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Invited Article

Polycystic Ovary Syndrome Research: A Scientometric Assessment of Global Publications Output During 2007-16

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ABSTRACT

The paper examines 1829 global publications on polycystic ovary syndrome research, as covered in Scopus database during 2007-16, recording an annual average growth rate of -0.58% and citation impact averaged to 13.78 citations per paper. The top 10 most productive countries individually contributed global share from 4.05% and 18.21%, with largest global publication share coming from USA followed by U.K and China (9.57% and 9.40% share each), Italy (6.40%), Turkey (5.19% share), India, Iran, Greece, Egypt and France (from 4.05% to 4.54%) during 2006-17. Together, the 10 most productive countries accounted for 70.31% and 96.97% share of global publications and citation output during 2007-16. The national share of international collaborative papers across top 10 countries in polycystic ovary syndrome research varied from 4.21% to 32.00%, during 2007-16. Medicine accounting for the highest publications share (93.66%), followed by biochemistry, genetics & molecular biology (30.62%) and pharmacology, toxicology & pharmaceutics (3.72%) during 2007-16..The top 15 most productive organizations and authors together contributed 19.57% and 15.25% respectively as their share of global publication output and 51.06% and 49.79% respectively as their share of global citation output during 2007-16. Among the total journal output of 1793 papers, the top 15 journals contributed 37.20% share to the global journal output during 2007-16. Of the total global polycystic ovary syndrome research output, the top 27 highly cited publications registered citations from 100 to 727 and they together received 5556 citations, with 205.78 citations per paper. These 27 highly cited papers resulted from research pursuits of 124 authors and 92 organizations. These 27 highly cited papers appeared in 15 journals: Human Reproduction Update published 8 papers, 3 papers each in Fertility & Sterility and Human Reproduction, 2 papers each in Endocrine Reviews and Clinical Endocrinology, and 1 paper each in other journals.

Key words: Polycystic Ovary Syndrome, Global publications output, Bibliometrics, Scientometrics.

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INTRODUCTION

Polycystic Ovarian Syndrome (PCOS) is one of the most common women endocrine disorders, affecting approximately 5-10% of women worldwide, with less than 50% of them diagnosed. The syndrome is present throughout a woman's life from puberty through post-menopause and affects women of all races and ethnic groups.[1] Seventy seven years ago, two American gynecologists Irving F. Stein, Sr. and Michael Leo Leventhal first described this syndrome. The syndrome was considered as a problem of anovulation and infertility. They described their treatment of anovulation using wedge resection.[2] Polycystic ovarian syndrome is a condition in which a woman's levels of the sex hormones estrogen and progesterone are out of balance. This leads to the growth of ovarian cysts (benign masses on the ovaries).[3] Polycystic ovary syndrome is a complex condition characterized by elevated androgen levels, menstrual irregularities, and/or small cysts on one or both ovaries. The disorder can be morphological (polycystic ovaries) or predominantly biochemical (hyperandrogenemia). Hyperandrogenism, a clinical hallmark of PCOS, can cause inhibition of follicular development, microcysts in the ovaries, anovulation, and menstrual changes.[4]

Polycystic ovaries are slightly larger than normal ovaries and have twice the number of follicles (small cysts). Having polycystic ovaries does not mean you have polycystic ovary syndrome. Around 6 or 7 in 100 (6–7%) of women with polycystic ovaries have PCOS.[5]

The three main features of PCOS are: (i) irregular periods – which means your ovaries don't regularly release eggs (ovulation), (ii) excess androgen – high levels of "male hormones"

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in your body, which may cause physical signs such as excess facial or body hair (see signs and symptoms below) and (iii) polycystic ovaries – your ovaries become enlarged and contain many fluid-filled sacs (follicles) which surround the eggs (it's important to note that, despite the name, if you have PCOS you don't actually have cysts). If you have at least two of these features you may be diagnosed with PCOS. Polycystic ovaries contain a large number of harmless follicles that are up to 8 mm (approximately 0.3in) in size. The follicles are under-developed sacs in which eggs develop. In PCOS, these sacs are often unable to release an egg, which means that ovulation doesn't take place.[6] PCOS is associated with reproductive and metabolic consequences. It was believed that research findings that the long-term reproductive outcomes of women with PCOS are surprisingly similar compared to women with normal ovaries, and that they have an ovarian reserve possibly superior to women with normal ovaries. The typical features of PCOS, specifically the anovulatory cycles tend to normalize over time, but in spite of a decrease over time, free androgen levels remain elevated compared to age-matched control subjects. Overall, the accumulated data from several European cohort studies of older women with a previous diagnosis of PCOS suggest an increased incidence of type 2 diabetes, increased prevalence of several features of the metabolic syndrome, but no increased incidence of mortality from CVD.[7]

