

Effect of Yoga Intervention on Polycystic Ovarian Disease - Bibliometric Analysis

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Abstract: Polycystic Ovarian Disease (PCOD) is an endocrine pathology prevalent among women of reproductive age, distinguished by menstrual irregularities, hyperandrogenic manifestations, and the presence of polycystic ovarian morphology. Non-pharmacological interventions, such as yoga, are increasingly explored for managing PCOD symptoms. This study evaluates the research trajectory on yoga interventions for PCOD using bibliometric data analysis. A bibliometric analysis was conducted using the SCOPUS database. Stringent inclusion criteria were applied, focusing on studies centered on yoga interventions for PCOD, published in English, and accessible through Open Access journals. Out of the initial pool of 26 journals, 17 articles were closely examined, resulting in the final selection of 6 articles for in-depth analysis. The analysis revealed a significant rise in publications on yoga for PCOD, highlighting its growing recognition as a non-pharmacological treatment. These findings emphasize the need for interdisciplinary collaboration and further evidence-based studies to confirm yoga's effectiveness in managing PCOD, suggesting its potential role in comprehensive care for women with PCOD.

Keywords: Polycystic Ovarian Disease, Yoga, Bibliometric Analysis

1. Introduction

Polycystic ovarian Disease (PCOD) is an endocrine pathology that impacts a woman's Ovaries, contain eggs may fail to mature and form tiny cysts. These sacs may enlarge and fill with liquid. In extreme cases (Madhu et al., 2013) reported an instance where a surgically removed ovarian tumor weighed 56.95 kilograms, illustrating the potential severity of this condition.

The underlying issues often start with the hypothalamic-pituitary-ovarian (HPO) axis, (Mohammed et al., 2021), Follicle Stimulating Hormone (FSH) and luteinizing hormone (LH) facilitate the stimulation of the pituitary gland to secrete. Under normal physiological conditions, the menstrual cycle is meticulously regulated by a delicate equilibrium of hormones, including FSH and LH, which orchestrate the maturation and release from the ovaries. In PCOD, the hormonal imbalance often involves elevated levels of androgens (male hormones). This imbalance prevents the eggs from maturing properly and being released during ovulation. This leads to hypo menorrhea, hyper menorrhea and amenorrhea because the hormone progesterone isn't produced (Wardhan, 2016).

PCOD is on the rise among women due to factors like unhealthy lifestyles significantly influence the severity of PCOD (Pathak & Nichter, 2015), Poor dietary habits can contribute to insulin resistance and weight gain, both key risk factors for PCOD (Shrestha et al., 2019). Chronic stress further disrupts hormonal balance (Goyal et al., 2021), and sedentary lifestyles characterized by lack of physical activity worsen metabolic dysfunction, increasing susceptibility to PCOD (Verma et al., 2024).

Polycystic Ovarian Syndrome (PCOS), often used interchangeably with PCOD, affects a significant percentage of women worldwide. According to the World Health Organization (2023) said up to 70% of women afflicted with polycystic ovary syndrome (PCOS) may remain undiagnosed, culminating in the persistence of untreated symptoms and chronic health complications. In India, Minhas (2023) a study highlighted the prevalence of PCOD across various age groups: 3.8% in teenage girls, 16.81% in young

adults, 11.58% in adults, 1.44% in older adults, and 0.55% in seniors, with the highest prevalence observed in women aged 18-35 years (Jalilian et al., 2015; Bhambhu et al., 2022).

PCOD symptoms manifest across biological, psychological, and social dimensions, significantly impacting a woman's overall well-being. Biologically, PCOS presents with symptoms such as irregular periods, obesity, and hirsutism. The predisposition to developing type 2 diabetes, hypercholesterolemia, hypertension, and endometrial carcinoma, fertility challenges. PCOS can be passed down through genes from parents or can develop due to changes in the womb environment before birth (Gu et al., 2015). Psychologically, PCOD can cause negative body image, eating disorder and mood states. It can lead to more severe issues such as severe depression and anxiety disorders. Socially, the symptoms of hirsutism and obesity can result in social stigma, negatively impacting a woman's quality of life and contributing to chronic health issues. Additionally, the symptoms associated with PCOD may vary over time.

Recent studies have expanded the understanding of PCOD's multifaceted impact. Emerging research suggests links between PCOD and cognitive dysfunction later in life, indicating that imbalances hormones may adversely affect neurological function (Huddleston et al., 2024). As highlighted in the article "PCOS and Thyroid Disorders - Unravelling The Interconnection," there is an increased prevalence of thyroid dysfunction among individuals with PCOD, suggesting a complex and intertwined relationship between these endocrine disorders (The Time Now, 2024).

Effective management of PCOD requires a comprehensive approach, combining lifestyle modifications, psychosocial support regular physical activity, a balanced diet and stress reduction techniques to improve insulin sensitivity, promote weight management, and alleviate symptoms. Although there is no definitive cure, these management strategies can markedly improve the quality of life for women suffering from PCOD (Baidya & Kumari, 2023; Devi & Rani, 2022).

Yoga has emerged as a promising complementary therapy for managing PCOD. It offers a holistic approach that integrates physical, mental, and emotional well-being. Yoga practices, encompassing asanas (physical postures), pranayama (breath control techniques), and meditation help to regulate the endocrine system, improve metabolic health, and reduce stress. Specific yoga postures enhance muscle strength, improve insulin sensitivity, and facilitate weight management. Regular yoga practice also promotes cardiovascular health and hormonal balance. Research indicates that yoga can significantly reduce serum testosterone and prolactin levels, mitigate anxiety, and enhance overall well-being in women with PCOD (Singh, 2022; Wardhan, 2016; Subramanya & Telles, 2009; Devi & Rani, 2022).

The impact of PCOD on women's health, a substantial proportion of affected women remains undiagnosed and lack awareness of effective management strategies. According to a survey conducted by OZiva, 65% of women in India remain largely unaware of the symptoms associated with PCOS. (ET HealthWorld, 2021), 35% of women have never discussed their condition, and 48% feel uncomfortable discussing it. Alarmingly, 25% of Indian women are unaware of PCOS or PCOD. This diagnostic gap leads to untreated symptoms and long-term health issues. Therefore, there is a critical need to explore alternative and complementary therapies, such as yoga, to provide holistic management options for PCOD.

Bibliometric analysis involves the quantitative examination of scholarly literature, offering an objective approach to research that reduces the potential for reviewer biases often present in qualitative reviews. The primary aim is to identify research clusters and emerging trends to guide future studies. This is achieved using bibliometric tools such as the VOSviewer and Biblioshiny software. Through bibliometric analysis, researchers can pinpoint key contributors, including authors, countries, and institutions that have made significant contributions to a specific domain. Additionally, cluster analysis reveals the interconnectedness of various works within the field. By quantitatively interpreting changes in a particular area of study, bibliometric analysis provides insights into publication trends and patterns on a specific theme. It delivers valuable and timely information, making it a critical tool for understanding and evaluating advancements in a given subject (Sutar et al., 2024).

This research seeks to address the current gap by conducting an exhaustive bibliometric analysis of the impact of yoga interventions on PCOD, thereby enriching the existing body of knowledge and guiding future practices.

2. Theoretical Framework and Previous Studies on Yoga and PCOD

PCOD characterized by hyperandrogenism (elevated levels of male hormones), irregular menstrual cycles, and polycystic ovaries. PCOD significantly impacts both physical and psychological health. The

core pathophysiological features of PCOD include hyperandrogenism, insulin resistance and chronic low-grade inflammation. These factors contribute to common symptoms such as hirsutism (excessive hair growth in undesired areas), acne, obesity, and infertility. Additionally, PCOD is often associated with psychological issues, including depression, anxiety and a decreased quality of life.

Yoga, an ancient mind-body practice, has been increasingly explored as a potential intervention for PCOD. Yoga integrates intricate physical postures (asanas), sophisticated breath regulation techniques (pranayama), and profound meditative practices (dhyana), aiming to achieve harmony between the mind, body, and spirit. The theoretical framework for the effects of yoga on PCOD encompasses several mechanisms through which yoga may exert its benefits.

Yoga practices can enhance insulin sensitivity, reducing insulin resistance, which is a key factor in PCOD pathophysiology. Enhancing insulin sensitivity aids in weight management and lowers the risk of developing type 2 diabetes, which is frequently linked with PCOD. Regular yoga practice can help regulate endocrine function, potentially normalizing hormone levels, including reducing hyperandrogenism. This can alleviate symptoms like hirsutism and acne. Yoga contributes to weight loss and maintenance, particularly by reducing Anthropometric factors (body mass index (BMI) & between waist to hip. Managing weight is crucial in mitigating the symptoms and complications of PCOD. Yoga is well-documented for its stress-reducing effects. It lowers cortisol levels (a stress hormone), which can be elevated in women with PCOD. Diminished stress levels can exert an influence on overall health and well-being. Yoga has been shown to reduce the symptoms of anxiety, stress and depression, which are common in women with PCOD. Improved mental health can enhance the quality of life and emotional resilience. Yoga promotes a holistic approach to health underscores the equilibrium of mind, body, and spirit. This holistic perspective encourages healthier lifestyle choices, including better dietary habits and increased physical activity.

An expanding corpus of research substantiates the advantageous effects of yoga on alleviating PCOD symptoms. Moitra et al. (2011) examined yoga therapy program for 12 weeks among women with PCOS and found significant improvements in menstrual regularity, reduced testosterone levels, and decreased anxiety scores. Participants also reported an overall improvement in quality of life. Similarly, Ranjani et al. (2013) conducted a randomized controlled trial (RCT) assessing the impact of yoga on metabolic parameters in women with PCOD. The study found significant reductions in BMI, waist-to-hip ratio, and insulin resistance among the yoga group in comparison to the control group.

