fig. 2 Numbers of citations according to years on breast reduction

However, the related literature has little information about the publications on this issue.

Bibliometrics is the statistical analysis of written publications such as articles or books in the academic literature [1, 2]. Bibliometric methods are used in many research fields to explore the effects of fields, researcher groups or an author, or the international effect of a specific study [3–5]. As for citation analysis, it is a common bibliometric method based on the web or graph demonstration of citations among scientific documents and the formation of the relationships between authors or articles [6]. In this study, we aim to provide researchers with important information to guide them by making a bibliometric analysis of breast

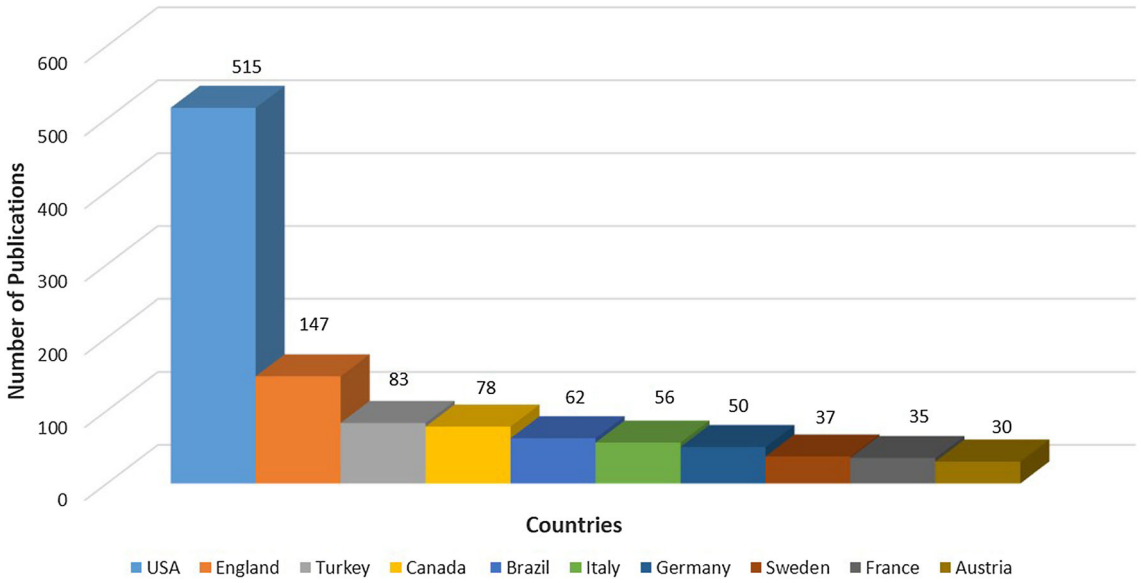

Fig. 3 Top 10 countries according to total number of publications on breast reduction

Table 1 First 10 authors by record count and citation on breast reduction

Authors	Record count	%	Citation	Authors	Citation
Drew PJ	13	0.91	111	Schnur PL	323
Iwuagwu OC	13	0.91	98	Hall-Findlay EJ	259
Nahabedian MY	12	0.84	176	Mclaughlin JK	246
Ferreira LM	11	0.77	90	Karp NS	206
Hall-Findlay EJ	11	0.77	259	Ferreira MC	198
Platt AJ	11	0.77	137	Blomqvist I	184
Swanson E	11	0.77	81	Spear SL	178
Karp NS	10	0.70	206	Larossa D	178
Ferreira MC	9	0.63	198	Nahabedian MY	176
Losken A	9	0.63	135	Munhoz AM	159

reduction publications indexed in the Thomsen Reuters Web of Science (WoS) database between 1980 and 2016.

Materials and Methods

All the documents published between 1980 and 2016 that included "breast reduction," "gigantomastia," "reduction mammaplasty," and "reduction mammoplasty" keywords (TITLE: ("breast reduction") OR TITLE: (gigantomastia) OR TITLE: ("reduction mammaplasty") OR TITLE: ("reduction mammoplasty")) were downloaded from the WoS (Thomson Reuters, New York, NY, USA) and were subjected to bibliometric analysis (data Access date: 1st of October, 2017); those published in 2017 were excluded. Bibliometric network visualizations were formed using VOSviewer (version 1.6.5). Active authors, countries, scientific journals, and universities in biostatistics publications were identified using bibliometric analyses; relationships were investigated between co-authorship, citation, co-citation analyses, and mostly used keywords.

The network visualization map is expressed with labels, circles, colors, and lines. Cluster analysis is performed within the analysis, and the colors show the clusters to which they belong. Depending on the preference, the size of the circle indicates the size of the number of citations. The bigger the size, the more articles or citations it has. Closeness and distance of the elements to each other indicate their relationship. Generally, if two elements are close to each other, then they have a strong relationship. Besides, thickening of the lines shows the strength of the relationship. Colors range between blue and red in the density visualization map. As the number of elements in the area of an element increases, and the density of the neighboring elements becomes higher, then the color of the point gets redder. In opposite cases, the point gets blue. This graph demonstrates grouping or clustering between the graph elements.