Literature Review

Only few bibliometric studies have been carried in this area in the past. Amongst such studies, Brüggmann, Berges, Klingelhöfer, Bauer, Bendels, Louwen, Jaque and Groneberg[8] assessed all PCOS-related publications indexed between 1900- 2014 in the Web of Science and applied density equalizing mapping projections, scientometric techniques and economic benchmarking procedures. A total of 6261 PCOS-specific publications and 703 international research collaborations were found. The USA was identified as the most active country in total and collaborative research activity. In the socioeconomic analysis, the USA was also ranked first (25.49 PCOS-related publications per gross domestic product [GDP]/capita), followed by the UK, Italy and Greece. When research activity was related to population size, Scandinavian countries and Greece were leading the field. For many highly productive countries, gender analysis revealed a high ratio of female scientists working on PCOS with the exception of Japan. Ram[9] analyzed the research publications in the area of PCOS for a period of 40 years using SCOPUS database. The author analyzed the literature for types of publications, languages, productive journals, authors, countries & institutions, subjects covered, and citation impact. It was found that PCOS literature is spread over 99 countries of the world where United States had contributed the highest number of articles. Among research contribution of BRICS countries, China has produced the maximum number of articles. 'Fertility and Sterility' is the most productive journal and published 9.96% of PCOS articles. 'S Franks', the most productive author, has contributed 178 articles on PCOS. Yayci, Guler, Ömer, Ataçağ and Cetin[10] made a quantitative analysis of the scientific publications (8891) related to "Polycystic Ovary Syndrome" and investigated publications originating from Turkish institutions and authors, which are published in *Science Citation Index* Expanded covered medical journals between 1980 and 2012. Among these contributions, 2836 (31.9%) were from United States of America, followed by England (9.75%), Italy (8.45%), Turkey (5.34%). The international scientific repertory on polycystic ovary syndrome was relatively poor in the beginning of 1980s, however; we observed an international acceleration with respect to the publication number after 1990s. Publications from Turkey on the other hand showed up only after 1990s. Turkey's contribution to international repertory of polycystic ovary syndrome research speeded up after 2000s. When the ranking of the authors with respect to the number of publications was evaluated, R. Azziz was found to be the first, followed by R.S. Legro RS and Franks S. B.O. Yildiz, F. Kelestimur , H. Yarali were the first three among Turkish authors. ''Fertility and Sterility" was found to be the most preferred journal publishing papers about polycystic ovary syndrome.

OBJECTIVES

The main objective of this study is to study the performance status of global polycystic ovary syndrome research publications during 2007-16, as covered in Scopus database. In particular, the study focuses on the following analyses of the growth of world research output on polycystic ovary syndrome and its citation impact, contribution and citation impact of top 10 most productive countries, the international collaboration share of top 10 most productive countries, distribution of global research output by broad subject areas and the dynamics of its growth and decline, identification of significant keywords, the publication productivity and citation impact of top 15 most productive global organizations and authors, modes of research communication and identification of key sources and the characteristics of top 27 highly cited papers**.**

METHODOLOGY

The publication data on polycystic ovary syndrome research was retrieved and downloaded from the Scopus database (http://www.scopus.com) covering the 10 years period 2007-16. Scopus is an online bibliographical multidisciplinary publication and citation database prepared by Elsevier and covers nearly 22,000 titles in the science, technology, medical, social sciences and humanities. Our search strategy was based on the search for polycystic ovary syndrome research publications in which keywords such as "polycystic ovary syndrome"' or "polycystic ovarian syndrome" or "ovary polycystic" or "ovarian hyperstimulation" or "hyperandrogen anovulation" were appearing in either "Keyword tag" or "Article Title tag". The time was set from 2007 to 2016. Using analytical commands or tags, such as ''year", "document type", "source type", ''language", "subject area", ''keyword", ''author name", ''affiliation", ''country/territory" and ''source type" available in Scopus database, we were able to analyze publication distribution by year-wise, document type, source type, language-wise, subject-wise, keywords, source title and identify important authors and organizations and distribution of international collaborative publications and also leading collaborative countries. The analyses is further enhanced with the help of citations received, h-index, international collaborative papers and high cited papers particularly in case of authors and organizations. The publications receiving 100 or more citations from the date of publications till 21 June 2017 was designated here as high cited papers. The quality of research output was indirectly assessed using indicator as citation per paper. A number of raw and relative bibliographical indicators were used to assess and understand the growth and dynamics of global polycystic ovary syndrome research. The raw bibliographical indicators used were: growth rate number of publications and international collaborative publications, citation per paper, h-index, etc. Among relative bibliographical indicators, we have used activity index and relative citation index.