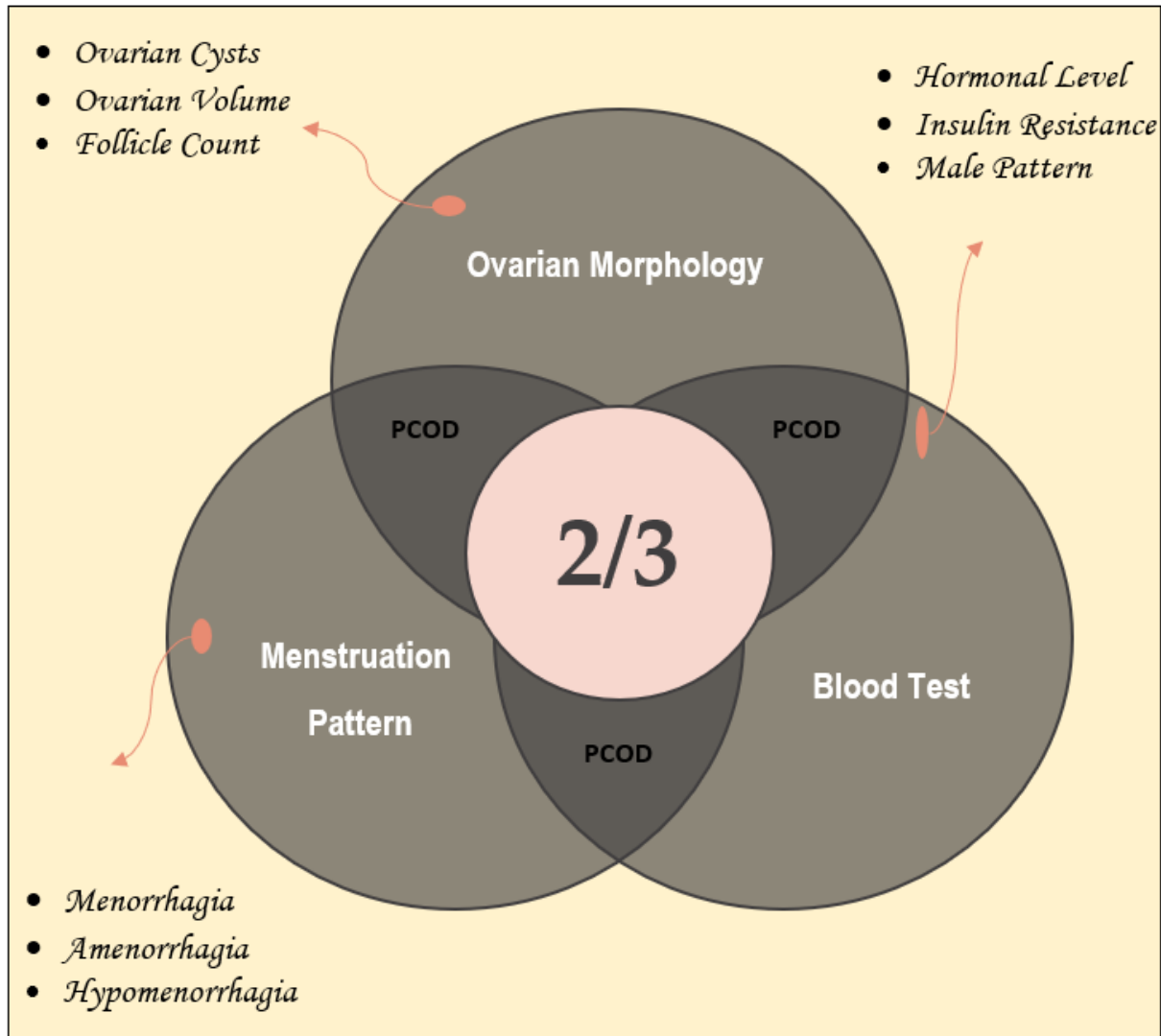
Psychological well-being has also been a focus of yoga studies. Saxena et al. (2012) reported significant reductions in anxiety and depression levels on women with PCOD, leading to an enhanced quality of life. Verma et al. (2015) found lower cortisol levels and improved mood among participants, indicating the stress-reducing benefits of yoga. Comparative studies have further highlighted yoga's efficacy. Patel and Pradhan (2014) says that yoga has been found to be as effective as conventional exercise in reducing BMI and improving insulin sensitivity, with added mental health benefits. Gopinath et al. (2017) demonstrated that women in the yoga intervention group experienced significant improvements in both physical and psychological parameters compared to the non-intervention group, which did not receive any intervention. These findings address that yoga can be a holistic and strong approach to managing PCOD symptoms, addressing both physical and psychological aspects.

The theoretical framework and empirical evidence suggest that yoga can be an efficacious intervention for managing PCOD symptoms. By addressing both physical and psychological aspects, yoga offers a holistic approach to treatment. Regular practice of yoga can improve insulin sensitivity, regulate hormone levels, reduce stress, and enhance mental health, collectively contributing to a better overall quality of life for women with PCOD. However, further research, particularly extended-duration and extensive-scale investigations studies, is necessary to bolster the evidence base and establish more comprehensive guidelines for incorporating yoga into PCOD management strategies.

Criteria of the PCOD

The Rotterdam criteria, introduced in 2003, are the most widely accepted diagnostic framework for PCOD, also known as PCOS. These criteria helps to find out the diagnosing PCOD, recognizing the variability in symptom presentation among individuals. A diagnosis is confirmed when a patient exhibits at least two out of three test. The first feature, oligo-ovulation or anovulation, refers to irregular or absent menstrual cycles, indicating disrupted ovulation. Women with PCOD often experience extended intervals between periods or of menstruation pattern, which can result in challenges related to fertility and hormonal balance (Azziz et al., 2009). The second feature, hyperandrogenism, is characterized by elevated levels of androgens, which are male hormones naturally present in small amounts in females.

Hyperandrogenism manifests clinically through symptoms such as excessive hair growth like hirsutism, acne and hair thinning or loss. Biochemical confirmation involves measuring elevated androgen levels in blood tests (Fauser et al., 2004). The third feature is the presence of polycystic ovaries, which are identified through ultrasound imaging. Polycystic ovaries are defined by the presence of 12 or smaller follicles, each measuring 2–9 mm in diameter, or an increased ovarian volume exceeding 10 mL. These features indicated the presence of multiple underdeveloped follicles that fail to mature and release eggs (Rotterdam ESHRE/ASRM-Sponsored PCOS Consensus Workshop Group, 2004). Together, these criteria provide a comprehensive diagnostic framework that accommodates the diverse manifestations of PCOD, ensuring accurate diagnosis and effective management.



Objectives of the study

The objectives of the titled "EFFECT OF YOGA INTERVENTION ON POLYCYSTIC OVARIAN DISEASE - BIBLIOMETRIC ANALYSIS" is to evaluate the research trajectory and impact of yoga interventions on Polycystic Ovarian Disease (PCOD) through a detailed bibliometric analysis. The study aims to highlight the growing recognition and efficacious of yoga as a non-pharmacological intervention for managing PCOD symptoms and to identify research gaps for future exploration.

1. Assess the trends and growth in the number of publications related to yoga interventions for PCOD over recent years.
2. Identify patterns in research output, highlighting any significant increases or fluctuations.
3. Examine the global distribution of research contributions related to yoga interventions for PCOD.
4. Identify countries that have produced significant research in this area, highlighting potential disparities or concentrations

5. Analyze the citation patterns of studies focusing on yoga interventions for PCOD over different years.
6. Determine which studies have received the highest citations, indicating their impact and influence in the field.
7. Investigate the distribution of journals that publish research on yoga interventions for PCOD.
8. Identify prominent journals in the field, assess their impact factors, and analyze publishing trends over time.

Research Gap

- To provide a comprehensive overview of existing research on yoga roles in managing the PCOD.
- To highlight the research gaps and identify areas that require further investigation, particularly in the biological, psychological, and social aspects of PCOD management.
- To guide the future research efforts by suggesting methodologies, research areas, and interventions that have been most effective, to promoting the growth of high-quality studies in this field.

Methodology

The methodology entails a systematic review of existing literature, concentrating on studies that investigate the effects of yoga on PCOD. This review includes criteria for selecting studies, sources of information, search techniques, process for choosing relevant studies, methods for collecting data, and measures for summarizing findings.

Inclusion Criteria

The criteria for determining eligibility in this research: peer-reviewed journal articles, studies specifically addressing yoga interventions for PCOD management, research articles written in English, open access articles for unrestricted data access and strictly experimental studies.

Exclusion Criteria

The exclusion criteria are publications restricted to editorial content, in languages other than English, journals that require payment for access, theoretical papers without practical application, and treatments and exercises not related to PCOD.

Information Sources

The primary source for data was the SCOPUS database, selected for its comprehensive coverage of peer-reviewed literature across various disciplines, including sports science and health sciences.

Search Strategy

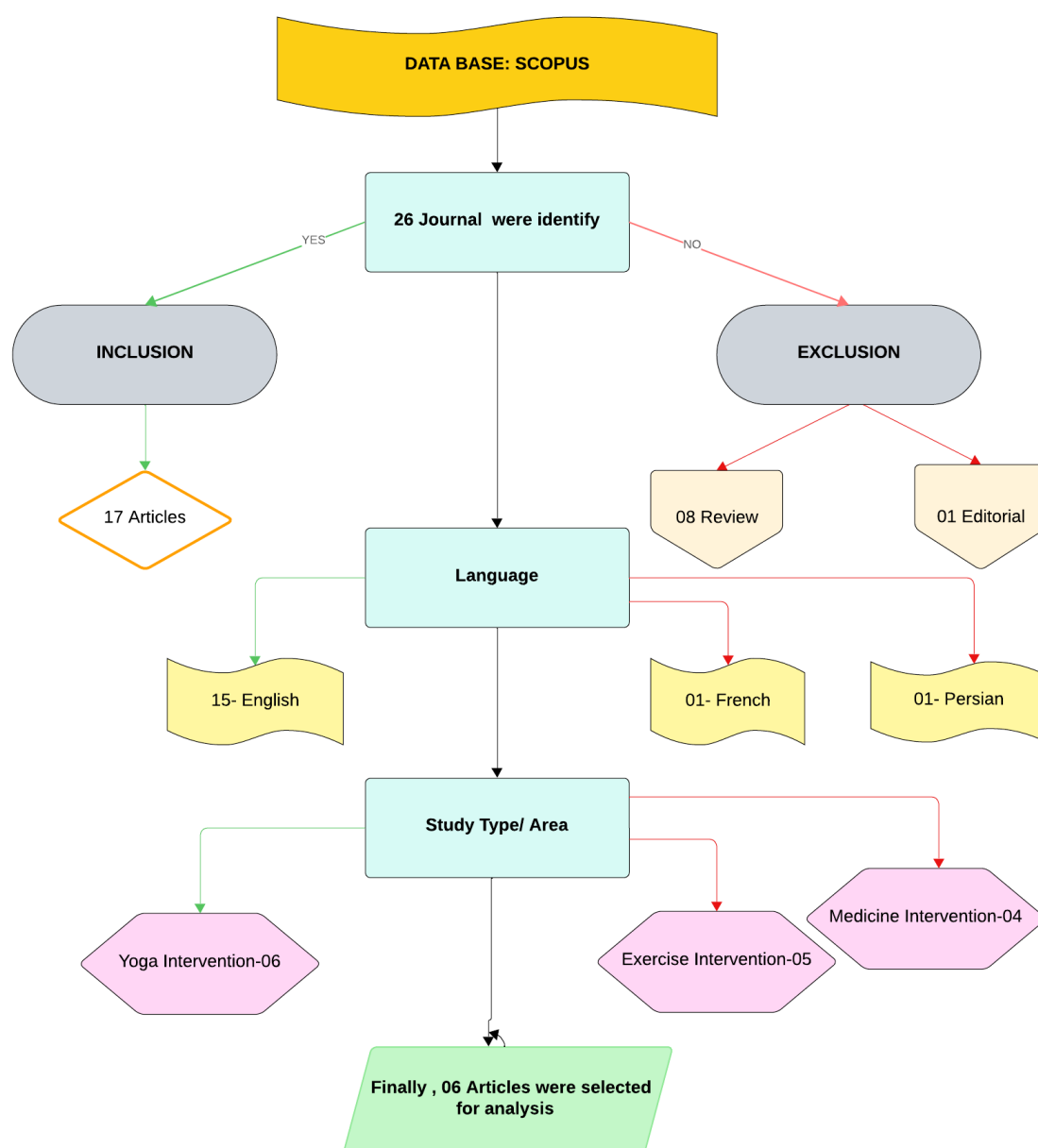
The search methodology encompassed the utilization of precise keywords and Boolean operators to delineate pertinent studies. The Search terminologies included "PCOD," "yoga," "intervention," and "treatment." The search was confined to articles published in English and accessible in open access journals. The search period covered publications from the earliest available records up to the present.

Selection Process and Data Collection Process

The selection process comprised an initial screening of article titles and abstracts, followed by a thorough full-text review and final selection based on established criteria. Data collection used a standardized form to extract key information from selected articles, including author(s), publication year, journal name, study design, sample size, population demographics, intervention details, outcomes, and key findings. Detailed data extraction is illustrated in Flow Chart 1.