Table 2 Ten most cited manuscripts in breast reduction

No	Article	Author	Journal name/ published	Total citation	Average citations per year
1	A simplified vertical reduction mammaplasty: shortening the learning curve	Hall-Findlay, EJ	Plastic and Reconstructive Surgery-1999	189	9.95
2	Reduction mammaplasty: an outcome analysis	Dabbah, A; Lehman, JA; Parker, MG; et al.	Annals of Plastic Surgery-1995	117	5.09
3	Reduction mammaplasty: long-term efficacy, morbidity, and patient satisfaction	Davis, GM; Ringler, SL; Short, K; et al.	Plastic and Reconstructive Surgery-1995	117	5.09
4	2 types of normal human breast epithelial-cells derived from reduction mammaplasty: phenotypic characterization and response to Sv40 transfection	Kao, CY; Nomata, K; Oakley, CS; et al.	Carcinogenesis-1995	117	5.09
5	Reduction mammaplasty: an outcome study	Schnur, PL; Schnur, DP; Petty, PM; et al.	Plastic and Reconstructive Surgery-1997	114	5.43
6	Reduction mammaplasty improves symptoms of macromastia	Gonzalez, F; Walton, RL; Shafer, B; et al.	Plastic and Reconstructive Surgery-1993	112	4.48
7	Experience with reduction mammaplasty combined with breast conservation therapy in the treatment of breast cancer	Spear, SL; Pelletiere, CV; Wolfe, AJ; et al.	Plastic and Reconstructive Surgery-2003	109	7.27
8	Reduction mammaplasty and correction of ptosis with a short inframammary scar	Marchac, D; Deolarte, G	Plastic and Reconstructive Surgery-1982	109	3.03
9	Reduction mammaplasty provides long-term improvement in health status and quality of life	Blomqvist, L; Eriksson, A; Brandberg, Y	Plastic and Reconstructive Surgery-2000	100	5.56
10	Breast reduction: evolution of a technique—a single vertical scar	Lassus, C	Aesthetic Plastic Surgery-1987	95	3.06

Results

A total number of 1427 publications were found in the WoS database. The publications received 13,181 total citations and the average number of citations per publication was 9.1.

Publication Types and Research Areas

Of all these publications, 869 (60.90%) were articles, 293 (20.53%) were letters, 116 (8.13%) editorial material, 115 (8.06%) proceedings papers, 73 (5.12%) meeting abstracts, 23 (1.61%) reviews, 18 (1.26%) discussions, 10 (0.70) notes, and 10 (0.70%) were corrections. The top 10 research areas in which these publications were published included surgery with 1178 publications (82.55%), oncology with 78 publications (5.47%), obstetrics gynecology with 67 publications (4.70%), general internal medicine with 42 publications (2.94%), pathology with 28 publications (1.97%), research experimental medicine with 16 publications (1.12%), public environmental occupational health with 14 publications (0.98%), anesthesiology with 13 publications (0.91%), pediatrics with 10 publications (0.70%), and orthopedics with 9 publications (0.63%). By language, 1371 (96.2%) of these publications have been published in English, 26 (1.8%) in German, 25 (1.7%) in French, 3 (0.1%) in Spanish, 1 (0.1%) in Korean, and 1 (0.1%) in Russian.

Development of Publication and Citation Numbers

The change of the number of publications and citations according to years is presented in Figs. 1 and 2, respectively. An analysis of the figures shows that most publications were done in the year 2016, and the number of citations which started to increase after 1994 received the maximum value in 2013.

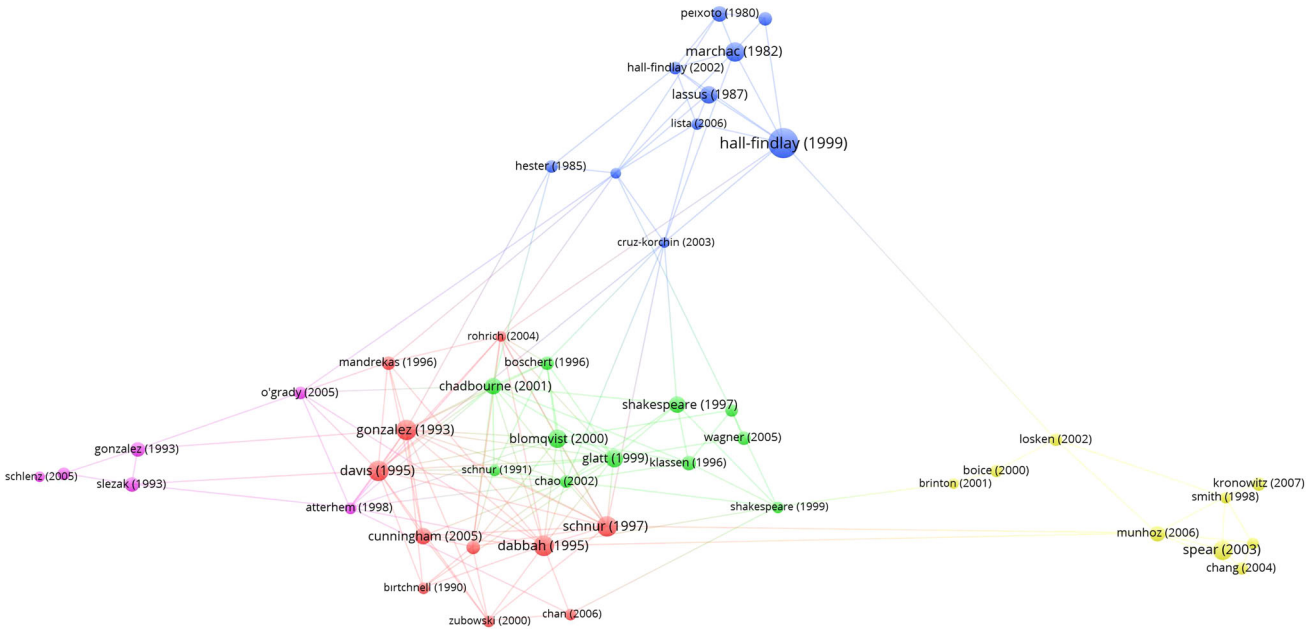

Fig. 4 Network visualization map of citation analysis of active authors according to documents on breast reduction

Active Countries

The three countries that had the most contributions according to the number of citations were the USA (515), England (147), and Turkey (83), respectively. The top 10 countries are shown in Fig. 3.

