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## A SCIENTOMETRIC ANALYSIS ON POLYCYSTIC OVARIAN SYNDROME BETWEEN 1975 AND 2018

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**Introduction:** This study aimed at a scientometric analysis of Polycystic Ovarian Syndrome (PCOS) Literature.

**Materials and Methods:** The web of Science database was used to analyze specific keywords for PCOS. GunMap 2 and VOSviewer were used to generate data analysis, tables, and figures.

**Results:** A total of 6015 publications were published between 1975 and 2018. 73.12% of them are original articles. The branch of medicine which has the most publication is Obstetrics and Gynecology. The top country is The USA, followed by the UK and China, respectively. The most published journal on PCOS is Fertility and Sterility, with 624 publications. H index of the PCOS is 150.

**Conclusion:** Approximately 52% of the scanned publications related to PCOS were made from the USA, UK, China, and Italy. The contribution of all remaining countries to the literature is less than these four countries. Researchers in these remaining countries should be encouraged and supported to make publications.

**Keywords:** Stein-Leventhal Syndrome, PCOS, Polycystic Ovarian Syndrome, scientometric, analysis, bibliometric

### 1. Introduction

Stein and Leventhal first described polycystic Ovary Syndrome (PCOS) in 1935. The authors described a triad of amenorrhea, hirsutism, and polycystic ovaries (Leventhal, 1935). The syndrome's pathophysiology has not been fully understood, although it was first described in 1935 and many years passed. PCOS diagnosis is made by detecting two of the 3 characteristic findings (Fauser, 2003).

Scientometrics, also known as "science of science," is a novel and popular statistical field to clarify publication patterns and trends in a specific area (Senel, 2017). Although there has been an increasing popularity of bibliometric and scientometric evaluation of academic productivity in recent years, to the best of our knowledge, medical literature lacks a scientometric study relevant to PCOS. Therefore, the present study was aimed to analyze PCOS literature in a scientometric manner.

## 2. Materials and methods

All data we evaluated in our scientometric analyses were retrieved from the Web of Science database (WoS, Thomson Reuters, New York, NY, USA) Core Collection. The keywords of "polycystic ovary syndrome, polycystic ovarian syndrome, and PCOS" were used for our search. All materials produced between 1975 and 2018 were included in the analyses performed in the present study. *GunnMap* 2 mapping tool was used to generate an info-map showing global productivity of PCOS publications (GunnMap, Accessed January, 12, 2018). Scientometric networks were created using VOSviewer free software version 1.6.7 (Vosviewer).

## 3. Results

### General features of PCOS literature

We found 6015 documents relevant to PCOS between 1975 and 2018. The most common document type was an original article (73.12%) followed by review and abstract (13.53 and 7.75%, respectively; Table 1). The most studied areas in PCOS literature were Obstetrics / Gynecology, Reproductive Biology, and Endocrinology (n=2806, 1970 and 1604 items, respectively; Table 2). English was the dominant language of the literature with 5848 documents (97.22%) followed by French, German, Spanish, and Russian (n=63, 39, 21, and 9 papers, respectively).

### Countries, authors, institutions, and journals

The United States of America was detected to be the leading country of PCOS literature with 1623 articles (26.98%) followed by the UK, China, Italy, and Canada (9.31, 8.36, 7.46 and 4.27%, respectively; Figure 1). However, publications relevant to PCOS were noted to be produced from nearly all regions of the world except for most countries in Africa (Figure 2). Franks S from the UK was the most prolific author with 71 papers in PCOS literature (Table 3). The University of California System from the USA was the highest contributing institution with 188 documents, followed by Harvard University, University of London, and Pennsylvania Commonwealth System of Higher Education (n=142, 134 and 104 papers, respectively; Table 4). Fertility and Sterility was the most productive source title with 624 articles (10.37%) followed by Human Reproduction, Journal of Clinical Endocrinology Metabolism, and Gynecological Endocrinology (8.19, 4.87 and 3.92%, respectively; Table 5).