(((KEY(polycystic ovary syndrome or polycystic ovarian syndrome) OR TITLE (polycystic ovary syndrome or polycystic ovarian syndrome)) AND PUBYEAR > 2006 AND PUBYEAR < 2017) or ((KEY(ovary polycystic or ovarian hyperstimulation or hyperandrogen* anovulation) OR TITLE(ovary polycystic or ovarian hyperstimulation or hyperandrogen* anovulation)) AND PUBYEAR > 2006 AND PUBYEAR < 2017))

ANALYSIS

Publications analysis

The global research output on polycystic ovary syndrome cumulated to a total of 1829 publications in 10 years during 2007-16, growing at -0.58%

Table 1: World Output in Polycystic Ovary Syndrome Research, 2007-16

Publication Period	World		
	TP	TC	CPP
2007	163	3615	22.18
2008	141	3465	24.57
2009	187	4183	22.37
2010	191	2759	14.45
2011	199	3243	16.30
2012	179	2759	15.41
2013	203	2129	10.49
2014	220	1997	9.08
2015	219	878	4.01
2016	127	168	1.32
2007-11	881	17265	19.60
2012-16	948	7931	8.37
2007-16	1829	25196	13.78

TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper

growth rate increasing from 163 in 2007 to 127 publications in 2016. The polycystic ovary syndrome research registered 7.60% quinquennial growth from 881 to 948 publications during the period 2007-11 to 2012-16. The citation impact of global publications on polycystic ovary syndrome averaged to 13.78 citations per publication (CPP) during 2007-16, but their five-yearly impact declined from 19.60 CPP to 8.37 CPP during 2007-11 to 2012-16 (Table 1). Of the total global publications output, 70.75% (1294) was published as articles, 20.94% (383) as reviews, 1.69% (31) as letters, 1.48% (27) as conference papers, 1.42% (26 each) as editorials and short surveys and the rest as book chapters (15 papers), articles in press (6 papers) and erratum (4 papers).

Top 10 Most Productive Countries in Polycystic Ovary Syndrome

The global research output on polycystic ovary syndrome originated from as many as 74 countries during 2007-16. The distribution of research output by country of publication is highly skewed. The top 10 most productive countries in polycystic ovary syndrome research accounted for 70.31% and 96.97% share of global publications and citation output during 2007-16 (Table 2). Their five-yearly global publication share increased from 65.27% to 75.00% during 2007-11 to 2012-16. Of the 74 countries, 45 contributed 1-10 papers each, 15 countries 11-50 papers each, 10 countries 51-100 papers each and 4 countries 101-400 papers each. Their global share of top 10 countries ranged between 4.05% and 18.21% during 2007-16, with USA accounting for the highest global share (18.21%), followed by U.K and China (9.57% and 9.40% share each), Italy (6.40%), Turkey (5.19% share), India, Iran, Greece, Egypt and France (from 4.05% to 4.54%) during 2006-17. The five-yearly cumulative output of China increased by 11.79%, followed by 1.97% in India, 1.70% in Turkey and 1.64% in Iran, whereas it decreased by 2.78% in U.K, 1.67% in Italy, 1.66% in USA, 0.54% in Greece, 0.52% in France and 0.19% in Egypt during 2007-11 to 2012-16. Five of top 10 countries scored relative citation index above the world average *i.e.* more than 1.38: Greece (2.46), France (2.36), Italy (2.34), USA (1.74) and U.K. (1.40) during 2007-16 (Table 2).

International Collaboration

The national share of international collaborative papers across top 10 countries in polycystic ovary syndrome research varied from 4.21% to 32.00%, with U.K. (32.00%) accounting for the highest national share, followed by Greece (28.75%), France (28.38%), Italy (28.21%), USA (26.43%), Egypt (21.33%), China (20.93%), India (10.84%), Iran (8.54%) and Turkey (4.21%) during 2007-16 (Table 2).

Subject-Wise Distribution of Research Output

The global research output on polycystic ovary syndrome reported during 2007-16 spreads across three sub-fields (as identified in Scopus database classification), with medicine accounting for the highest publications share (93.66%), followed by biochemistry, genetics & molecular biology (30.62%) and pharmacology, toxicology & pharma-

Table 2: Global Publication Share of Top 10 Most Productive Countries in Polycystic Ovary Syndrome during 2007-16

S.No	Name of the Country	Number of Papers			Share of Papers			TC	CPP	ICP	%ICP	RCI
		2007-11	2012-16	2007-16	2007-11	2012-16	2007-16					
1	USA	168	165	333	19.07	17.41	18.21	8003	24.03	88	26.43	1.74
2	U.K.	97	78	175	11.01	8.23	9.57	3366	19.23	56	32.00	1.40
3	China	29	143	172	3.29	15.08	9.40	1409	8.19	36	20.93	0.59
4	Italy	64	53	117	7.26	5.59	6.40	3776	32.27	33	28.21	2.34
5	Turkey	38	57	95	4.31	6.01	5.19	852	8.97	4	4.21	0.65
6	India	31	52	83	3.52	5.49	4.54	708	8.53	9	10.84	0.62
7	Iran	32	50	82	3.63	5.27	4.48	419	5.11	7	8.54	0.37
8	Greece	41	39	80	4.65	4.11	4.37	2712	33.90	23	28.75	2.46
9	Egypt	37	38	75	4.20	4.01	4.10	780	10.40	16	21.33	0.75
10	France	38	36	74	4.31	3.80	4.05	2408	32.54	21	28.38	2.36
	Total	575	711	1286	65.27	75.00	70.31	24433	19.00	293	22.78	1.38
	World	881	948	1829	100.00	100.00	100.00	25196	13.78			
	Share of 10 Countries in World Total	65.27	75.00	70.31				96.97				

TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper; ICP=International Collaborative Papers; RCI=Relative Citation Index

Table 3: Subject-Wise Breakup of Global Publications in Polycystic Ovary Syndrome Research during 2007-16

S.No	Subject*	Number of Papers (TP)			Activity Index		TC	CPP	%TP
		2007-11	2012-16	2007-16	2007-11	2012-16	2007-16	2007-16	2007-16
1	Medicine	842	871	1713	102.05	98.10	23582	13.77	93.66
2	Biochemistry, Genetics & Molecular Biology	244	316	560	90.46	108.87	9449	16.87	30.62
3	Pharmacology, Toxicology & Pharmaceutics	24	44	68	73.27	124.84	659	9.69	3.72
	World Output	881	948	1829	100.00	100.00			

*There is overlapping of literature covered under various subjects
TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper

Table 4: Significant Keywords in Literature on Polycystic Ovary Syndrome Research during 2007-16

S.NO	Keywords	Frequency	S.No	Keywords	Frequency	S.No	Keywords	Frequency
1	Ovary Polycystic Disease	1648	21	Androgen	264	41	Ovary Follicle Development	121
2	Polycystic Ovary Syndrome	1330	22	Chorionic Gonadotropins	257	42	Menstrual Irregularities	118
3	Hyperandrogenism	602	23	Progesterone	249	43	Female Fertility Agents	116
4	Anovulation	589	24	Menstrual Cycle	244	44	Estrogen Complications	114
5	Female Infertility	548	25	Ovulation	234	45	Reproduction	102
6	Follitropin	505	26	Infertility	223	46	Gonadorelin	100
7	Luteinizing Harmone	476	27	Gonadotropins	221	47	Cardiovascular Disease	96
8	Pregnancy	473	28	Ovarian hyper stimulation Syndrome	218	48	Ovary Insufficiency	94
9	Insulin Resistance	463	29	Pathophysiology	212	49	Live Births	92
10	Ovulation Induction	414	30	PCOS	211			
11	Ovary	389	31	Muellerian Inhibiting Factor	210			
12	Obesity	388	32	Oral Contraceptive Agents	155			
13	*In-vitro* Fertilization	350	33	Anti-Muellerian Harmone	153			
14	Ovary Hype- stimulation	350	34	Oligomenorrhea	148			
15	Polycystic Ovarian Syndrome	324	35	Metabolic Syndrome	146			
16	Pregnancy Rate	303	36	Follicle Stimulating Harmone	141			
17	Insulin	301	37	Amenorrhea	138			
18	Ovary Follicle	297	38	Embryo Transfer	138			
19	Hirsutism	270	39	Non-Insulin Dependent Diabetes Mellitus	125			
20	Ovarian Follicle	265	40	Oocyte	123			

ceutics (3.72%) during 2007-16. The activity index, which computes changes in research activity in the sub-fields over time 2007-11 to 2012-16 (world average activity index of a given subject being taken as 100), witnessed increase in biochemistry, genetics & molecular biology (from 90.46 to 108.87) and pharmacology, toxicology & pharmaceutics (from 73.27 to 124.84), as against decline of research activity in medicine (from 102.05 to 98.10) from 2007-11 to 2012-16. Among 3 subjects, biochemistry, genetics & molecular biology scored the highest citation impact per paper of 16.87 citations per paper, followed by medicine (13.77) and pharmacology, toxicology & pharmaceutics (9.69) during 2007-16 (Table 3).

Significant Keywords

Around 49 significant keywords have been identified from the literature, which point towards possible directions of research trends in polycystic ovary syndrome. These keywords are listed in Table 4 in the decreasing order of the frequency of occurrence during 2007-16.

Top 15 Most Productive Global Organizations

The productivity of top 15 most productive global organizations pursuing polycystic ovary syndrome research varied from 18 to 40 publications in 10 years and together they account for 19.57% (358) publication share and 51.06% (12865) citation share during the period 2007-16. The scientometric profile of these 15 organizations is presented in Table 5. **Six organizations** registered publications output above the group average of 23.67: Aristotle University of Thessaloniki, Greece (40 papers), Centre

Table 5: Scientometric Profile of Top 15 Most Productive Global Organizations in Polycystic Ovary Syndrome during 2007-16