Active Institutes

The top five organizations that contributed to the literature in terms of the number of publications are Harvard University (15; 1.05%), New York University (15; 1.05%), The University of Texas (15; 1.05%), Federal University of São Paulo (14; 0.98%), and University São Paulo (14; 0.98%), and the top five organizations-enhanced ones are Harvard University (24; 1.68%), Karolinska Institute (19; 1.33%), Georgetown University (17; 1.19%), University of Hull (17; 1.19%), and New York University (16; 1.12%).

Active Authors and Citation analysis

The top two authors who contributed most according to the number of publications were Drew PJ and Iwuagwu OC (13; 0.91%). Other authors are presented in the first three columns of Table 1. The top two authors according to the citation rankings were Schnur PL (323) and Hall-Findlay EJ (259). The top 10 authors are presented in the last two columns of Table 1.

Citation Analysis

The top 10 articles that received the most citations are given in Table 2. With 189 citations, the top-cited publication was the document entitled "A Simplified Vertical Reduction Mammaplasty: Shortening the Learning Curve" written by Hall-Findlay, EJ published in Plastic and Reconstructive Surgery Journal in 1999 [7]. The study entitled "Experience with Reduction Mammaplasty Combined with Breast Conservation Therapy in the Treatment of Breast Cancer" written by Spear et al. [8] and published in Plastic and Reconstructive Surgery in 2003 was the top-cited document according to average citations per year. Of the 1427 articles, there were 50 articles that received at least 50 citations. The network map and density map in relation to the bibliometric analysis of these top-cited articles are shown in Figs. 4 and 5, respectively. An analysis of Fig. 4 shows that the authors are divided into 5 different clusters. The size of the circle indicates the number of citations the document received.

Active Journals

The journals with most publications were Plastic and Reconstructive Surgery (483; 33.85%), Annals of Plastic Surgery (164; 11.50%), and Aesthetic Plastic Surgery (147; 10.30%), respectively. The average number of citations according to year belonged to a journal out of these three journals, which was British Journal of Plastic Surgery. The first 4 columns of Table 3 present the first 10 journals that

