

## **Mapping of Andrology Research Productivity: A Scientometric Study Based on Scopus Database**

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**Abstract** - To examine the development of global research outputs on Andrology, the study was analyzed based on the articles indexed in Scopus Database for the period 2007-2016. In this study, the Andrological research outputs were limited to the subject area "Medicine". The yearly distribution of Andrological literature with growth analysis, authorship pattern with its nature of collaboration, citation analysis with relative quality index were statistically analyzed in this study. Furthermore the study analyzed the geographical distribution of literature, highly cited research outputs, most preferred journals, prolific institutions and the bibliographical form of documents. A total number of 2619 research outputs published in the field between 2007 and 2016 and collaborated research work dominates throughout the study period. In the overall productivity 80.45% publications received citations with an average of 11.98 citations per paper. The average value of uncited/cited ratio is 0.24. Article written by Cooper T.G., et al., in Human Reproduction Update published in the year 2009 on "World Health Organization reference values for human semen characteristics" received a maximum of 646 citations. United States of America has contributed 23.37% of the total productivity and ranked top in terms of publications. "Andrology" is the most preferred journal among the researchers and the organization "Rigshospitalet" has contributed the maximum number of publications. "Article" seems to be the most preferred form of communications by the researchers in this field.

**Keywords:** Scientometrics, Andrology, Authorship Pattern, Citation Analysis, Scopus Database.

## **Introduction**

The term Andrology was introduced by Harold Siebke in 1951 and getting popular only after the foundation of a scientific journal titled *Andrologie* in West Germany in the year 1969 (Schirren 2009). Now it is recognized as an area of science and medicine with multidisciplinary and multifaceted field concerned with all aspects of male reproductive health (WHO) and includes the study of semen and of spermatozoa (Jequier 1990). It includes research in Biochemistry, Genetics, Histology, Immunology, Molecular Biology, Pathology, Pharmacology, Physiology and Endocrinology along with Urology, Microsurgery, Gynaecology, Internal Medicine, Pediatrics, Psychology and Animal Husbandry (Rosemberg 1986).

Even though Andrology is a surgical subject, it also comprises a mixture of surgery and medicine (Jequier 1990). American Andrological Association has demonstrated its ability to place the specialty Andrology upon as high a plane as that occupied by Gynaecology, Ophthalmology or Dermatology (Rosemberg 1986).

## **Review of Literature**

**Sweileh (2017)** carried out a bibliometric study to assess the growth of publications, active countries and institutions, highly cited articles, citation analysis, international collaboration, journals involved in publishing articles on refugees, asylum seekers and IDP to determine if it is indeed recognized as a growing health problem from a public and mental health aspects. **Ho, Siu and Chuang (2016)** made a bibliometric analysis on dengue-related publications from 1991 to 2014 and found that the average number authors per article increased from 4.0 to 6.7 during the period. **Senel and Demir (2015)** analyzed the telemedicine and teledermatology literature published during the period 1980-2013 and found that the USA ranked first in both the research fields in terms of number of publications. **Sweileh, et al (2017)** analyzed the world-wide scientific literature in mobile health during the period 2006 – 2016 and found that most of the publications were by article type. **Yang, et al (2017)** carried out a bibliometric study to identify publication trends in the field of telemedicine within the past two decades. **Zhang, et al (2016)** performed a bibliometric analysis focusing on studies involving male infertility worldwide during the period 1995-2014 and found that the USA and its institutions play a dominant role. **Koo (2017)** studied the profile of research articles on aromatherapy published in the past two decades (1995–2014) and found that half of the total publications were from non-English speaking countries. **Yiran, et al (2017)** examined the publication pattern of exosome research output at the global level and found that the citations per paper was 33.8.

## **Methodology**

The study aims to analyze the Global publications trend on the Andrology research outputs. Scopus database was used to retrieve the data with a time span of ten years from 2007 to 2016. The Bibliometric/Scientometric Indicators like Relative Growth Rate (RGR), Doubling Time for articles (Dt(a)), Degree of Collaboration (DC), Collaboration Index (CI), Relative Quality Index (RQI), Citation per Paper (CPP) and Cited and Uncited Ratio of the publications were analyzed in the study. For analysis and preparing tables SPSS and Excel software were used in the study. The following search string was used to download the data:

**(TITLE-ABS-KEY ("ANDROLOGY") AND PUBYEAR > 2006 AND PUBYEAR < 2017 AND (LIMIT-TO (SUBJAREA,"MEDP")))**

### Objectives of the Study

- To study the yearly publication trend on Andrology research output, its Relative Growth Rate (RGR) and Doubling time for articles (DT(a))
- To study the Authorship pattern by using the parameters like Degree of Collaboration (DC), Collaboration Index (CI).
- To study the Citation Analysis on publications like Citation per paper, Relative Quality Index (RQI), Cited and Uncited ratio.
- To find out the highly cited publications
- To find out the country wise distribution of publications during the study period
- To find out the researcher's most preferred journals for communicating their research outputs
- To find out the major contributing Institution to the area of study
- To identify the most preferred bibliographic form of documents for publishing the research outputs

### Limitations of the Study:

This study is limited to publications indexed in Scopus database only. The duration of the study period confines to ten years (2007-2016). The documents were refined by limiting the search to subject category "Medicine".

### Data Analysis

Table 1 represents the yearly distribution of publications on Andrology. The growth analysis of the publications is calculated by Relative Growth Rate (RGR). The Relative Growth Rate (RGR) is the increase in number of articles/pages per unit of time (Hunt, R. 1978). RGR can be calculated, another indicator used to measure the growth of publications is Doubling Time (DT), which is defined as the time period required for the number of publications to double in quantity in one year and it can be calculated using the formula:  $DT = 0.693/RGR$ .