Bias Assessment and Data Synthesis

A modified Biblioshiny tool using the R package for bibliometrics in R-Studio was used to assess study biases. Primary measures focused on yoga's impact on PCOD symptoms, while secondary measures covered intervention adherence and adverse effects. Results were synthesized using narrative methods due to the diversity of study designs. Subgroup and sensitivity analyses were conducted, adhering to PRISMA 2020 guidelines for a systematic review. This approach aims to provide a transparent understanding of yoga's effects on PCOD and highlight research gaps for future exploration.



FLOW CHART 1

Table 1 Overview of Yoga Interventions for PCOD

S.no	Author/ Year	Keywords	Criteria	Variables
1	Nidhi, Padmalatha, Nagarathna, Amritanshu (2012)	<ul style="list-style-type: none"> Adolescents Insulin Resistance Lipid levels PCOS Yoga 	Rotterdam	<ul style="list-style-type: none"> Fasting insulin Fasting blood glucose insulin resistance Blood lipid values body mass index Waist circumference Hip circumference Waist-to-hip ratio
2	Nidhi, Padmalatha, Nagarathna, Ram (2012)	<ul style="list-style-type: none"> PCOS Quality of life Yoga Adolescent girls RCT 	Rotterdam	<ul style="list-style-type: none"> Emotions Body hair Weight Infertility Menstrual problems

3	Nidhi et al. (2013)	<ul style="list-style-type: none"> • Holistic Yoga Program • PCOS • Adolescent Endocrine Parameters 	Rotterdam	<ul style="list-style-type: none"> • Anti-Müllerian Hormone • Luteinizing Hormone • Follicle-Stimulating Hormone • Body Mass Index (BMI) • Hirsutism • Menstrual Frequency
4	Patel et al. (2019)	<ul style="list-style-type: none"> • PCOS • Androgen • Mindful Yoga • Endocrine Parameters 	Rotterdam	<ul style="list-style-type: none"> • Serum free testosterone levels • Dehydroepiandrosterone • Anxiety and depression • blood glucose, insulin levels, body mass index and waist-to-hip ratio
5	Selvaraj et al. (2020)	<ul style="list-style-type: none"> • adolescent girls • exercise • lifestyle modifications • PCOS • Risk assessment • school girls • yoga 	No criteria was followed	<ul style="list-style-type: none"> • Demographic Variables • Socioeconomic Factors • Lifestyle Factors • Risk Assessment Score
6	Mohseni et al. (2021)	<ul style="list-style-type: none"> • Yoga • PCOS, • Anthropometric • Endocrine Parameters • Infertility • Menstrual Cycle 	Rotterdam	<ul style="list-style-type: none"> • Anti-Müllerian Hormone • Luteinizing Hormone • Follicle-Stimulating Hormone • Body Mass Index (BMI), Weight, Waist and Hip Circumference • Menstrual Frequency, Hirsutism Score

Strengths of included studies

The reviewed studies on PCOD or PCOS interventions demonstrated several strengths across various aspects. Nidhi et al. (2012) and Nidhi et al. (2013) focus on adolescents, a critical age group for early intervention in PCOS, evaluating multiple metabolic parameters such as insulin resistance and lipid levels, and using the Rotterdam criteria for standardized PCOS diagnosis. These studies, along with Patel et al. (2019), incorporated holistic yoga programs, offering non-pharmacological interventions that assess hormonal changes, menstrual frequency, and psychological well-being, thus providing a multifaceted approach to managing PCOS. The inclusion of quality of life factors, such as emotional and psychological well-being, is emphasized in both Nidhi et al. (2012) and Patel et al. (2019), enhancing the depth of PCOS management. In addition, Selvaraj et al. (2020) focuses on lifestyle modifications and preventive strategies for adolescent girls, with a comprehensive risk assessment approach that includes social, environmental, and socioeconomic factors. Mohseni et al. (2021) evaluated the both endocrine and anthropometric parameters, with a focus on menstrual cycles and hirsutism scores, enhancing the understanding of the effects of yoga interventions on PCOS.

Limitations of included studies

The reviewed studies exhibit certain limitations that may affect the validity and generalizability of their findings. Nidhi et al. (2012) and Nidhi et al. (2013) lack explicit details on sample size, diversity and control groups, limiting causal inferences and external validity. Self-reported anthropometric and psychological measures introduce potential bias, while the absence of long-term follow-ups restricts the assessment of sustained effects. Patel et al. (2019) and Selvaraj et al. (2020) face challenges with subjectivity in self-reported outcomes, unclear intervention durations and a lack of standardized PCOS diagnostic criteria, potentially affecting study consistency. Selvaraj et al. (2020) and Mohseni et al. (2021) do not provide the comprehensive details on randomization and blinding procedures, and their reliance on self-reported lifestyle factors and menstrual data. The absence of control groups in some studies further limits the ability to establish causality between yoga interventions and PCOS improvements.

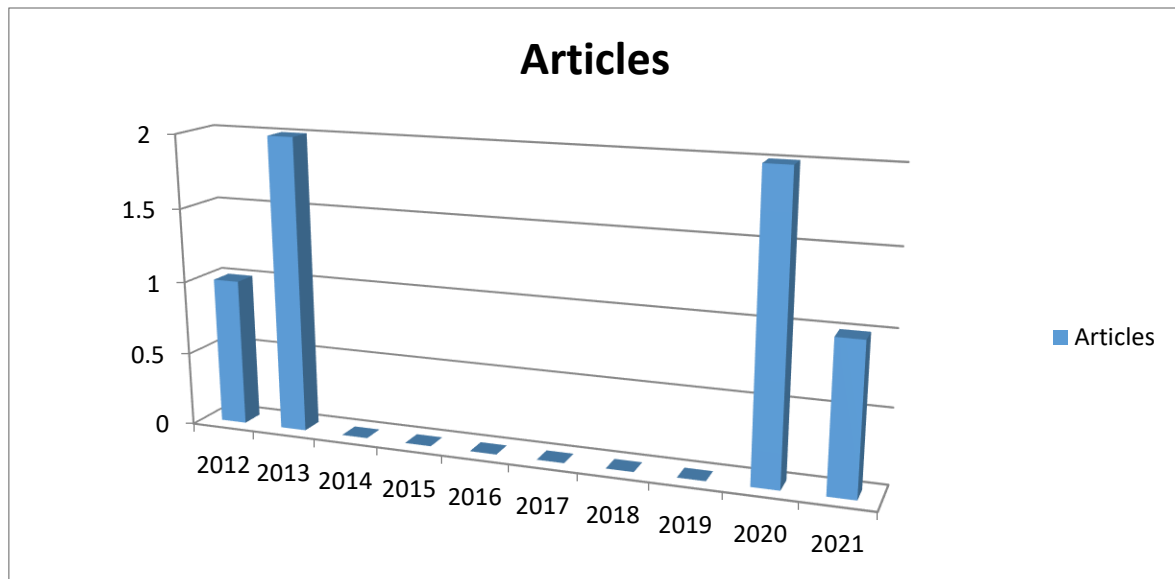


Figure 1: Annual Publications on Yoga Intervention for PCOD (2012-2021)

The bibliometric analysis of articles on yoga intervention for Polycystic Ovarian Disease (PCOD) from 2012 to 2021 shows fluctuating research interest. Peaks in publication occurred in 2013 and 2019, with two articles each, while other years had one or no articles. Notably, no articles were published from 2015 to 2017, indicating a gap in research activity. The resurgence in publications from 2018 onward may reflect growing evidence of yoga's benefits for PCOD, such as hormonal balance and stress reduction. The observed fluctuations highlight the need for sustained research. Future studies should address gaps and provide robust evidence through clinical trials and longitudinal studies. Comprehensive reviews and meta-analyses are necessary to consolidate knowledge and guide effective yoga practices for PCOD management. An interdisciplinary research approach, involving gynecology, endocrinology, and complementary medicine, will provide a holistic understanding of yoga's role in managing PCOD and support the integration of these findings into practice and policy for improved patient outcomes.

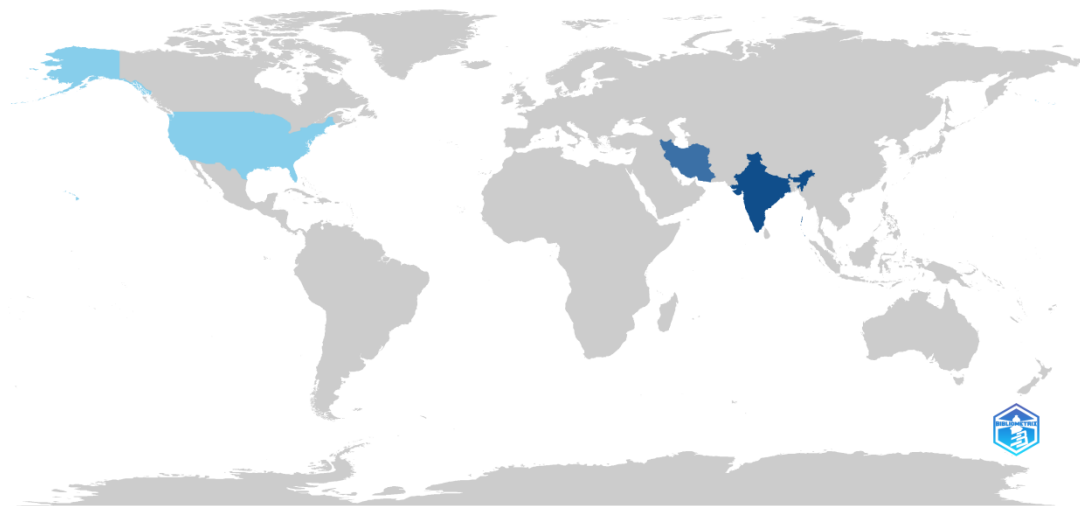


Figure 2: Geographical Distribution of Research Contributions on Yoga Intervention for PCOD

The bibliometric analysis of yoga's effect on Polycystic Ovarian Disease (PCOD) reveals significant research contributions from the USA, Iran, and India, with India leading with four contributions. This dominance reflects India's deep cultural and historical connection to yoga. The USA's single contribution indicates growing interest in integrating holistic therapies into conventional medicine, while Iran's contribution suggests an emerging interest in alternative therapies. The geographical distribution underscores the cultural context's importance in yoga research and highlights a global trend

towards exploring holistic health practices. The findings emphasize the need for international collaboration to further validate and standardize yoga interventions for PCOD.