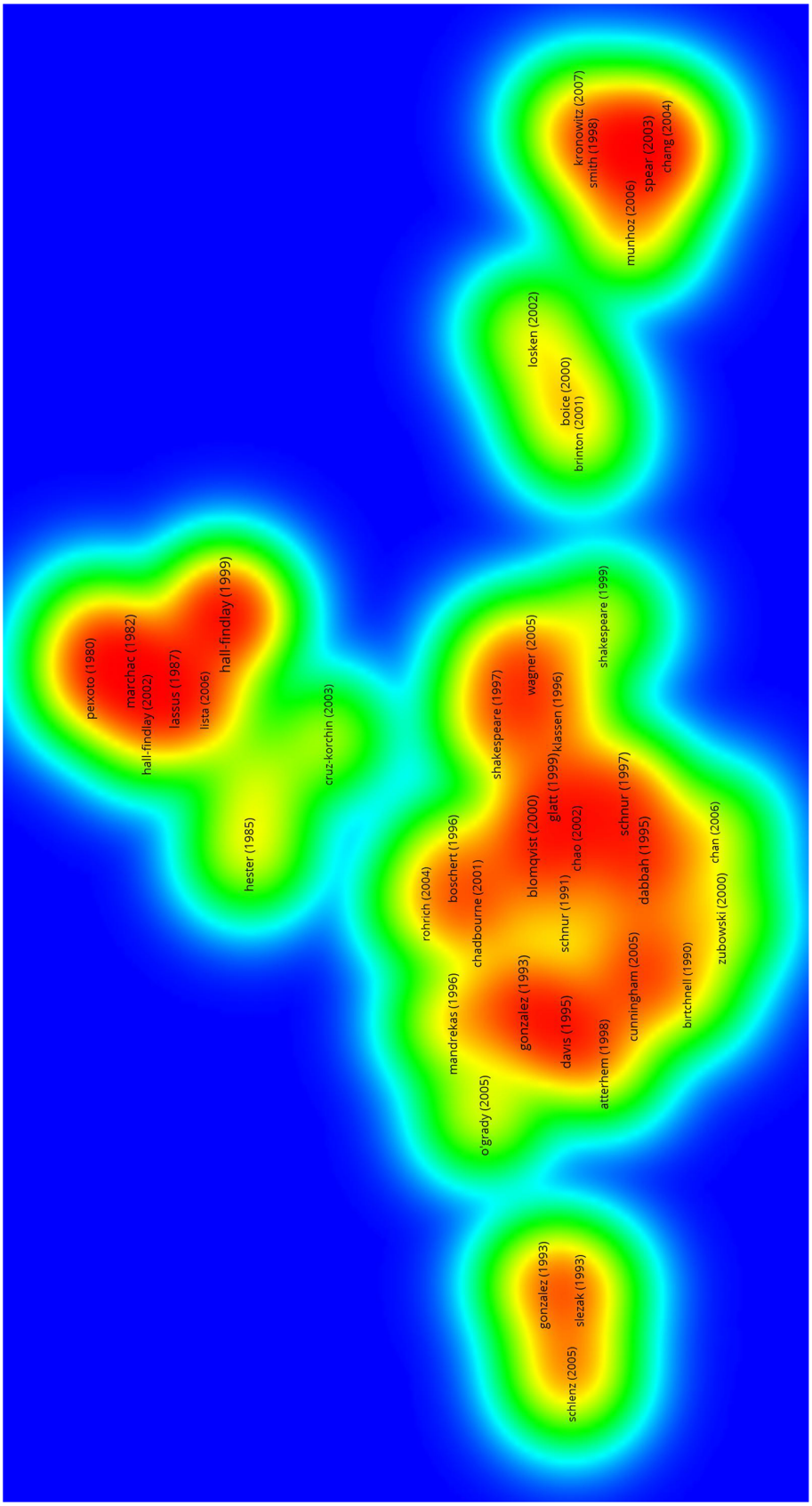

Fig. 5 Density map of citation analysis of active authors according to documents on breast reduction

Table 3 First 10 journal sources by number of publications and citations in breast reduction

Journal name	Number of publications	%	Citations	Journal name	Citations
Plastic and Reconstructive Surgery	483	33.85	6021	Plastic and Reconstructive Surgery	6021
Annals of Plastic Surgery	164	11.50	1864	Annals of Plastic Surgery	1864
Aesthetic Plastic Surgery	147	10.30	1032	British Journal of Plastic Surgery	1049
Journal of Plastic Reconstructive and Aesthetic Surgery	78	5.47	529	Aesthetic Plastic Surgery	1032
British Journal of Plastic Surgery	54	3.78	1049	Journal of Plastic Reconstructive and Aesthetic Surgery	529
Aesthetic Surgery Journal	41	2.87	101	Scandinavian Journal of Plastic and Reconstructive Surgery and Hand Surgery	316
Scandinavian Journal of Plastic and Reconstructive Surgery and Hand Surgery	22	1.54	316	American journal of surgery	147
Clinics in Plastic Surgery	17	1.91	98	Aesthetic Surgery Journal	101
European Journal of Plastic Surgery	15	1.05	57	Clinics in plastic surgery	98
Breast	11	0.77	61	British medical journal	89
Geburtshilfe Und Frauenheilkunde	11	0.77	9	Mayo clinic Proceedings	83

contributed to the literature most and the number of citations they received. The top 10 rankings according to the number of citations are given at the end of the last two columns of Table 3. Among 210 journals with a total number of 1427 publications, citation analysis relationships were performed with 79 journals that had at least two articles on this issue (Fig. 6). Circle size indicates the number of citations that the journals received.

Co-citation Analysis

The top three journals with most co-citations were Plastic and Reconstructive Surgery (6333), Annals of Plastic Surgery (1300), and Aesthetic Plastic Surgery (946). Among 2290 journals, co-citation analyses were performed with 60 journals that received at least 30 citations (Fig. 7). Circle size indicates the number of citations. Robbins TH, 1977 (128 citations) [9], Courtiss EH, 1977 (122 citations) [10], Lejour M, 1994 (112 citations) [11], Mckissock PK, 1972 (96 citations) [12], and Dabbah A, 1995 (91 citations) [13] were the five top-cited publications. From 8026 co-citations, analyses were performed with 40 articles that were cited at least 40 times (Fig. 8). Circle size indicates the number of citations.

Trend Topics Related to Breast Reduction

It was found that a total of 987 different keywords were used in 1427 publications. Analyses were performed with 53 keywords that were used at least 5 times. Mostly used keywords were reduction mammaplasty (204), breast reduction (176), breast (47), mammaplasty (mammoplasty) (60), gigantomastia (39), macromastia (33), breast cancer (32), breast hypertrophy (28), complications (24), mastopexy (24), breast surgery(21), reduction (17), quality of life (15), breast reconstruction (12), oncoplastic surgery (11), outcomes (11), plastic surgery (11), vertical scar (10), complication (9), surgery (9), pregnancy (9), breast reduction surgery (9), body mass index (8), obesity (8), mastectomy (8), and superomedial pedicle (8), respectively. Others are demonstrated in Fig. 9. The top-cited keywords among these are demonstrated in Fig. 10. The right bottom of the graph demonstrates the number of citations according to color. The number of citations