### Citations and scientometric network analyses

H index of the PCOS literature was measured as 150, and the total number of citations was 153,409 (116,099 without self-citations). The average citations per item were 25.51. The most cited document in PCOS literature was an original article titled "Revised 2003 consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome" written by Chang J *et al.* in 2004. The most used keywords of PCOS literature were noted to be "polycystic ovarian syndrome," "obesity," and "hyperandrogenism" (Table 7). Scientometric keyword network analysis revealed a "starburst" pattern in which the keyword of "polycystic ovarian syndrome" centered (Figure 3). The USA was the most collaborative country, followed by the UK, Italy, Australia, and Canada (Figure 4). Yale University from the USA, Shandong University from China, and the University of Michigan from the USA were the most collaborative institutions (Figure 5).

#### 4. Discussion

According to the National Institutes of Health, PCOS is the most common endocrine disease in women, and its prevalence is between 6 and 10%. The prevalence of the disease is raised to 15% if Rotterdam criteria are used. In one study, the prevalence was reported up to 20% (Yen, 1970; Wang, 2017; Lizneva, 2016)). The syndrome is associated with increased levels of androgens. Because of this, some cutaneous lesions such as hirsutism and acne may be seen (Yılmaz, 2016). In addition, PCOS has an increased risk of cardiovascular diseases because of increased incidence of hypertension, insulin resistance, adverse lipid profile and is associated with a higher risk of gestational diabetes mellitus and diabetes mellitus independent of body mass index (Joham, 2013; Sathyapalan, 2012). PCOS is a complex endocrinological disease in which subclinical infertility (adverse infant and maternal pregnancy outcome, ovulation) and psychological diseases (anxiety, low self-esteem, depression) are seen (McCuen, 2017; Lizneva, 2016).

Research investigating the different disorders and conditions in previous scientific studies has found that PCOS literature's predominant country is the United States of America. Unlike the latest scientometric reports, our study indicated that developing countries such as China, Turkey, and Iran are on the top ten productive countries list (Senel 2019; Senel 2018; 2018<sup>b</sup>). The scientific publications related to PCOS have increased since 1990, doubled in 2006, and reached 200 publications annually. In 2012, publications doubled to almost 400 per year (Bruggmann, 2017). This increase in PCOS studies may be due to the investigation of metformin in the treatment and an increase in genetic studies (18). The USA is the country with the highest number of publications as expected and followed by the UK and China. Among the top ten countries, there are countries like Turkey and Iran. This finding is similar to a previous study (Velazquez, 1994). PCOS is a multidisciplinary disease, and it concerns many branches of medicine. This study determined that many of the publications about Gynecology and Obstetrics were related with PCOS in many branches such as Molecular Biology, Pediatrics, Pharmacology, Cell Biology, and Genetics.

Key message: PCOS is a syndrome associated with many clinical conditions and has been the subject of many studies, but more research is still needed to understand.

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**Table 1.** Document types in scientific literature relevant to polycystic ovarian syndrome published between 1975 and 2018

| Document Type         | Number <sup>a</sup> | % <sup>a</sup> |
|-----------------------|---------------------|----------------|
| Original Article      | 4398                | 73.12          |
| Abstract              | 466                 | 7.75           |
| Review                | 814                 | 13.53          |
| Proceedings Paper     | 346                 | 5.75           |
| Note                  | 14                  | 0.23           |
| Letter                | 60                  | 0.99           |
| Editorial Material    | 119                 | 1.98           |
| News                  | 1                   | 0.02           |
| Correction            | 12                  | 0.2            |
| Book Chapter          | 17                  | 0.28           |
| Discussion            | 2                   | 0.03           |
| Book Review           | 1                   | 0.02           |
| Retracted Publication | 3                   | 0.05           |
| <b>Total</b>          | <b>6015</b>         | <b>100</b>     |