S.No	Name of the Organization	TP	TC	CPP	HI	ICP	%ICP	RCI
1	Aristotle University of Thessaloniki, Greece	40	1009	25.23	15	13	32.50	1.83
2	Centre Hospitalier Regional Universitaire de Lille, France	33	2122	64.30	13	8	24.24	4.67
3	Mansoura University, Egypt	30	384	12.80	12	3	10.00	0.93
4	University Medical Center, Utrecht, Netherlands	29	1375	47.41	18	18	62.07	3.44
5	Trehan University of Medical Sciences, Iran	25	188	7.52	8	2	8.00	0.55
6	University of Athens, Greece	25	813	32.52	12	2	8.00	2.36
7	McGill University, Canada	21	340	16.19	9	4	19.05	1.17
8	Universidad de Sao Paulo USP, Brazil	21	122	5.81	6	5	23.81	0.42
9	Sun Yat-Sen University, China	20	244	12.20	9	8	40.00	0.89
10	Pen State College of Medicine, USA	20	1700	85.00	12	9	45.00	6.17
11	University of Athens, Greece	20	1528	76.40	13	3	15.00	5.54
12	Peking University, China	19	294	15.47	7	5	26.32	1.12
13	Imperial College, London, U.K	19	618	32.53	11	6	31.58	2.36
14	University Of Adelaide, Australia	18	1705	94.72	10	12	66.67	6.87
15	Universidad de Chile, Chile	18	423	23.50	13	7	38.89	1.71
	Total of 15 organizations	358	12865	35.94	11.2	105	29.33	2.61
	Total of World	1829	25196	13.78				
	Share of top 15 organizations in World total output	19.57	51.06					

TP='Total Papers; TC='Total Citations; CPP=Citations Per Paper; HI=h-index; ICP=International Collaborative Papers; RCI=Relative Citation Index

Hospitalier Regional Universitaire de Lille, France (33 papers), Mansoura University, Egypt (30 papers), University Medical Center, Utrecht, Netherlands (29 papers), Trehan University of Medical Sciences, Iran and University of Athens, Greece (25 papers each) during 2007-16.

Five organizations registered impact above the group average of 35.54 citations per publication during 2007-16: University Of Adelaide, Australia (94.72), Pen State College of Medicine, USA (85.0), University of Athens, Greece (76.4), Centre Hospitalier Regional Universitaire de Lille, France (64.3) and University Medical Center, Utrecht, Netherlands (47.41)., **Eight organizations** registered h-index above the group average of 11.2: University Medical Center, Utrecht, Netherlands (18), Aristotle University of Thessaloniki, Greece (15), University of Athens, Greece, Centre Hospitalier Regional Universitaire de Lille, France and Universidad de Chile, Chile (13 each), Pen State College of Medicine, USA, University of Athens, Greece and Mansoura University, Egypt(12 each) during 2007-16.

Seven organizations contributed international collaborative publications share above the group average of 29.33%: University Of Adelaide, Australia (66.67%), University Medical Center, Utrecht, Netherlands (62.07%), Pen State College of Medicine, USA (45.0%), Sun Yat-Sen University, China (40.0%), Universidad de Chile, Chile (38.89%), Aristotle University of Thessaloniki, Greece (32.5%), Imperial College, London, U.K during 2007-16.

Five organizations registered the relative citation index above the group average (2.61) of all organizations: University Of Adelaide, Australia (6.87), Pen State College of Medicine, USA (6.17), University of Athens, Greece (5.54), Centre Hospitalier Regional Universitaire de Lille, France (4.67) and University Medical Center, Utrecht, Netherlands (3.44) during 2007-16.

Top 15 Most Productive Authors

The research productivity of top 15 most productive authors pursuing in polycystic ovary syndrome varied from 13 to 33 publications in 10 years. Together they account for 15.25% (279) global share and 49.79% (12544) citation share during 2007-16. The scientometric profile of these 15 authors is presented in Table 6.

Eight authors registered publications output above the group average of 18.6: D. Dewailly (33 papers), E.Diamantri-Kandarakis (23 papers), S. Franks and R.S. Legro (22 papers each), B.C.J.M. Fauser and R.Homburg (21 papers each), I.Katskis and S.Palomba (19 papers each) during 2007-16.

Five authors registered impact above the group average of 44.46 citations per publication: R.S. Legro (92.05), E.Carmina (92.0), E. Diamantri-Kandarakis (71.52), D. Dewailly (64.3) and B.C.J.M. Fauser (52.71) during 2007-16.

Seven authors registered h-index above the group average of 11.27 of all authors: B.C.J.M. Fauser (23), R.S. Legro, E. Diamantri-Kandarakis, D. Dewailly and S. Palomba (13 each), S. Franks and R. Homburg (12 each) during 2007-16.

Seven authors contributed international collaborative publications share above the group average of 30.82% of all authors: B.C.J.M. Fauser and R. Homburg (66.67% each), Z.J.Chen and E. Carmina (53.85% each), R.S. Legro (40.91%), A.H. Balen (40.0%) and I. Katskis (31.58%) during 2007-16.

Five authors registered the relative citation index above the group average (3.11) of all authors: E. Carmina and R.S. Legro (6.73 each), E. Diamantri-Kandarakis (5.23), D. Dewailly (4.70) and B.C.J.M. Fauser (3.85) during 2007-16.