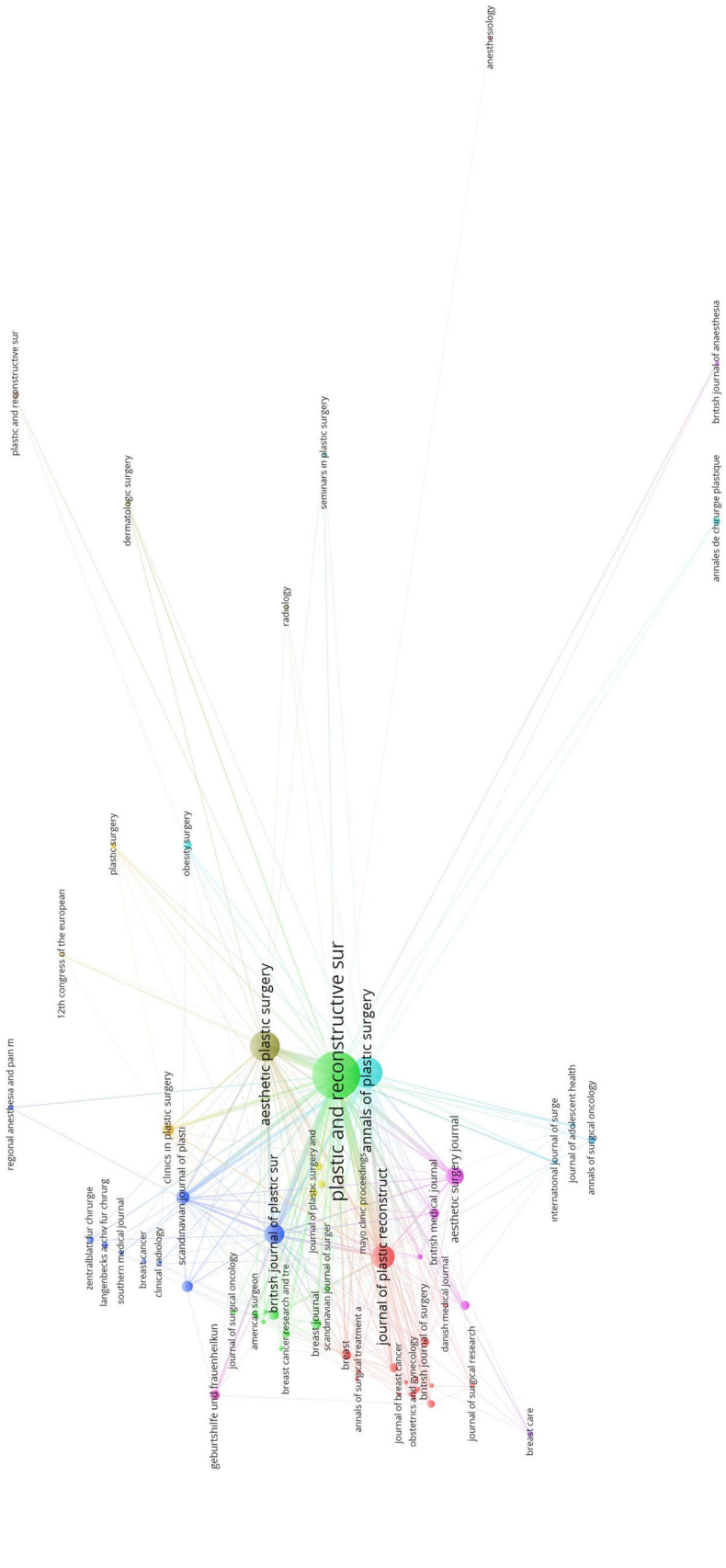

Fig. 6 Network visualization map of citation analysis of active journals in publishing articles