<sup>a</sup> Total number may exceed the number of the publications in this field, and total percentages may exceed 100% because certain items were included in more than one category

**Table 2.** The first 10 research areas of the publications related to polycystic ovarian syndrome published between 1975 and 2018

| Research Areas          | Number of publications <sup>a</sup> | % <sup>a</sup> |
|-------------------------|-------------------------------------|----------------|
| Obstetrics / Gynecology | 2806                                | 46.65          |
| Reproductive Biology    | 1970                                | 32.75          |
| Endocrinology           | 1604                                | 26.67          |
| Internal Medicine       | 365                                 | 6.07           |
| Experimental Medicine   | 189                                 | 3.14           |
| Molecular Biology       | 174                                 | 2.89           |
| Pediatrics              | 161                                 | 2.68           |
| Pharmacology            | 152                                 | 2.53           |
| Cell Biology            | 140                                 | 2.33           |
| Genetics                | 112                                 | 1.86           |

<sup>a</sup> Total number may exceed the number of the publications in this field, and total percentages may exceed 100% because certain items were included in more than one category

**Table 3.** The first ten authors by record count in the literature of polycystic ovarian syndrome published between 1975 and 2018

| Author      | Country     | Record Count | %*   |
|-------------|-------------|--------------|------|
| Franks S    | UK          | 71           | 1.18 |
| Dewailly D  | France      | 66           | 1.1  |
| Fauser BCJM | Netherlands | 60           | 1    |
| Homburg R   | UK          | 55           | 0.91 |
| Legro RS    | USA         | 54           | 0.9  |
| Norman RJ   | Australia   | 45           | 0.75 |
| Tan SL      | Canada      | 44           | 0.73 |
| Azziz R     | USA         | 41           | 0.68 |
| Chen ZJ     | China       | 38           | 0.63 |
| Duleba AJ   | USA         | 38           | 0.63 |

\*of total documents published in polycystic ovarian syndrome literature

**Table 4.** The top ten institutions by number of publications in the literature of polycystic ovarian syndrome published between 1975 and 2018

| Organization                                         | Country | Document number | %    |
|------------------------------------------------------|---------|-----------------|------|
| University of California System                      | USA     | 188             | 3.13 |
| Harvard University                                   | USA     | 142             | 2.36 |
| University of London                                 | UK      | 134             | 2.23 |
| Pennsylvania Commonwealth System of Higher Education | USA     | 104             | 1.73 |
| Imperial College London                              | UK      | 90              | 1.5  |
| University of Athens                                 | Greece  | 88              | 1.46 |
| Universidad de Chile                                 | Chile   | 80              | 1.33 |
| Assistance Publique – Hôpitaux de Paris              | France  | 79              | 1.31 |
| McGill University                                    | Canada  | 79              | 1.31 |
| Yale University                                      | USA     | 77              | 1.28 |

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**Table 5.** The first ten journal sources in the literature of polycystic ovarian syndrome, according to the number of published documents

| Journal Name                                                       | Number of Publications | %     |
|--------------------------------------------------------------------|------------------------|-------|
| Fertility and Sterility                                            | 624                    | 10.37 |
| Human Reproduction                                                 | 493                    | 8.19  |
| Journal of Clinical Endocrinology Metabolism                       | 293                    | 4.87  |
| Gynecological Endocrinology                                        | 236                    | 3.92  |
| Reproductive Biomedicine Online                                    | 108                    | 1.79  |
| Clinical Endocrinology                                             | 105                    | 1.74  |
| European Journal of Obstetrics Gynecology and Reproductive Biology | 83                     | 1.38  |
| Human Reproduction Update                                          | 73                     | 1.21  |
| Endocrinology                                                      | 72                     | 1.2   |
| Journal of Assisted Reproduction and Genetics                      | 72                     | 1.2   |