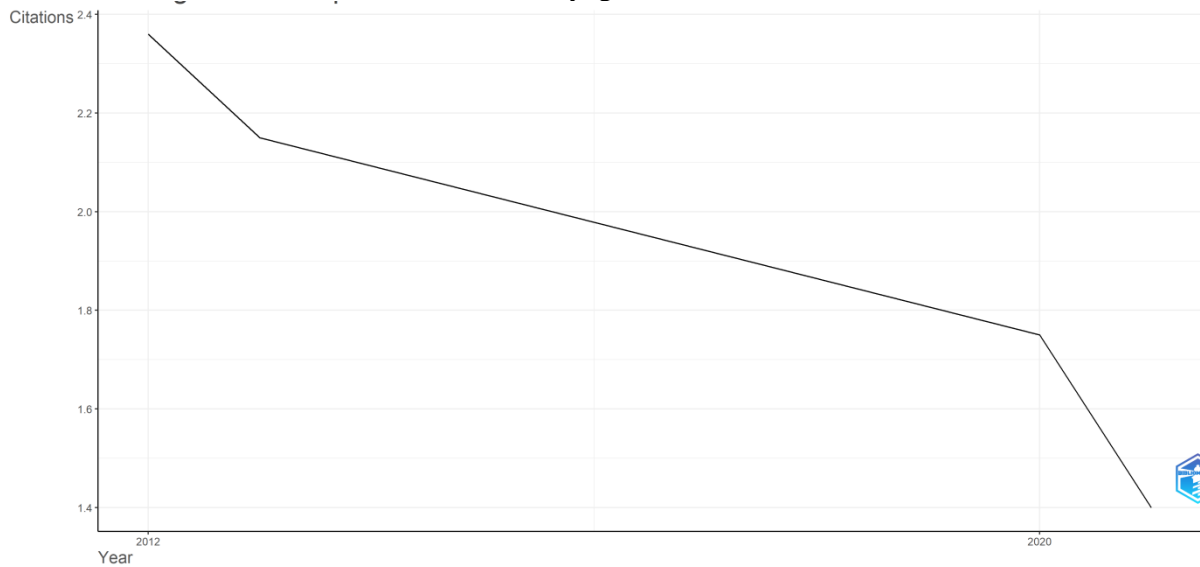


Figure 3: Yearly Citation Distribution for Studies on Yoga Interventions in PCOD (2012-2021)

The bibliometric analysis of the effect of yoga intervention on Polycystic Ovarian Disease (PCOD) reveals significant trends and insights into the research landscape. The analysis, represented by a bar chart, shows the number of citations over four key years: 2012, 2013, 2020, and 2021. There is a marked increase in citations over the years, indicating a growing interest and recognition of the topic in the academic and medical communities. The earliest year, 2012, shows a moderate level of citations, establishing foundational interest. In 2013, there is a substantial increase, suggesting heightened interest and key studies that spurred further research. The year 2020 maintains significant citation levels, attributed to growing evidence supporting yoga's efficacy for PCOD and increased health and wellness research. Citations peak dramatically in 2021, reflecting a culmination of research efforts and possibly comprehensive reviews or meta-analyses. This upward trend suggests yoga is increasingly recognized as beneficial for managing PCOD, driven by its efficacy in hormonal balance and stress reduction, its holistic approach, and increasing acceptance of alternative therapies. The rise in citations by 2021 indicates growing validation of yoga in PCOD management, potentially leading to broader clinical integration. The analysis underscores the necessity for continued research, focusing on large-scale, randomized controlled trials and longitudinal studies can further establish yoga's efficacy and safety in managing PCOD.

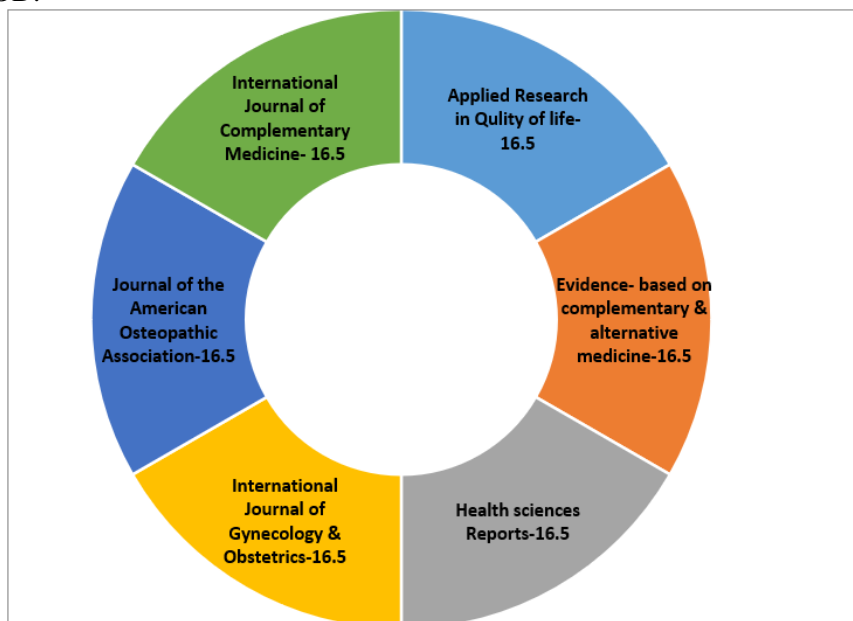


Figure 4: Distribution of Journals Publishing on Yoga Intervention for PCOD

The bibliometric analysis on yoga intervention for Polycystic Ovarian Disease (PCOD) shows an even distribution of research across six journals, each contributing 16.7%. These journals are "Applied Research in Quality of Life," "Evidence-Based Complementary and Alternative Medicine," "Health Sciences Reports," "International Journal of Gynecology & Obstetrics," "International Journal of Complementary Medicine," and the "Journal of the American Osteopathic Association." This balanced representation highlights the interdisciplinary interest in yoga's impact on PCOD. This comprehensive approach suggests that future research should integrate yoga with conventional treatments, focusing on holistic and interdisciplinary methods to provide more effective care for PCOD patients. Long-term studies and collaborative efforts among healthcare providers and yoga practitioners are essential to fully understand and utilize yoga's benefits for PCOD.

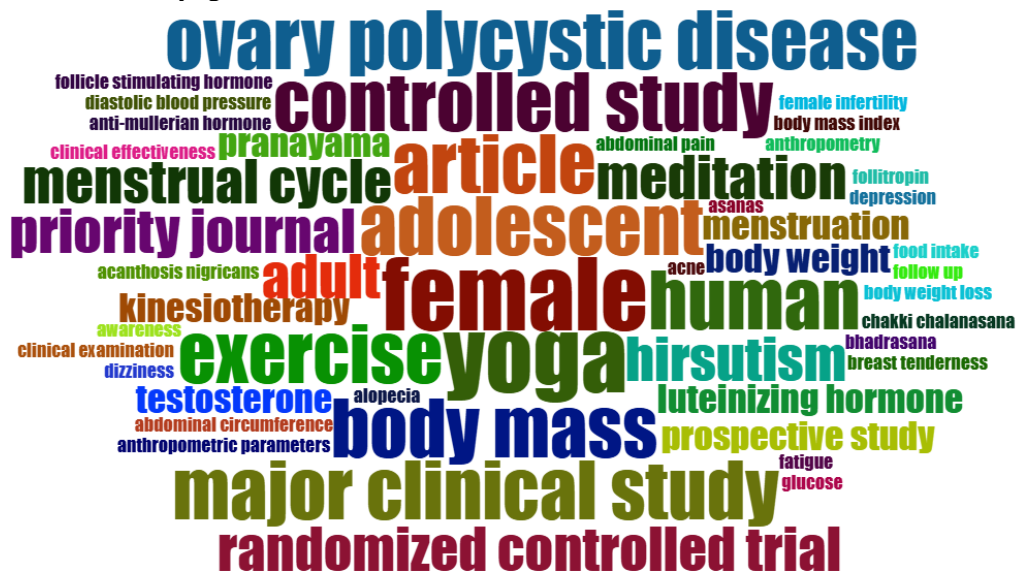


Figure 5: Word Cloud Representation of Key Terms Related to PCOD

The word cloud highlights key terms associated with PCOD, emphasizing its prevalence among females, particularly adolescents with "menstrual cycle," "hirsutism," and "body mass" being prominent. The presence of "testosterone," "luteinizing hormone," and "follicle-stimulating hormone" underscores the hormonal imbalances central to PCOD diagnosis and management. The frequent mention of "exercise," "yoga," "meditation," and "pranayama" suggests the growing importance of lifestyle interventions alongside medical treatments. Additionally, terms like "randomized controlled trial" and "major clinical study" indicate extensive research efforts in this field. Symptoms such as "acne," "alopecia," "depression," and "fatigue" highlight the multifaceted impact of PCOD on overall health. This visualization reflects the holistic approach needed for PCOD management, integrating medical, lifestyle, and psychological factors.

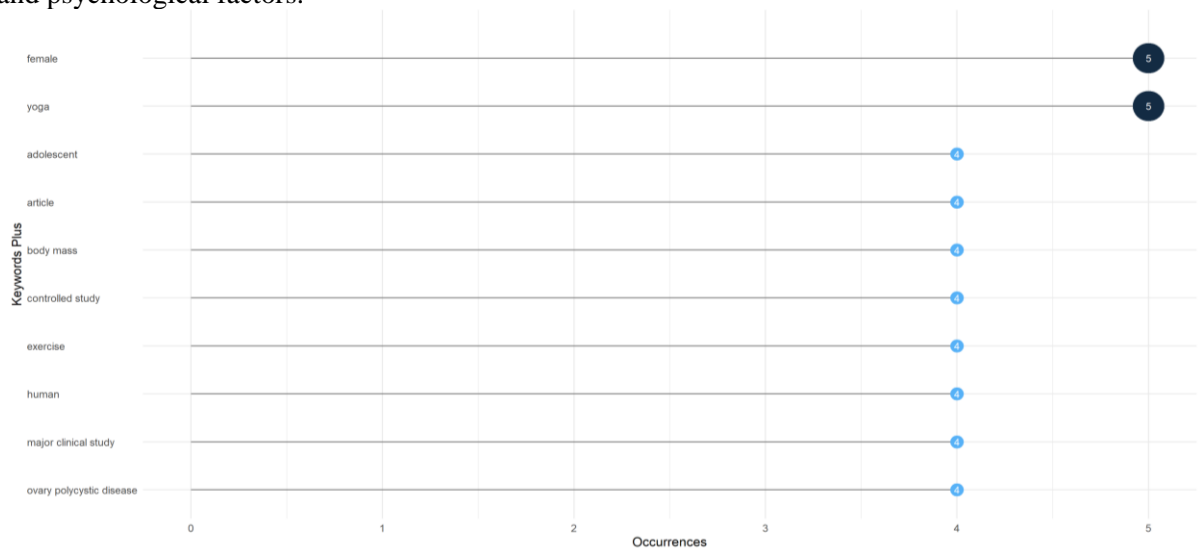


Figure 6: Most Frequently Occurring Words in PCOD Research

The visualization highlighted the most frequently occurring keywords in research related to PCOD. The terms female and yoga appear most frequently, indicating a strong research focus on women and the role of yoga as a therapeutic intervention. Other commonly mentioned keywords, such as adolescent, body mass and exercise, to suggest that studies often explore PCOD impact on younger populations and its correlation with weight management and physical activity. The presence of controlled study and major clinical study underscores the emphasis on rigorous research methodologies in understanding PCOD. This analysis reflects a growing interest in lifestyle-based interventions, particularly yoga and exercise in managing the PCOD symptoms and improving overall health outcomes.