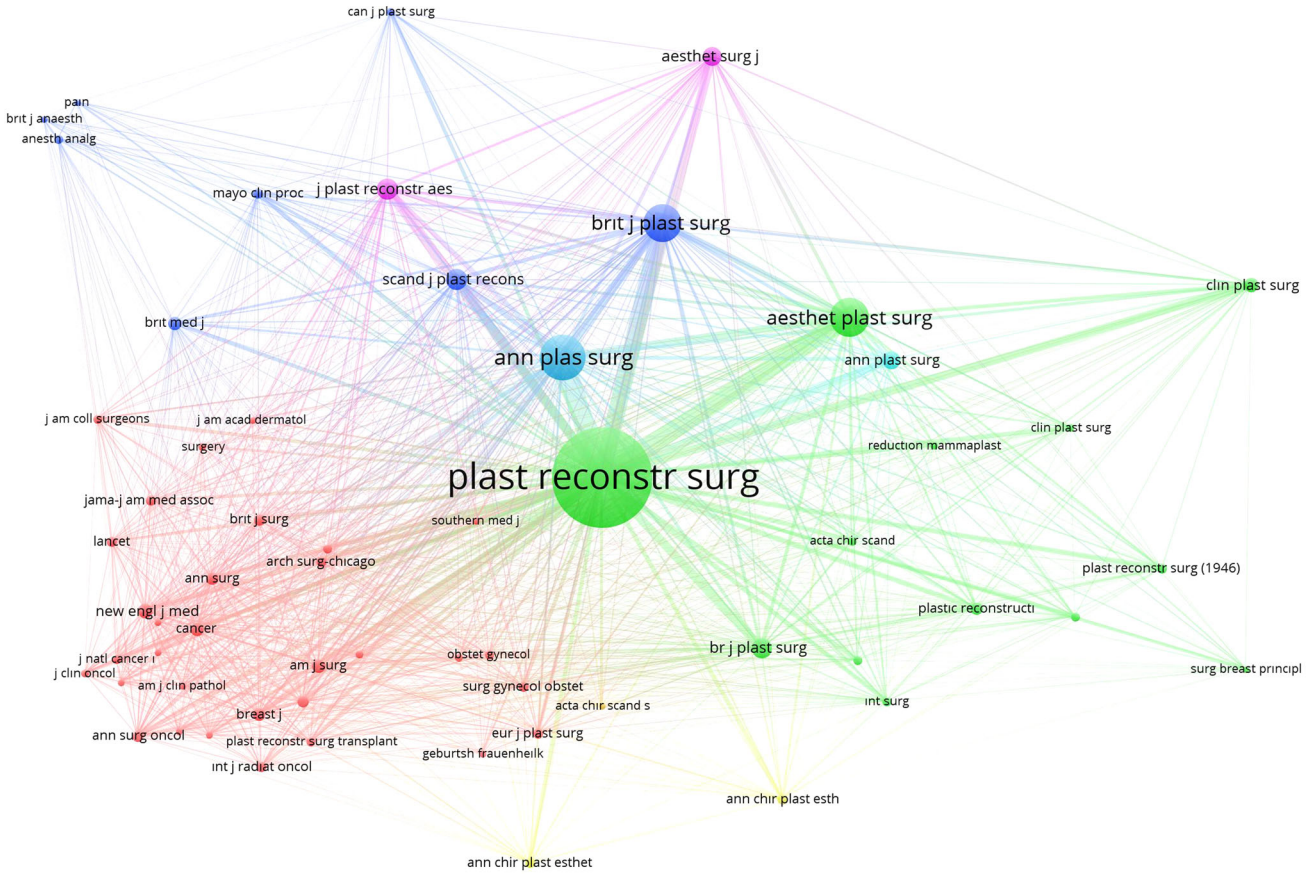

Fig. 7 Network visualization map of co-citation analysis of active journals in cited references

increases from blue to red. The top-cited trend keywords included body image, outcome, quality of life, smoking, complication, bilateral breast reduction, and self-esteem (Fig. 10).

Discussion

Parallel to communication networks and economic developments, there has been an increase in the awareness about breast reduction, leading to an increase in the number of patients operated on. However, the literature has a limited number of studies about the analysis of breast reduction publications. This study will enlighten specifically researchers in terms of the collaboration between trend topics, journals, countries, authors, as well as top-cited notable articles. This study is the first bibliometric study about the issue of breast reduction. International collaboration and some other analyses have been cited firstly in this present study.

An analysis of the publications in three plastic surgery journals in 2002 was performed in the article entitled "Analysis of publications in three plastic surgery journals for the year 2002" written by Huemer et al. [14] and published in Plastic and Reconstructive Surgery in 2004. The breast reduction section of the article presented breast reduction articles, new methods of reduction techniques, and analyses of post-operative results such as different scar patterns and nipple areola complex sensation; however, it was inadequate in terms of reflecting the publications about breast reduction. The article entitled "Plastic Surgery and the Breast: A Citation Analysis of the Literature" written by Cormac W et al. in 2014 and published in Plastic Reconstructive Surgery Glob Open journal reported 100 top-cited articles about breasts in the plastic surgery literature and analyzed the features of these articles. Features such as topic, article type, country of origin, institution, authorship, and publication year of the articles were investigated separately. Findings showed that, with the top-cited 100 articles and 81 articles including the top-cited article, Plastic Reconstructive Surgery was identified as the journal that provided the most contribution. The USA produced 73% of the top 100 articles. The most productive institution was Texas University and M. D. Anderson Cancer Center [15]. The study included only citation analyses and a limited number of article analyses; there

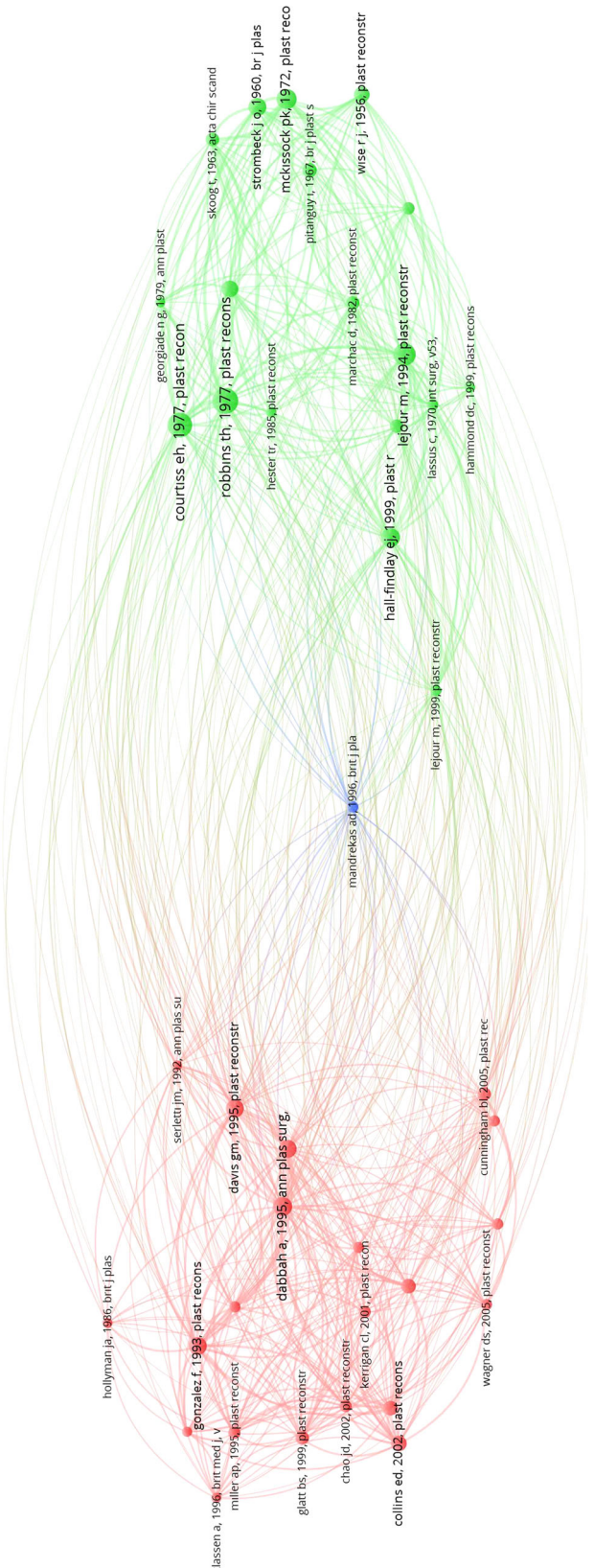

Fig. 8 Network visualization map of co-citation analysis of active journals in cited sources