**Table 6.** Ten most cited manuscripts in polycystic ovarian syndrome literature

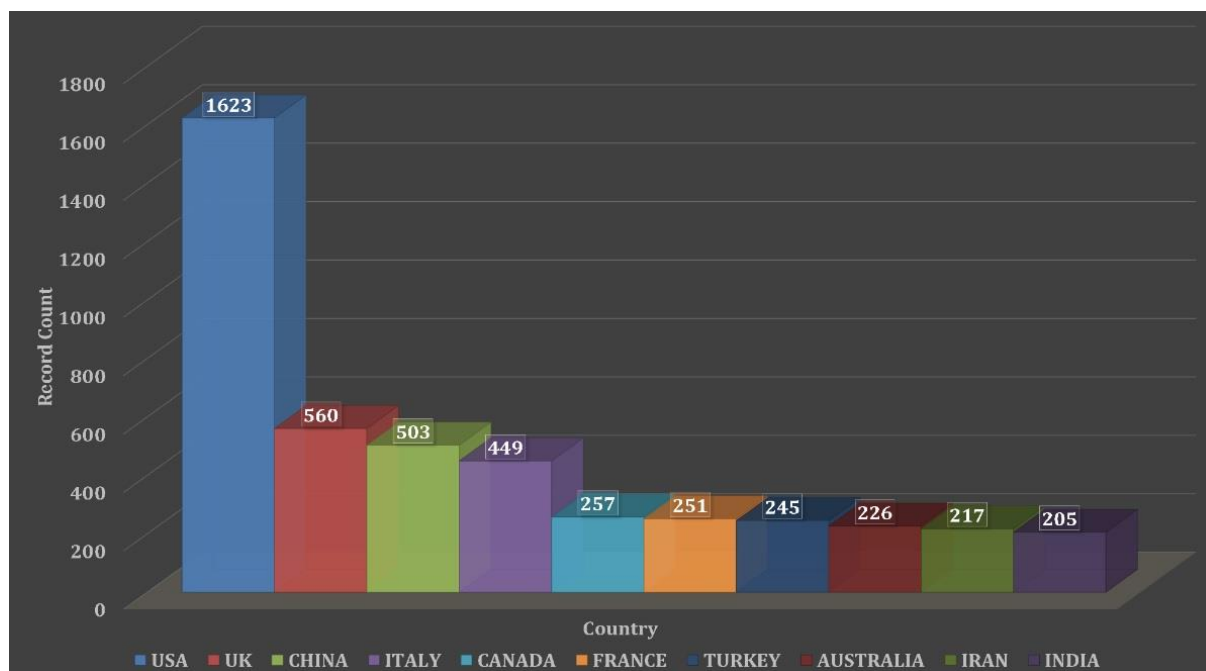
| Article                                                                                                                                              | Author                                                             | Journal Name/Published                         | Total Citation | Average Citations per Year |
|------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|------------------------------------------------|----------------|----------------------------|
| Revised 2003 consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome                                        | Chang, J; Azziz, R; Legro, R; <i>et al.</i>                        | Fertility and Sterility                        | 2366           | 147.88                     |
| Revised 2003 consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome (PCOS)                                 | Fauser, BCJM; Chang, J; Azziz, R; <i>et al.</i>                    | Human Reproduction                             | 2339           | 146.19                     |
| Aromatase Deficiency in Male and Female Siblings Caused by A Novel Mutation and The Physiological-Role of Estrogens                                  | Morishima, A; Grumbach, MM; Simpson, ER; <i>et al.</i>             | Journal of Clinical Endocrinology & Metabolism | 984            | 39.36                      |
| The Androgen Excess and PCOS Society criteria for the polycystic ovary syndrome: the complete task force report                                      | Azziz, Ricardo; Carmina, Enrico; Dewailly, Didier; <i>et al.</i>   | Fertility and Sterility                        | 842            | 76.55                      |
| Cellular and molecular mechanisms of metformin: an overview                                                                                          | Viollet, Benoit; Guigas, Bruno; Sanz Garcia, Nieves; <i>et al.</i> | Clinical Science                               | 709            | 88.63                      |
| Obesity, endogenous hormones, and endometrial cancer risk: A synthetic review                                                                        | Kaaks, R; Lukanova, A; Kurzer, MS                                  | Cancer Epidemiology Biomarkers & Prevention    | 647            | 35.94                      |
| The role of TNF alpha and TNF receptors in obesity and insulin resistance                                                                            | Hotamisligil, GS                                                   | Journal of Internal Medicine                   | 581            | 27.67                      |
| Improvement in Endocrine and Ovarian-Function During Dietary-Treatment of Obese Women with Polycystic-Ovary-Syndrome                                 | Kiddy, DS; Hamiltonfairley, D; Bush, A; <i>et al.</i>              | Clinical Endocrinology                         | 569            | 20.32                      |
| Decreases in ovarian cytochrome P450c17 alpha activity and serum free testosterone after reduction of insulin secretion in polycystic ovary syndrome | Nestler, JE; Jakubowicz, DJ                                        | New England Journal of Medicine                | 541            | 22.54                      |
| Ultrasound assessment of the polycystic ovary: international consensus definitions                                                                   | Balen, AH; Laven, JSE; Tan, SL; <i>et al.</i>                      | Human Reproduction Update                      | 536            | 31.53                      |