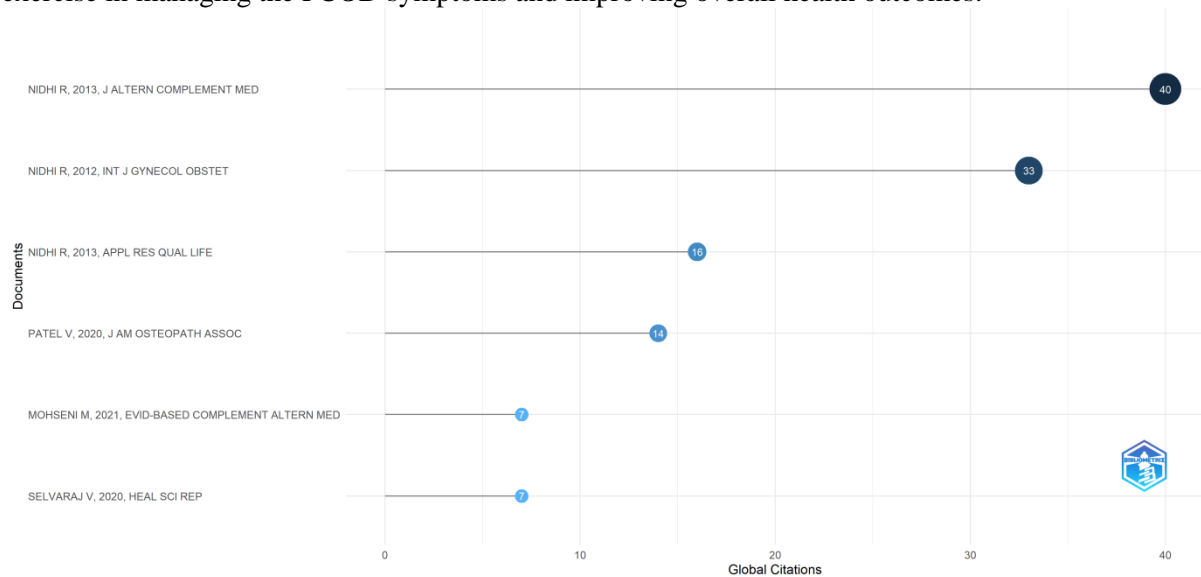


Figure 7: Global Citation Analysis of PCOD Research Documents

The visualization presents the most globally cited documents in research related to PCOD. The highest-cited paper is by Nidhi R., 2013 (J Altern Complement Med) with 40 citations, followed by Nidhi R., 2012 (Int J Gynecol Obstet) with 33 citations, emphasizing the strong influence of these studies in the field. Another study by Nidhi R., 2013 (Appl Res Qual Life) has 16 citations, indicating a consistent contribution to PCOD-related research. Recent papers such as Patel V., 2020 (J Am Osteopath Assoc) with 14 citations and studies by Mohseni M., 2021, and Selvaraj V., 2020, each with 7 citations, demonstrated the growing interest in evidence-based complementary and alternative medicine for PCOD management. The citation trends highlight the significance of past research while indicating emerging contributions in recent years.

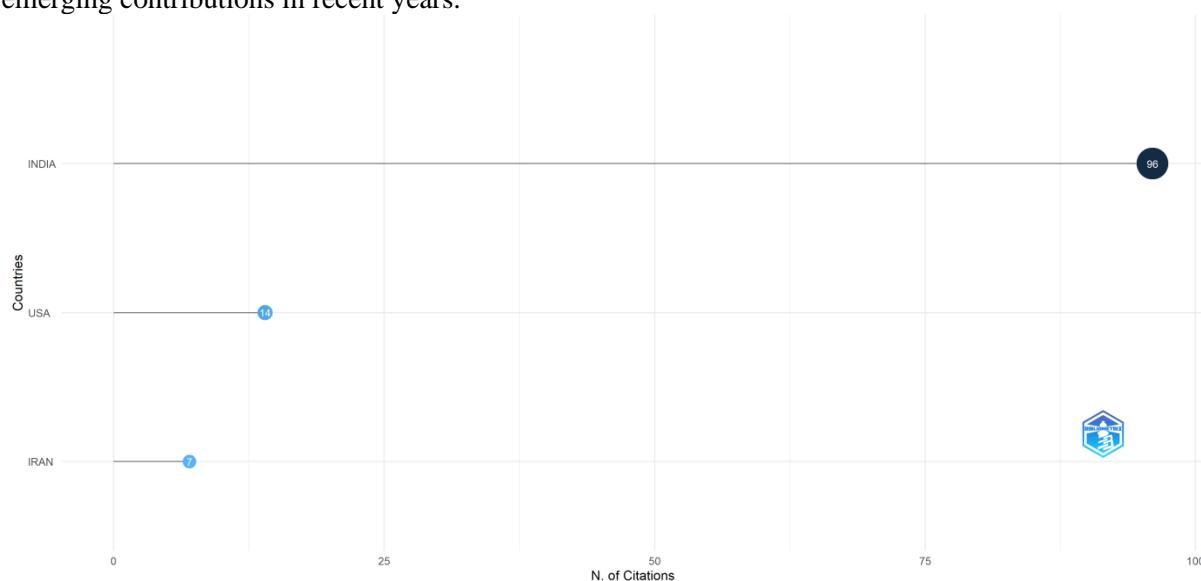


Figure 8: Citation Distribution Across Countries in PCOD Research

The visualization represents the most cited countries based on the number of citations in a research analysis. The data indicates that India holds the highest number of citations, totaling 96, significantly

outpacing the other countries. The USA follows with 14 citations, while Iran ranks third with 7 citations. The disparity in citation numbers suggests a dominant contribution from Indian research in the analyzed dataset. This trend could indicate a strong influence of Indian research publications in the respective field. India's leading position in terms of citation impact.

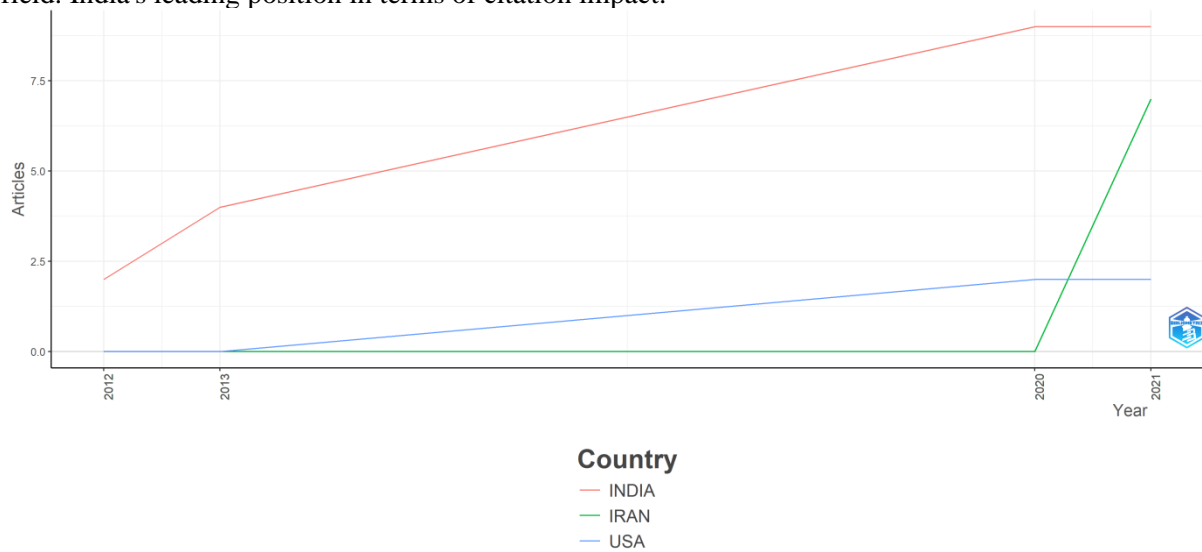


Figure 9: Country-wise Research Output Over Time on PCOD

The graph represents the research article production trends of India, Iran and the USA over time. India has shown a steady increase in research output from 2012 to 2021, reaching a peak around 2021 and maintaining a high production rate. The USA demonstrates a rise in research output, with a moderate increase over the years. Iran shows minimal research production until 2020, after which there is a sharp surge in 2021, indicating a sudden boost in scholarly contributions. This trend suggests India's consistent dominance in research output, while Iran's recent rise could indicate new research initiatives or increased academic contributions.

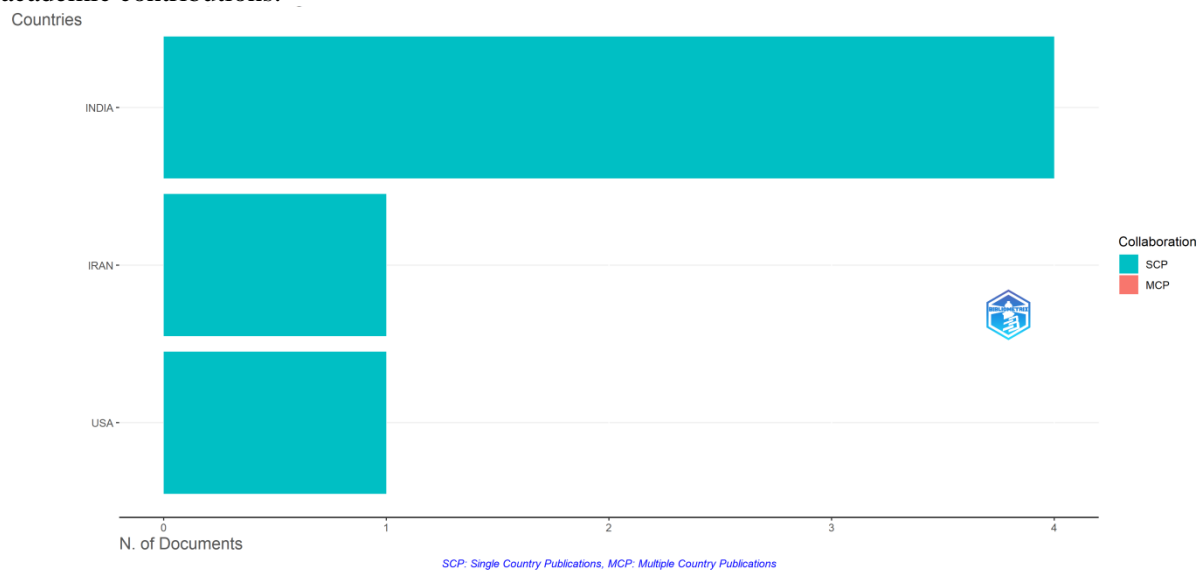


Figure 10: Corresponding Author's Country-wise Contributions to PCOD Research

The graph illustrated the distribution of corresponding author countries in research publications, distinguishing between Single Country Publications (SCP) and Multiple Country Publications (MCP). India has the highest number of corresponding author contributions, followed by Iran and the USA. The dominance of SCP (Single Country Publications) across all three nations suggests that most research outputs originate from within a single country rather than through international collaborations. This indicates strong independent research activity in India, Iran and the USA, with limited multi-country collaboration in the analyzed dataset.

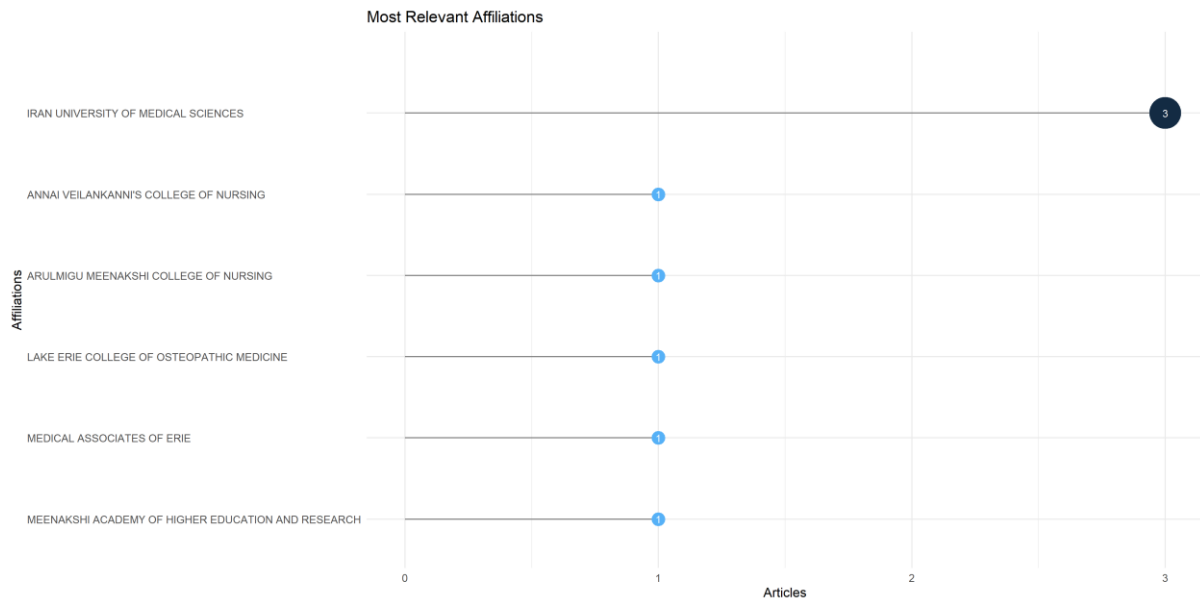


Figure 11: Notable Research Affiliations in PCOD Studies

The visualization represents the most relevant affiliations contributing to research publications. The x-axis denotes the number of articles, while the y-axis lists the institutions. The Iran University of Medical Sciences has the highest contribution with three articles, while other institutions, such as Annai Veilankanni's College of Nursing, Arulmigu Meenakshi College of Nursing, and Lake Erie College of Osteopathic Medicine, have each contributed one article. The distribution highlights a concentration of research efforts at a few institutions, with a relatively lower contribution from other affiliations. This suggests a need for broader institutional involvement in the research domain.