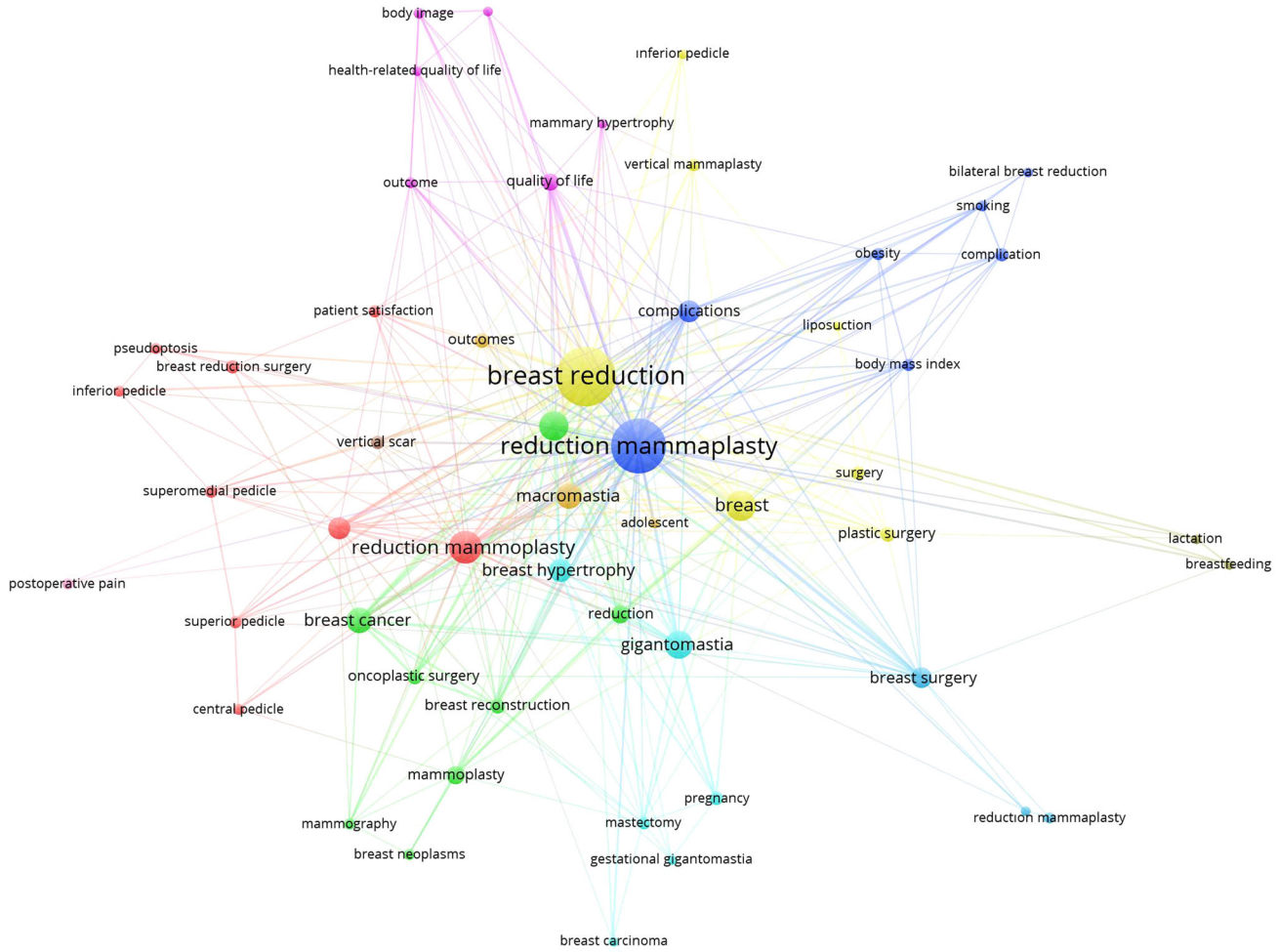

Fig. 9 Network visualization map of relationships between the most commonly used keywords in the abstract on breast reduction

were no research analyses that were performed directly with breast reduction. In the study entitled "A Bibliometric Analysis of the 100 Most-cited Articles in Rhinoplasty" published in Plastic Reconstructive Surgery Glob Open journal in 2016, Sinha et al. [16] made an analysis of the most cited 100 publications about rhinoplasty. There are no bibliometric studies about breast reduction in the literature.