**Table 7.** Most used 40 keywords in PCOS literature between 1975 and 2018

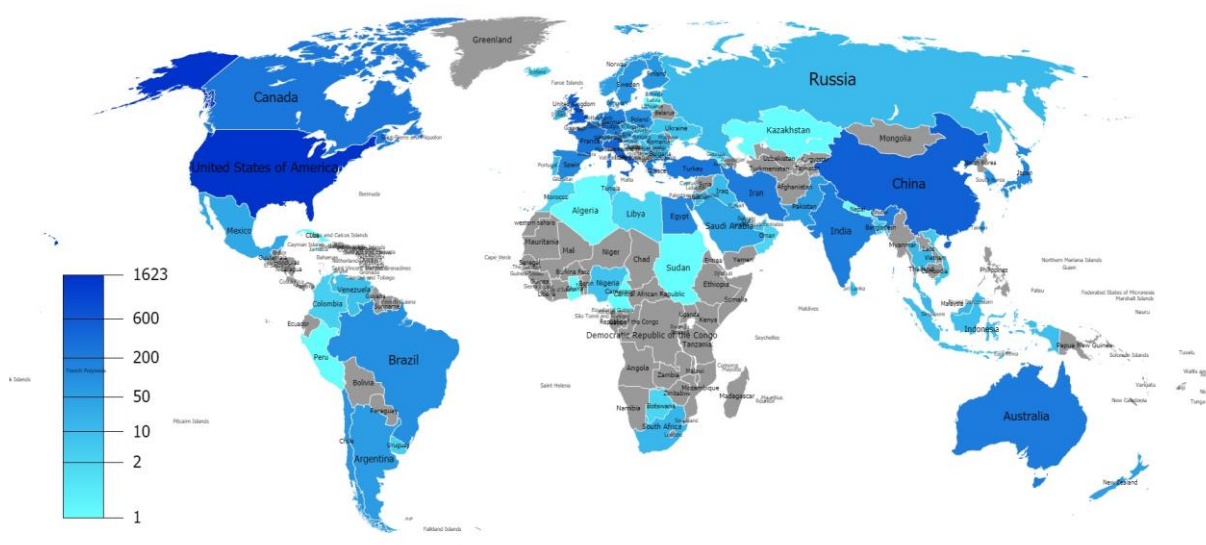
| Keyword                                    | Occurrences | Total link strength | Keyword                  | Occurrences | Total link strength |
|--------------------------------------------|-------------|---------------------|--------------------------|-------------|---------------------|
| 1. Polycystic ovary/ovarian syndrome, PCOS | 1075        | 2656                | 2. Obesity               | 240         | 780                 |
| 3. Hyperandrogenism                        | 240         | 780                 | 4. Insulin resistance    | 228         | 692                 |
| 5. Metformin                               | 210         | 682                 | 6. Infertility           | 162         | 495                 |
| 7. Androgen(s)                             | 156         | 462                 | 8. Ovulation induction   | 148         | 457                 |
| 9. Anti-Mullerian hormone, AMH             | 154         | 443                 | 10. Anovulation          | 116         | 405                 |
| 11. Hirsutism                              | 124         | 397                 | 12. Pregnancy            | 118         | 373                 |
| 13. IVF                                    | 115         | 357                 | 14. Testosterone         | 113         | 326                 |
| 15. Metabolic syndrome                     | 97          | 323                 | 16. Insulin              | 94          | 319                 |
| 17. Clomiphene citrate                     | 97          | 317                 | 18. Ovarian reserve      | 97          | 262                 |
| 19. Ovarian hyperstimulation syndrome      | 93          | 233                 | 20. Ovulation            | 66          | 214                 |
| 21. Fertility                              | 70          | 205                 | 22. LH                   | 57          | 203                 |
| 23. FSH                                    | 54          | 182                 | 24. Gonadotropins        | 49          | 179                 |
| 25. Leptin                                 | 54          | 178                 | 26. Endometriosis        | 59          | 168                 |
| 27. Steroidogenesis                        | 52          | 167                 | 28. Letrozole            | 53          | 162                 |
| 29. Progesterone                           | 57          | 162                 | 30. Puberty              | 40          | 154                 |
| 31. Ultrasound                             | 51          | 154                 | 32. Follicular fluid     | 54          | 153                 |
| 33. Laparoscopic ovarian drilling          | 55          | 153                 | 34. Body mass index, BMI | 45          | 151                 |
| 35. Oocyte                                 | 46          | 147                 | 36. Granulosa cells      | 50          | 142                 |
| 37. Diabetes                               | 42          | 138                 | 38. Ovarian stimulation  | 45          | 137                 |
| 39. Adolescence                            | 38          | 129                 | 40. Menopause            | 39          | 129                 |