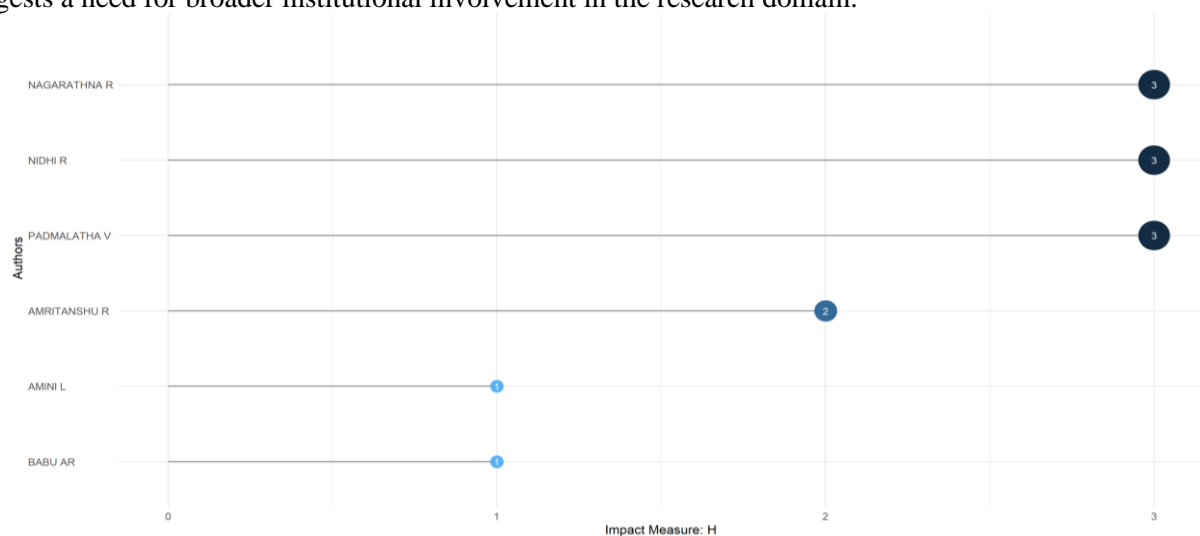


Figure 12: Author Impact Analysis Based on H-Index in PCOD Research

The chart showcased the local research impact of authors based on their H-index. Nagarathna R, Nidhi R, and Padmalatha V lead with an H-index of 3, indicating strong research influence. Amritanshu R follows with a 2, while Amini L and Babu AR have an H-index of 1, suggesting lower academic impact. Larger and darker bubbles signify higher influence. The data highlights varying research contributions, suggesting potential for increased collaboration and targeted publishing for those with lower impact.

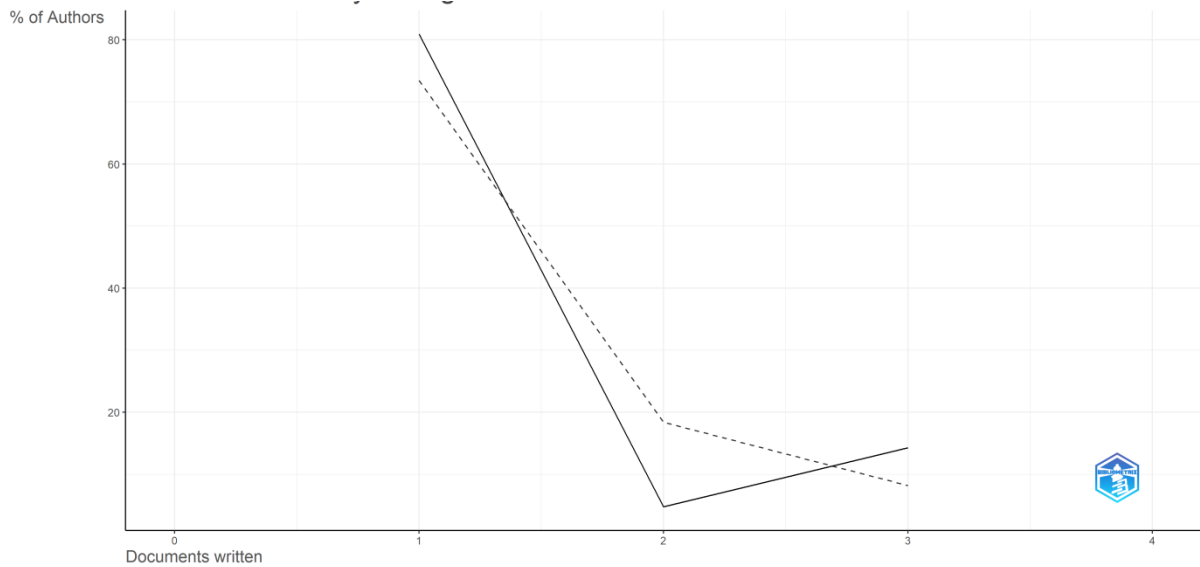


Figure 13: Author Productivity Analysis Using Lotka's Law in PCOD Research

The graph represents author productivity following Lotka's Law, which states that a small number of authors contribute a large number of publications, while the majority produce only a few. The x-axis indicates the number of documents written, while the y-axis shows the percentage of authors. The sharp decline suggests that most authors have written only one paper, while very few have multiple contributions. The observed data (solid line) and the expected trend show a general alignment, confirming the applicability of Lotka's Law in this research domain. This highlights the presence of a few prolific authors driving the majority of contributions.

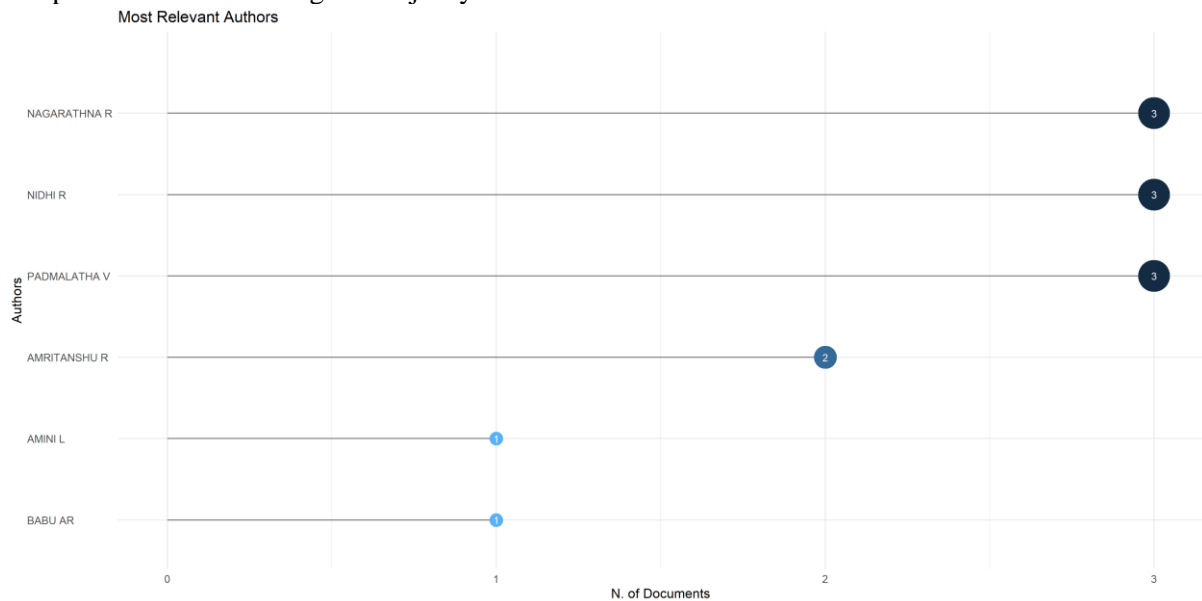


Figure 14: Most Prolific Authors in PCOD Research

The visualization highlights the most relevant authors based on the number of documents they have contributed. The x-axis represents the number of documents, while the y-axis lists the authors. Nagarithna R, Nidhi R, and Padmalatha V have the highest contribution, each with three publications, indicating their significant role in this research domain. Amritanshu R follows with two documents, while Amini L and Babu AR have each contributed one. This distribution aligns with typical bibliometric trends, where a few authors contribute extensively, while the majority publish fewer documents.

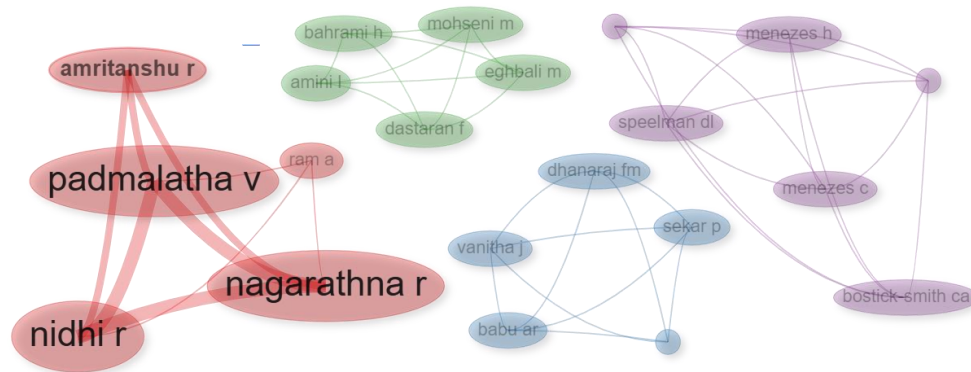


Figure 15: Author's Collaboration Network in PCOD Studies

The author collaboration network highlighted key researchers and their co-authorship relationships. Nagarathna R, Nidhi R, and Amritanshu R are central figures with the strongest collaborations, as indicated by their larger node sizes and thicker connecting edges. These authors form the core of the network, driving most research interactions. Peripheral authors, such as Speelman DI, Mohsen M, and Babu AR, have weaker ties, indicating limited or occasional collaborations. Strengthening connections between central and peripheral researchers could enhance interdisciplinary research and broaden overall impact. Encouraging new collaborations across different clusters may lead to greater knowledge-sharing and innovation.