Findings showed that apart from surgery, breast reduction was used widely in the fields of oncology and obstetrics gynecology. An analysis of the number of publications and citations according to years showed that the number of publications and citations has increased rapidly in recent years; the number of studies on this issue seems to be increasing. Specifically, 1965 seems to be a critical year. It was found that the USA contributed to the literature most, followed by England and Turkey. Not only the developed countries but also developing countries, particularly Turkey and Brazil, were found to have contributions to the literature significantly higher than other developed countries. Most publications were found to be produced by Harvard University. The most active authors, according to the number of publications, were Drew PJ and Iwuagwu OC, and Schnur PL, and Hall-Findlay were the most active authors according to the number of citations. "A Simplified Vertical Reduction Mammaplasty: Shortening The Learning Curve" written by Hall-Findlay, EJ was the most important study in terms of the average number of citations per year. The second most important study in terms of the average number of citations per year was "Experience with Reduction Mammaplasty Combined with Breast Conservation Therapy in the Treatment of Breast Cancer" by Spear, SL; Pelletiere, CV; Wolfe, AJ; et al. An analysis of the figures obtained from the bibliometric analysis showed that in terms of both publication productivity and citation-co-citation, the most important journals in this field were Plastic and Reconstructive Surgery, Annals of Plastic Surgery, Aesthetic Plastic Surgery, and British Journal of Plastic Surgery. The study entitled "A reduction mammaplasty with the areola-nipple based on an inferior dermal pedicle" by Robbins TH published in Plastic

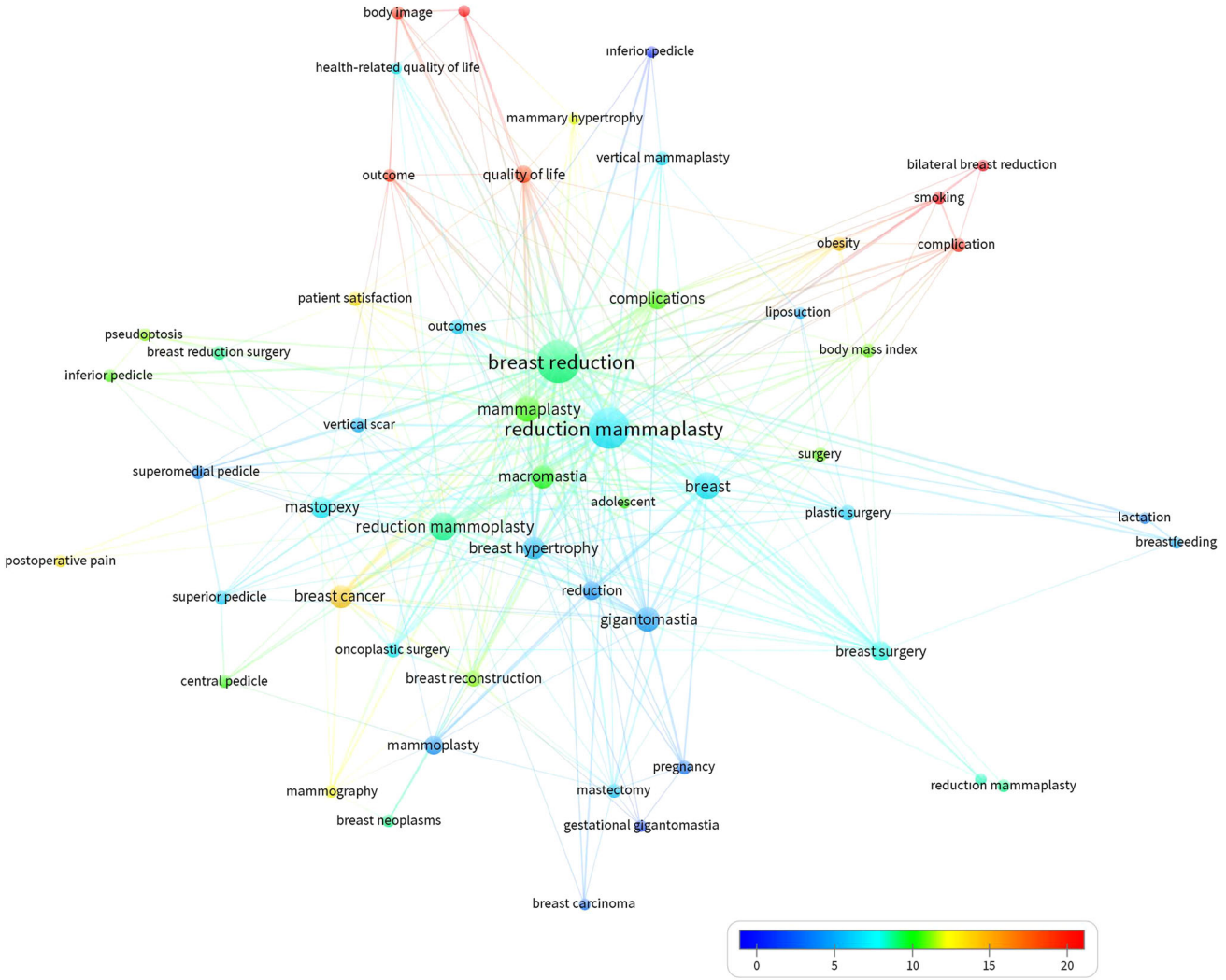

Fig. 10 Network visualization map of the most cited keyword in the abstract on breast reduction. Right bottom of the graph demonstrates number of citations according to color. Number of citations increases from blue to red

Reconstructive Surgery journal in 1977 was the publication that received most co-citations. Body image, outcome, quality of life, smoking, complication, bilateral breast reduction, and self-esteem were the trend keywords that received the most citations. Keyword analysis enabled to reveal the titles mostly highlighted in breast reduction operations.

Conclusion

The rapid increase, specifically after 1995, indicates that the following years will involve more and more studies on the issue of breast reduction. The USA contributed to the literature about breast reduction most. Other remarkable journals were *Plastic and Reconstructive Surgery, Annals of Plastic Surgery, Aesthetic Plastic Surgery and British Journal of Plastic Surgery*. Although the literature was contributed by the developed countries, developing countries, specifically Turkey and Brazil, also had significantly high contributions to the literature.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Informed Consent For this type of study formal consent is not required.

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