## Figure Legends

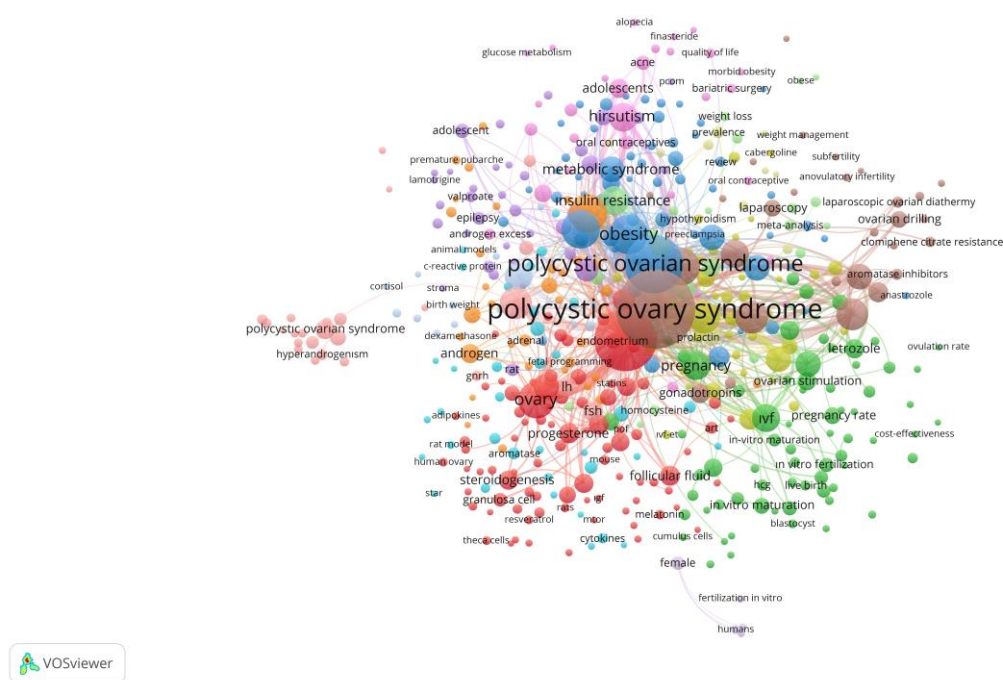
**Figure 1.** Top ten countries producing PCOS publications between 1975 and 2018