Medium of Research Communication

Of the total global research output on polycystic ovary syndrome, 98.03% (1793) appeared in journals. The top 15 most productive journals each reported 16 to 159 papers, together accounted for 37.20%

Table 6: Scientometric Profile of Top 15 Most Productive Authors in Polycystic Ovary Syndrome during 2007-16.

S .No	Name of the Author	Affiliation of the Author	TP	TC	CPP	HI	ICP	%ICP	RCI
1	D.Dewailly	Hospital Jeanne de Flandre, Universite Lille, France	33	2122	64.30	13	8	24.24	4.70
2	E.Diamantri-Kandarakis	University of Athens, Greece	23	1645	71.52	13	3	13.04	5.23
	S.Franks	Institute of Reproductive & Development Biology, Imperial College, London, U.K.	22	676	30.73	12	6	27.27	2.25
4	R.S.Legro	Penn State College of Medicine, USA	22	2025	92.05	13	9	40.91	6.73
5	B.C.J.M.Fauser	University Medical Center Heidelbergglannser. Utrecht, Netherlands	21	1107	52.71	23	14	66.67	3.85
6	R.Homburg	Barzilai Medical Center, Askhelon, Israel	21	397	18.90	12	14	66.67	1.38
7	I.Katskis	Aristotle University of Thessaloniki, Greece	19	426	22.42	8	6	31.58	1.64
8	S.Palomba	University Magna Graecia of Catanzaro, Italy	19	648	34.11	13	1	5.26	2.49
9	S. Catteau-Jonard	Hopital Jeanne de Flandre, CHRU, France	17	450	26.47	8	0	0.00	1.93
10	A.H. Balen	Leeds General Infirmary, Leeds, U.K.	15	431	28.73	8	6	40.00	2.10
11	F.Orio	University Parthenope of Naples, Italy	14	548	39.14	11	2	14.29	2.86
12	D.Panidis	Aristotle University of Thessaloniki, Greece	14	180	12.86	7	2	14.29	0.94
13	E.Carmina	University of Palermo, Italy	13	1196	92.00	8	7	53.85	6.73
14	Z.J. Chen	Provincial Hospital Affiliated to Shanding University, Jinan, China	13	175	13.46	9	7	53.85	0.98
15	A.Falbo	Graecia of Catanzaro, Italy	13	518	39.85	11	1	7.69	2.91
		Total of 15 authors	279	12544	44.96	11.27	86	30.82	3.11
		Total of World	1829	25196	13.78				
		Share of top 15 authors in World total output	15.25	49.79					

TP=Total Papers; TC=Total Citations; CPP=Citations Per Paper; HI=h-index; ICP=International Collaborative Papers; RCI=Relative Citation Index

Table 7: Top15 Most Productive Journals in in Polycystic Ovary Syndrome during 2007-16

Name of the Journal	Number of Papers		
	2007-11	2012-16	2007-16
Fertility & Sterility	115	44	159
Human Reproduction	47	37	84
Gynecological Endocrinology	34	48	82
Reproductive Biomedicine Online	35	21	56
Archives of Gynecology & Obstetrics	21	31	52
Journal of Clinical Endocrinology & Metabolism	25	16	41
European Journal of Obstetrics, Gynecology and Reproductive Biology	11	21	32
Seminars in Reproductive Medicine	16	9	25
Journal of Assisted Reproduction & Genetics	3	21	24
Human Reproduction Update	11	11	22
Reproductive Biology & Endocrinology	6	16	22
Obstetrics, Gynecology and Reproductive Medicine	9	9	18
Journal of Pediatric Adolescent Gynecology	9	8	17
Middle East Fertility Society Journal	7	10	17
Clinical Endocrinology	10	6	16
Total of 15 journals	359	308	667
Total global journal output	869	924	1793
Share of top 15 journals in global journal output	41.31	33.33	37.20

publications share (667 papers) of total journal papers during 2007-16. The publication share of top 15 most productive journals dropped from 41.31% to 33.33% between 2007-11 and 2012-16. *Fertility & Sterility Letters* emerged as the top most productive journal in polycystic ovary syndrome (with 159 papers), followed by *Human Reproduction* (84 papers), *Gynecological Endocrinology* (82 papers), *Reproductive Biomedicine Online* (56 papers), etc. during 2007-16 (Table 7).