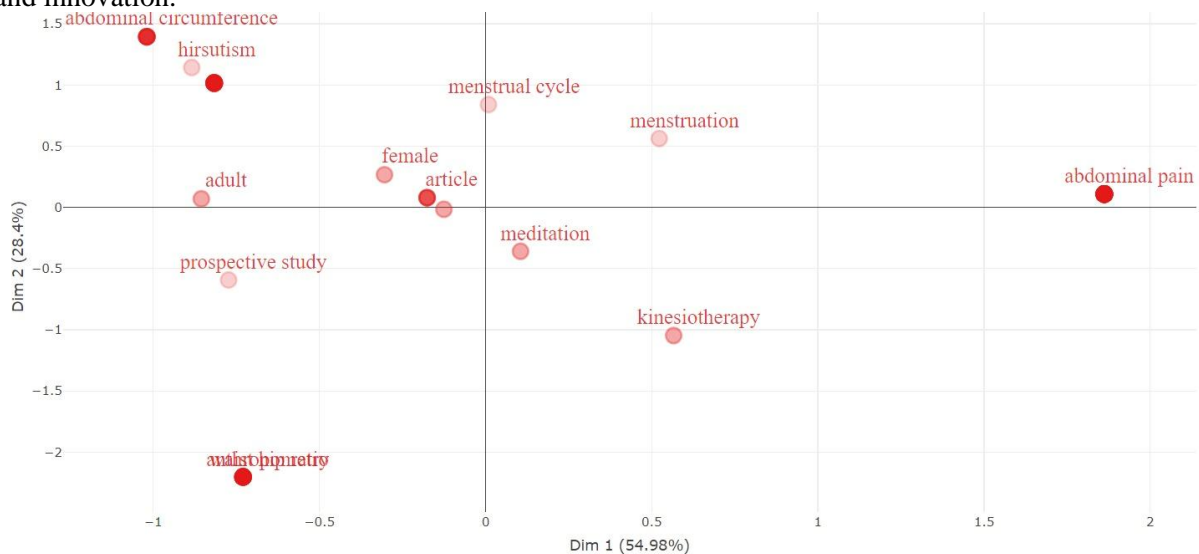


Figure 16: Factorial Analysis of Research Themes in PCOD Studies

The scatter plot represents key terms associated with a research study, likely related to PCOS, menstrual health, and therapeutic interventions. The two principal dimensions, Dim 1 (54.98%) and Dim 2 (28.49%), indicate the variance explained in the dataset. Terms such as abdominal pain, hirsutism, and abdominal circumference are positioned distinctly, suggesting their strong association with specific clusters of research themes. The presence of terms like menstrual cycle, menstruation, and meditation indicates an interrelation between reproductive health and lifestyle factors. Meanwhile, kinesiotherapy suggests a potential focus on physical rehabilitation. The term anthropometry appears significantly isolated, likely representing a unique methodological approach. The analysis highlights key research themes, emphasizing metabolic, reproductive, and therapeutic dimensions in the study.

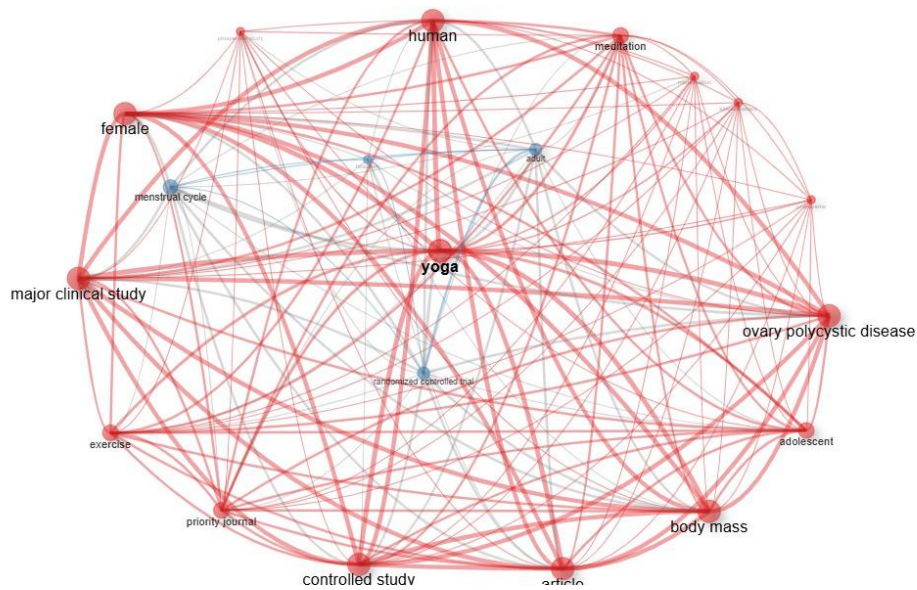


Figure 17: Thematic Mapping of PCOD Research Trends

The network visualization represents keyword co-occurrence in research related to PCOS, menstrual health and therapeutic interventions. Prominent terms such as female, body mass, yoga, exercise and adolescent appear as central nodes, indicating their strong associations with multiple concepts. The red, blue and green edges suggest different thematic clusters, likely linking metabolic factors, reproductive health and intervention strategies. Keywords like menstrual cycle, menstruation and kinesiotherapy highlight connections between hormonal regulation, physical activity and health outcomes. The dense interconnections suggest an interdisciplinary research focus, integrating biological, psychological and lifestyle factors in PCOS management. Strengthening links between underrepresented terms could provide insights into emerging research areas.

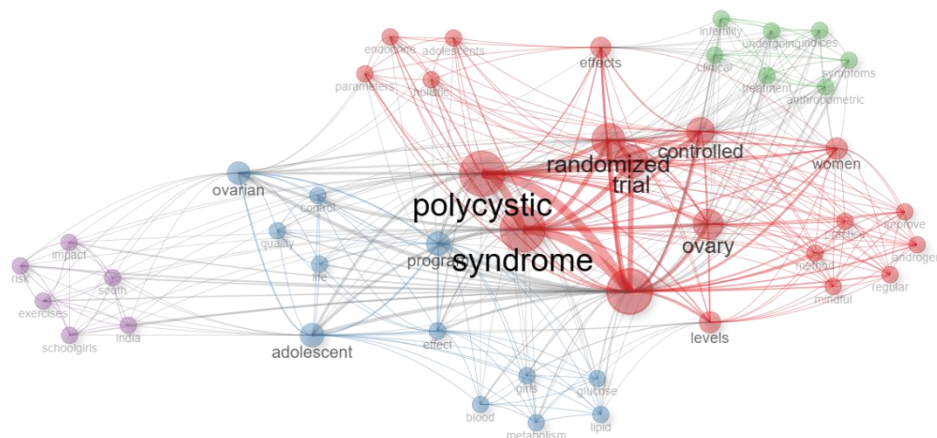


Figure 18: Keyword Co-occurrence Analysis in PCOD Research

The image presents a network visualization of key terms related to PCOD research, highlighting their interconnections. The prominent terms such as female, ovary polycystic disease, body mass, yoga, exercise and menstrual cycle indicate the primary focus areas in studies on PCOD. The strong linkages between yoga, exercise and controlled study suggest a significant research interest in non-pharmacological interventions for managing PCOD symptoms. The terms like major clinical study, randomized controlled trial and priority journal emphasize the presence of high-quality research and evidence-based studies in this domain. The visualization also indicates connections with broader health-related aspects such as meditation and human, suggesting holistic approaches in treatment

methodologies. The dense network structure with red and blue nodes signifies strong relationships between these concepts, reinforcing the importance of lifestyle interventions in managing PCOD.

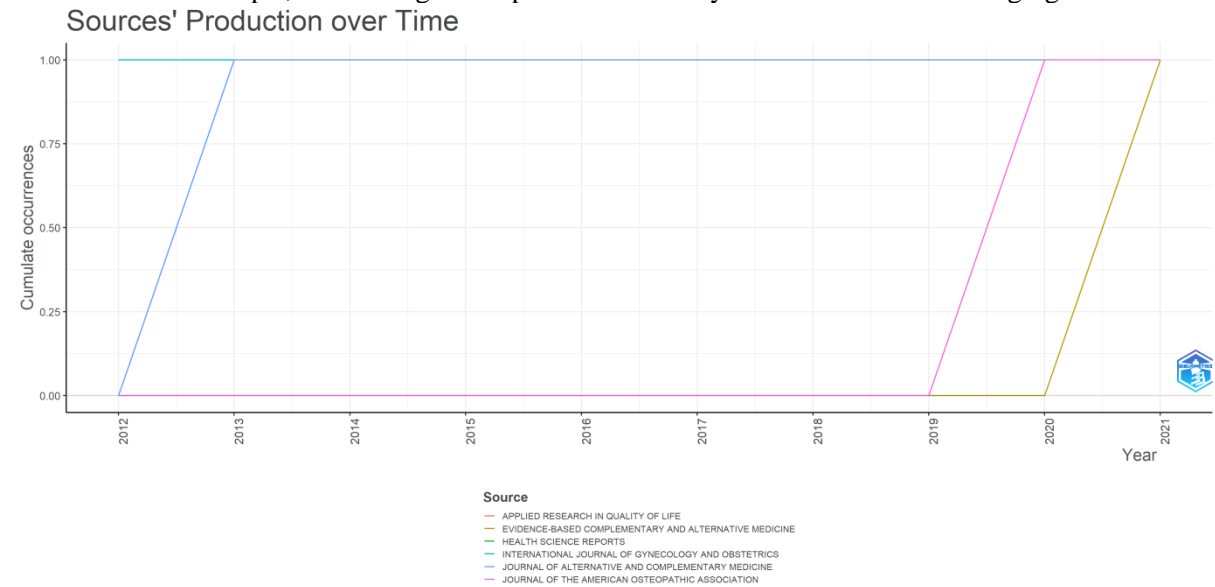


Figure 19: Trends in Source-wise Research Output Over Time on PCOD

The graph represents the cumulative occurrences of research publications from various sources over time. It highlights the timeline of research contributions in specific journals related to quality of life, complementary medicine, gynaecology and osteopathic studies. The first notable rise in publications appears around 2013, with the health science reports showing early contributions. Subsequently from 2019 to 2021, there is an increase in publications from journals such as the journal of alternative and complementary medicine and applied research in quality of life, indicating a growing research focus in these areas. The trend suggests an emerging interest in complementary and alternative medicine approaches in women's health and gynaecology in recent years.