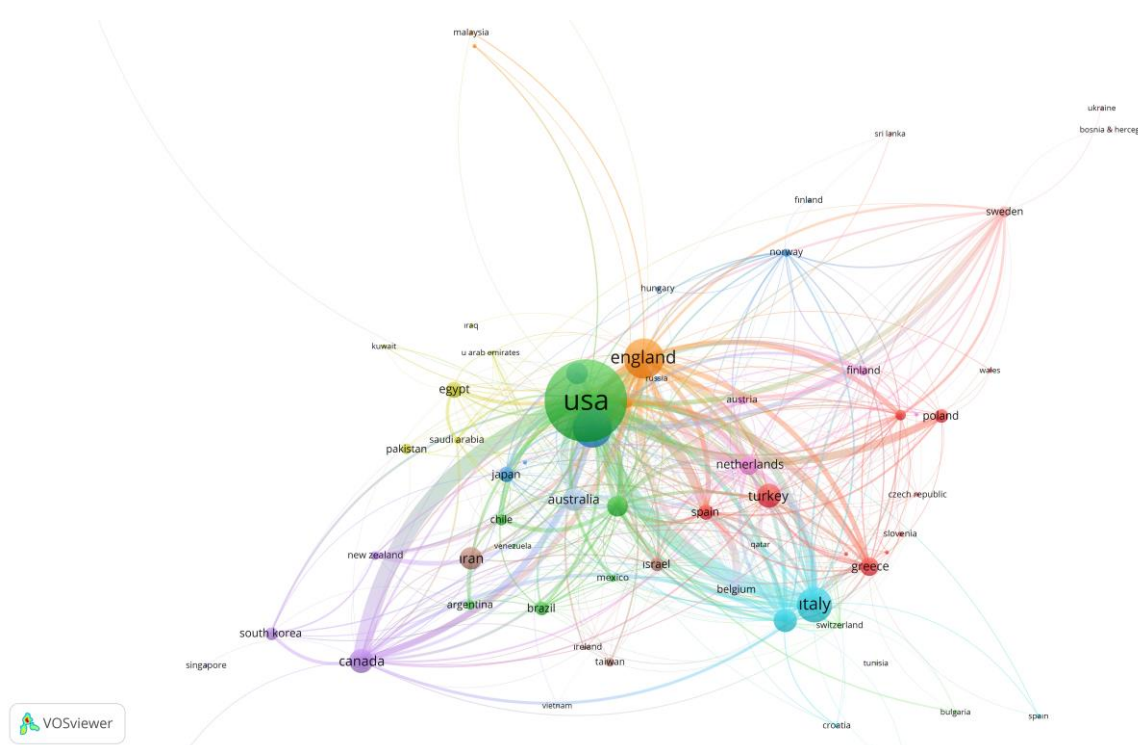
**Figure 2.** Distribution map of global productivity in PCOS literature between 1975 and 2018



**Figure 3.** Keyword network of PCOS literature



**Figure 4.** Scientometrics network of the most collaborative country in PCOS literature



**Figure 5.** Scientometrics network of the most collaborative institutions in PCOS literature