Highly Cited Papers

Of the total global output of 1829 papers on polycystic ovary syndrome, only 27 were identified as highly cited papers, each with high-end citations ranging from 100 to 727 citations per paper during 2007-16. These 27 highly cited papers together cumulated 5556 citations in 10 years, and averaged 205.78 citations per paper. Of the27 highly cited papers, 4 resulted from single stand-alone organizations (as non-collaborative papers) and 23 from collaborative participation across two or more organizations (as collaborative papers, 10 from across national collaboration and 13 from across international collaboration). Among international collaborative papers, the country participation was the largest from USA (11 papers), followed by Italy (11 papers), Netherlands (6 papers), France, Greece and Australia (4 papers each), Germany (3 papers), U.K. and Netherlands (2 papers each), Spain, Sweden, Bosnia & Herzegovina, Serbia, Turkey, Israel, Belgium, China, Austria and Switzerland's (1 paper each). The leading organizations contributing to high cited papers include University Medical Center, Utrecht, Netherlands (6 papers), Centre Hospitalier Regional Universitaire de Lille, France (4 papers), Aristotle University of Thessaloniki, Greece and University of Athens Medical Center, Greece (3 papers each), University of Athens, Greece and Penn State College of Medicine, USA (2 papers each), etc. The leading authors contributing to high cited papers include B.C.J.M.Fauser (5 papers), D.Dewailly and E.Diamantri-Kandarakis (4 papers each), R.S.Legro (3 papers), E.Carmina (2 papers), etc. These 27 highly cited papers resulted from research pursuits by a total of 124 authors and 92 organizations. Of the 27 highly cited papers, 16 were published as articles, 10 a review papers and 1 as short survey. These 27 highly cited papers appeared in 15 journals: *Human Reproduction Update* published *8* papers, 3 papers each in *Fertility & Sterility* and *Human Reproduction*, 2 papers each in Endocrine Reviews and Clinical Endocrinology, and 1 paper each in *American Journal of Physiology, Endocrinology & Metabolism, American Journal of Obstetrics & Gynecology, Biology of Reproduction, Endocrinology, Endocrinology & Metabolism, Expert Reviews in Molecular Medicine, Journal of Endocrinology & Metabolism, The Lancet, Nature Reviews Endocrinology* and *Trends in Endocrinology & Metabolism.*

SUMMARY & CONCLUSION

This paper provides a quantitative and qualitative description of polycystic ovary syndrome research by analyzing global publications data on the subject sourced from Scopus database covering 10 years period during 2007-16. This study finds that polycystic ovary syndrome is still a young and growing research field. Its global literature in 10 years did not grow as high as expected but it could cumulate its global output to 1829 publications only with negative -.58% annual growth rate during 2007-16. The average citation per paper registered by global publications on polycystic ovary syndrome was 13.78 during 2007-16, which decreased from 19.60 to 8.37 from 2007-11 to 2012-16. The decrease in citations per paper during 2012-16 was because publications in the later period could get less number of years to receive citations.

Currently, the distribution of polycystic ovary syndrome publications output is highly skewed. The 10 most productive countries in the world account for the largest 70.31% and 96.97% share of global publications and citation output during 2007-16. USA, China and U.K. are seen the world leaders in polycystic ovary syndrome research output together accounting for 37.18% global publication share and 50.71% citation share, whereas other contributing countries contributed comparatively less global share, with Italy and Turkey (with share from 5.19% to 6.40%) and India, Iran, Greece, Egypt and France (with share from 4.05% to 4.54%) during 2006-17. Greece, France and Italy have made the higher citation impact among top 10 countries with citation per paper of 33.90, 32.54 and 32.27.

Of the top 15 most productive global organizations, which account for nearly 19.57% and 51.06% of global publication and citation share, 10 are from developed countries and 5 from developing countries. Organizations from Australia, USA, Greece and France have registered comparatively higher citation impact per paper compared to other countries. As a result, the organizations from these countries among top 10 registered the relative citation index above the group average of all organizations: University Of Adelaide, Australia (6.87), Pen State College of Medicine, USA (6.17), University of Athens, Greece (5.54), Centre Hospitalier Regional Universitaire de Lille, France (4.67) and University Medical Center, Utrecht, Netherlands (3.44) during 2007-16. This data demonstrates that research collaboration at international level did play a big role in achieving citation quality of these organizations from Australia, Netherlands, USA, etc. University Of Adelaide, Australia (66.67%) contributed the largest international collaborative publications share, followed by University Medical Center, Utrecht, Netherlands (62.07%), Pen State College of Medicine, USA (45.0%), Sun Yat-Sen University, China (40.0%), Universidad de Chile, Chile (38.89%), Aristotle University of Thessaloniki, Greece (32.5%), Imperial College, London, U.K during 2007-16.

Of the top 15 most productive authors, which account for nearly 15.25% and 49.796% of global publication and citation share, 13 are from developed countries and 2 from developing countries. Authors from USA, Italy, Greece, France and Netherlands registered comparatively higher citation impact per paper compared to other countries. As a result, the authors from these countries among top 10 registered the relative citation index above the group average of all organizations: E. Carmina (Italy) and R.S. Legro (USA) (6.73 each), E. Diamantri-Kandarakis(Greece) (5.23), D. Dewailly (France) (4.70) and B.C.J.M. Fauser (Netherlands) (3.85) during 2007-16.