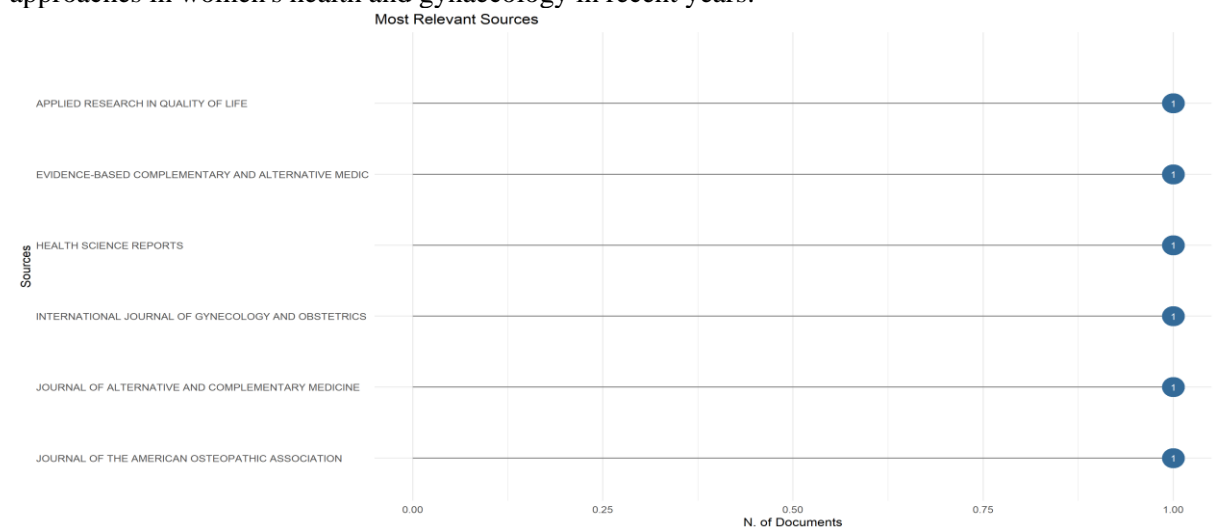


Figure 20: Most Influential Sources Publishing PCOD Research

The bar chart titled "Most Relevant Sources" highlighted six academic journals, each contributing one document on the analyzed topic. The sources include Applied Research in Quality of Life, Evidence-Based Complementary and Alternative Medicine, Health Science Reports, International Journal of Gynaecology and Obstetrics, Journal of Alternative and Complementary Medicine, and Journal of the American Osteopathic Association. The equal distribution of documents suggests that the research is multidisciplinary, spanning areas like complementary medicine, gynaecology and alternative therapies. This indicates that the topic is either emerging or not widely explored in a single journal, emphasizing the need for researchers to consult diverse sources for comprehensive insights.

3. Discussion

Table 2 Study Outcomes and Existing Research Gaps on Yoga Intervention on PCOD

S.n	Author	Intervention	Outcomes	Gap
1	Nidhi, Padmalatha, Nagarathna, Amritanshu (2012)	suryanamaskara, asanas, pranayama and meditation.	Yoga group significantly 5.4% reduction in fasting blood glucose (FBG), Changes in Insulin and Lipid Levels, reduced triglycerides, LDL, and total cholesterol.	<ul style="list-style-type: none"> • Limited Generalizability • Lack of Long-term • No significant changes in BMI or waist circumference were observed.
2	Nidhi, Padmalatha, Nagarathna, Ram (2012)	Asanas, Pranayama, Relaxation techniques, Meditation	yoga program in adolescent PCOS is significantly better than physical exercise program	<ul style="list-style-type: none"> • Small Sample Size • Narrow Age Range • Lack of Long-term Follow-up • Diverse Ethnicities and Populations • Focus on Specific Domains
3	Nidhi et al. (2013)	Holistic yoga and Exercise	No significant changes observed in Bio, Yoga was found to be more effective than conventional exercise.	<ul style="list-style-type: none"> • Limited Generalizability • Lack of Long-term Follow-up • Anthropometric Changes not Addressed.
4	Patel et al. (2019)	mindful yoga	Reduction in Androgen Levels, Improvement in Psychological Parameters, No Significant Changes in Metabolic Parameters.	<ul style="list-style-type: none"> • Small Sample Size • Diverse Participant Characteristics • Long-term Effects
5	Selvaraj et al. (2020)	Yoga and Exercises	Decreased from 11.8% to 5.9% after the intervention. Yoga a positive impact of the intervention on reducing PCOS risk	<ul style="list-style-type: none"> • Lack of Laboratory Investigations • Limited Population • Need for Long-term Follow-up
6	Mohseni et al. (2021)	Yoga	Significant Differences Hormonal Improvement, Menstrual Regulation, Hirsutism Improvement, No significant effect on blood pressure, prolactin, or body weight.	<ul style="list-style-type: none"> • Limited Generalizability • Lack of Long-term Follow-up • Anthropometric Limitations • Psychological Effects Not Explored

Yoga Intervention on PCOD

Yoga has a positive effect and major impact on PCOD, as highlighted in all six research studies. These studies consistently demonstrate that yoga interventions improve hormonal balance, insulin sensitivity, cardiovascular health, mental well-being and menstrual regulation, making it a highly effective non-pharmacological approach to managing PCOD. Research by Nidhi et al. (2012, 2013) emphasizes that yoga significantly lowers fasting blood glucose levels and improves lipid profiles, even more effectively than conventional exercise. Patel et al. (2019) and Mohseni et al. (2021) highlight the hormonal benefits of mindful yoga, including reduced androgen levels, improved menstrual regularity and alleviation of symptoms like hirsutism. Selvaraj et al. (2020) further supports the role of yoga in reducing PCOD risk by nearly 50%, showing its long-term potential. Additionally, the studies confirm that yoga lowers cortisol levels, reduces stress and enhances emotional well-being, which play a crucial role in balancing reproductive hormones. Although some studies note limitations like small sample sizes and lack of long-term follow-up, the collective evidence strongly supports yoga as a powerful and transformative intervention for PCOD management.

Biopsychosocial on PCOD

Bio Outcomes

The reviewed studies on yoga interventions for individuals with PCOS have demonstrated notable physical improvements. Yoga has shown a significant impact on hormonal balance, with reductions in Anti-Müllerian Hormone (AMH), Luteinizing Hormone (LH), and Follicle-Stimulating Hormone (FSH) levels, which indicates a regulatory effect on the endocrine system (Nidhi et al., 2013; Mohseni et al.,

2021). Additionally, improvements in menstrual regularity and reductions in hirsutism scores suggest better ovarian function, as evidenced in the studies by Patel et al. (2019) and Mohseni et al. (2021). Yoga also plays a key role in weight management, with reductions in Body Mass Index (BMI), waist-to-hip ratio, and fasting insulin levels, highlighting its positive effect on metabolic regulation (Nidhi et al., 2013; Mohseni et al., 2021).

Psycho Outcomes

Psychologically, yoga interventions have shown significant benefits, particularly in reducing stress, anxiety, and depression. Mindful yoga practices, as examined by Patel et al. (2019), have demonstrated a reduction in anxiety and depression levels. Yoga also improves overall quality of life, with enhancements in emotional well-being, body image, and reductions in infertility-related distress, as reported by Nidhi et al. (2012). Furthermore, the impact of yoga on body image perception has been particularly notable, with improvements in self-confidence and acceptance observed, especially in adolescent girls with PCOS (Nidhi et al., 2012).

Social Outcomes

Yoga interventions have also positively impacted social outcomes, contributing to enhanced overall well-being and social integration. The improvement in body image and weight regulation encouraged better social interactions, as noted in studies by Nidhi et al. (2012) and Selvaraj et al. (2020). Additionally, yoga promoted lifestyle modifications, increasing awareness of healthy diet and exercise behaviors, particularly among adolescent participants. These changes in behavior led to long-term positive social outcomes, such as improved self-esteem and better social relationships (Selvaraj et al., 2020).

Research Gap

- Lack of significant findings on anthropometric measures (BMI, waist circumference, body weight, body composition).
- Ovarian morphology is a critical test for diagnosing PCOS, but none of the studies considered it as a variable.
- Need for comprehensive hormonal and metabolic assessments (e.g., cortisol levels, thyroid function, insulin resistance).
- Absence of laboratory investigations like hormonal assays or genetic testing to explore the biological mechanisms of PCOS.
- Insufficient exploration of psychological effects (stress, mood, mental health) using standardized psychological assessment tools.
- Lack of long-term mental health evaluations (depression, anxiety, quality of life assessments).
- Limited focus on social factors (relationships, work-life balance) and their impact on overall social well-being.
- Absence of long-term follow-up studies to assess sustained effects on behavior and lifestyle changes.
- Lack of diverse populations in terms of age, ethnicity and socio-economic background, which limits generalizability.
- Small sample sizes and homogeneous populations (narrow age range, limited ethnic diversity).
- Need for longitudinal studies to assess long-term effects.
- Need for more randomized control trials (RCTs) to rigorously compare yoga with other interventions

These gaps highlight the need for more comprehensive and diverse research that takes into account the biological, psychological and social aspects of PCOS management..

4. Conclusions:

This bibliometric analysis reveals that yoga has a positive impact on Polycystic Ovarian Disease (PCOD). Yoga is increasingly recognized as a beneficial non-pharmacological intervention for managing PCOD symptoms. The studies analyzed demonstrate that yoga not only helps prevent and manage the biological aspects of PCOD, such as hormonal imbalances and insulin resistance, but also addresses psychological and social dimensions. Regular yoga practice has been shown to improve biopsychosocial parameters significantly. Biologically, yoga can help regulate menstrual cycles, reduce hyperandrogenism, and improve metabolic health. Psychologically, yoga reduces anxiety and

depression, enhancing overall mental well-being. Socially, yoga practice helps improve body image and reduces the stigma associated with PCOD symptoms.

This lack of awareness contributes to delays in diagnosis and management, exacerbating the condition's impact on women's health.

There are several implications for practice based on these findings. Firstly, there is an urgent need for public health initiatives to raise awareness about PCOD, particularly focusing on the lesser-known symptoms. This can help in early diagnosis and intervention, improving outcomes for affected women. Secondly, given the positive indications of yoga as a non-pharmacological intervention, healthcare providers should consider incorporating yoga into comprehensive treatment plans for PCOD, providing a holistic approach to managing the condition.

while the current research on yoga interventions for PCOD shows promise, it is evident that much work remains. Increased awareness and a more robust body of research are essential to fully understand and harness the benefits of yoga for women with PCOD. Addressing these gaps will ultimately result in enhanced health outcomes and an elevated quality of life for women affected by this condition.

Recommendation:

Based on the current trajectory of research and identified gaps in the existing literature on yoga interventions for PCOD, several critical variables warrant further exploration to deepen our understanding of yoga's effects and address these gaps comprehensively. First, investigating ovarian morphology, specifically through detailed measurements of ovarian volume and size, can elucidate the morphological changes induced by yoga interventions. Monitoring the number and characteristics of ovarian cysts before and after yoga practices can provide insights into how yoga impacts ovarian health directly.

In terms of mood states, further studies should measure changes in anxiety and depression levels among PCOD patients participating in yoga interventions. Understanding how yoga influences mood swings, which are common in PCOD, is also crucial. Moreover, exploring the impact of yoga on eating behaviors and potential eating disorders in PCOD patients is essential, considering the psychological dimensions of the syndrome.

Assessing PCOD-specific quality of life through comprehensive evaluations, such as standardized questionnaires like the PCOSQ, can provide a holistic view of the benefits of yoga beyond clinical measures. Additionally, measuring body satisfaction levels can shed light on how yoga affects body image and self-esteem in women with PCOD.

For future research directions, conducting longitudinal studies will be pivotal in evaluating the sustained effects of yoga on PCOD symptoms and overall health outcomes over extended periods. Increasing the number of high-quality randomized controlled trials will fortify the empirical foundation supporting the efficacy of yoga as a non-pharmacological intervention for PCOD. Encouraging interdisciplinary research involving gynecology, endocrinology, psychology and complementary medicine will provide a comprehensive understanding of yoga's benefits in managing PCOD from various perspectives.

Exploring cultural and geographical variations in the effectiveness of yoga interventions for PCOD is also crucial to developing culturally sensitive treatment protocols that account for diverse patient needs.

Lastly, Concentrating on disseminating research outcomes in prestigious, peer-reviewed academic journals will enhance the visibility and recognition of yoga as a viable treatment option for PCOD, thereby fostering broader acceptance and adoption among healthcare practitioners and patients alike.

By addressing these areas systematically, future research endeavors can bridge existing gaps in knowledge, provide robust evidence on the multifaceted benefits of yoga for women with PCOD, and ultimately improve their quality of life and overall well-being.

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