Both USA and Italy have emerged as world leaders in quality of research in polycystic ovary syndrome accounting for 22 of the top 27 highly cited papers in the field. These 27 highly cited papers together cumulated 5556 citations in 10 years, and averaged 205.78 citations per paper. Of the 27 highly cited papers, 4 resulted from single stand-alone organizations (as non-collaborative papers) and 23 from collaborative participation across two or more organizations (as collaborative papers, 10 from across national collaboration and 13 from across international collaboration). These 27 highly cited papers resulted from research pursuits by a total of 124 authors and 92 organizations. The leading organizations contributing to high cited papers include University Medical Center, Utrecht, Netherlands (6 papers), Centre Hospitalier Regional Universitaire de Lille, France (4 papers), Aristotle University of Thessaloniki, Greece and University of Athens Medical Center, Greece (3 papers each), etc. The leading authors contributing to high cited papers include B.C.J.M.Fauser (5 papers), D.Dewailly and E.Diamantri-Kandarakis (4 papers each), R.S.Legro (3 papers), E.Carmina (2 papers), etc. These 27 highly cited papers appeared in 15 journals*:* *Human Reproduction Update* published 8 papers, 3 papers each in *Fertility & Sterility* and *Human Reproduction*, 2 papers each in *Endocrine Reviews* and *Clinical Endocrinology*, and 1 paper each in the remaining journals.

Conclude that Polycystic ovary syndrome can cause distressing symptoms of hyperandrogenism (such as hirsutism), may impair fertility and is associated with the metabolic syndrome. Management has traditionally been guided by symptoms or by the wish to conceive, but prevention of the possible long-term consequences of the metabolic disturbance characteristic of anovulatory women with PCOS is now an important element of management. Important elements in the management of PCOS include focusing on the treatment of infertility, menstrual regulation, the treatment of symptoms of hyperandrogenism and the prevention of possible consequences of the metabolic disturbance. Proper diagnosis and management of PCOS is also essential to address patient concerns but also to prevent future metabolic, endocrine, psychiatric, and cardiovascular complications. There is need to develop guidelines at the national level for the assessment and management of reproductive-age adolescents and women with PCOS, including women with PCOS who are experiencing infertility. The guideline will apply in all health care settings and to a broad audience, including: community care practitioners; nurses; endocrinologists; obstetricians and gynaecologists; allied health professionals, psychologists, dietitians, exercise physiologists, etc. There is need also to build a National Center for Excellence in Polycystic Ovary Syndrome on the pattern of Australian model, which should generate new knowledge for improved health outcomes; ensure effective transfer of research into health policy and practice; develop the health and medical research workforce; and encourage participation and collaboration.

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Appendix 1. List of Top 10 High Cited Papers

1. Azziz R, Carmina E, Dewailly D, Diamanti-Kandarakis E, Escobar-Morreale HF, Futterweit W. The Androgen Excess and PCOS Society criteria for the polycystic ovary syndrome: the complete task force report (Article). Fertility and Sterility. 2009;91(2):456-88. Cited 727 times.
2. Norman RJ, Dewailly D, Legro RS, Hickey TE. Polycystic ovary syndrome (Review). Lancet, 2007, 370 (9588), pp. 685-697. Cited 591 times.
3. Goodarzi MO, Dumesic DA, Chazenbalk G, Azziz R. Polycystic ovary syndrome: Etiology, pathogenesis and diagnosis (Review). Nature Reviews Endocrinology. 2011;7(4):219-31. Cited 407 times.
4. Legro RS, Arslanian SA, Ehrmann DA, Hoeger KM, Murad MH, Pasquali R, *et al*. Diagnosis and treatment of polycystic ovary syndrome: An endocrine society clinical practice guideline (Article). Journal of Clinical Endocrinology and Metabolism. 2013;98(12):4565-92. Cited 320 times.
5. Diamanti-Kandarakis E, Dunaif A. Insulin resistance and the polycystic ovary syndrome revisited: An update on mechanisms and implications (Article). Endocrine Reviews. 2012;33(6):981-1030. Cited 306 times.
6. Engmann L, DiLuigi A, Schmidt D, Nulsen J, Maier D, Benadiva C. The use of gonadotropin-releasing hormone (GnRH) agonist to induce oocyte maturation after cotreatment with GnRH antagonist in high-risk patients undergoing in vitro fertilization prevents the risk of ovarian hyperstimulation syndrome: a prospective randomized controlled study (Article). Fertility and Sterility. 2008;89(1):84-91. Cited 237 times.
7. Palomba S, Falbo A, Zullo F, Orio Jr, F. Evidence-based and potential benefits of metformin in the polycystic ovary syndrome: A comprehensive review (Review). Endocrine Reviews. 2009;30(1):1-50. Cited 218 times.
8. Franks S, Stark J, Hardy K. Follicle dynamics and anovulation in polycystic ovary syndrome (Article). Human Reproduction Update. 2008;14(4):367-78. Cited 197 times.
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10. Mannerås L, Cajander S, Holmäng A, Seleskovic Z, Lystig T, Lönn M. A new rat model exhibiting both ovarian and metabolic characteristics of polycystic ovary syndrome (Article). Endocrinology. 2007;148(8):3781-91. Cited 185 times.

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