**Table 1- Yearly Distributions of Andrology Research Outputs**

S.No	Year	TP	TP (%)	CP	CP(%)	RGR	DT(a)
1	2007	196	7.48	196	7.48	-	-
2	2008	227	8.67	423	16.15	0.77	0.90
3	2009	231	8.82	654	24.97	0.44	1.59
4	2010	295	11.26	949	36.24	0.37	1.86
5	2011	288	11.00	1237	47.23	0.27	2.61
6	2012	355	13.55	1592	60.79	0.25	2.75
7	2013	216	8.25	1808	69.03	0.13	5.45
8	2014	224	8.55	2032	77.59	0.12	5.93
9	2015	290	11.07	2322	88.66	0.13	5.19
10	2016	297	11.34	2619	100.00	0.12	5.76
	<b>Total</b>	<b>2619</b>	<b>100.00</b>				

(TP- Total Publications; CP – Cumulative Publications;  $w_1$ - log of initial number of articles;  $w_2$ -log of final number of articles after one year; RGR-Relative Growth Rate; DT(a)- Doubling Time)

Table 2 represents the authorship pattern of the Andrology results outputs. The publications during the study period were categorized as single authored publications and multi authored publications viz., two authors, three authors, four authors and five and above authors (publications which contributed by five and more than five authors are categorized as a single entity). In this study, average number of authors per article was calculated by total number of authors/total number of publications and average number of articles per author was calculated by total number of publications/total number of authors and the same has been tabulated.

**Table 2- Authorship Pattern**

S. No.	Number of Authors	Total Publications	Percentage (%)	Total Authors
1	Single Author	310	11.84	310
2	Two Authors	284	10.84	568
3	Three Authors	283	10.81	849
4	Four Authors	297	11.34	1188
5	≥Five Authors	1445	55.17	7225
<b>Total</b>		<b>2619</b>	<b>100</b>	<b>10140</b>
<b>Average Number of Authors per article = 3.87</b>				
<b>Average Number of Article per Author =0.26</b>				

Table 3 reveals the yearly distribution of Authorship pattern on Andrology research outputs. In the bibliometric study, the authorship collaboration in publications during a specific time period can be calculated using the Degree of Collaboration (DC) indicator (Subramaniam, 1983). The Degree of Collaboration (DC) among authors is the ratio of the number of collaborative publications versus the total number of publications published in a discipline during certain period of time and the same can be calculated using the formula  $DC = N_m / (N_m + N_s)$ ; where,  $N_m$  = Number of multiple authors publications during a specific period in a discipline and  $N_s$  = Number of single authored publications in the discipline during the given period of time. The Collaborative Index (CI) (Ajiferuke et al., 1988) is interpreted as mean number of authors per paper. CI can be calculated using the following formula  $CI = \text{Number of authors in the multi-authored publications} / \text{Number of multi authored publications}$ .

**Table 3- Authorship Pattern vs Yearly Distributions**

Year	Single Author	Two Authors	Three Authors	Four Authors	≥Five Authors	TP	DC	CI
2007	25	18	16	28	109	196	0.87	4.33
2008	32	32	27	26	110	227	0.86	4.10
2009	31	27	24	31	118	231	0.87	4.20
2010	54	27	37	26	151	295	0.82	4.25
2011	29	26	25	36	172	288	0.90	4.37
2012	33	34	32	37	219	355	0.91	4.37
2013	22	25	14	20	135	216	0.90	4.37
2014	19	14	33	23	135	224	0.92	4.36
2015	29	35	48	34	144	290	0.90	4.10
2016	36	46	27	36	152	297	0.88	4.13
<b>Total</b>	<b>310</b>	<b>284</b>	<b>283</b>	<b>297</b>	<b>1445</b>	<b>2619</b>	<b>0.88</b>	<b>4.26</b>

(TP-Total Publications; DC: Degree of Collaboration; CI- Collaborative Index)

Table 4 represents the yearly distributions of publications and its citation analysis. Citation is an important factor for any research output, which is being used to measure its quality. The Citation per Paper (CPP) is the ratio between total numbers of citations received/ total number of publications in a specific period of time. Relative Quality Indicator (RQI) (Garg K C & Padhi P 2002) is a special indicator which is being used to measure the quality of publication produced in a specific field in a year/country/Institution. The average value of RQI is one. If the RQI is above the average value of one, then it is understood that more number of quality research works has been produced in that particular field in a year/country/Institution. The RQI can be calculated using the following formula:  $RQI = \frac{\text{Total number of citations received by the articles published in a year}}{\text{Total number of publications produced in that year}}$  /  $\frac{\text{Total number of Citations received by the publications during the study period}}{\text{total number of publications produced during the study period}}$ . The Uncited/Cited ratio is the ratio between uncited publications in a particular period of time/cited publications during the period.

**Table 4 – Citation Analysis vs Yearly Distributions**

S.No.	Year	TP	TNCP	TNUCP	TNC	CPP	RQI	Uncited/Cited Ratio
1	2007	196	169	27	3694	18.85	1.57	0.16
2	2008	227	202	25	4001	17.63	1.47	0.12
3	2009	231	190	41	4761	20.61	1.72	0.22
4	2010	295	257	38	5656	19.17	1.60	0.15
5	2011	288	253	35	4484	15.57	1.30	0.14
6	2012	355	299	56	4252	11.98	1.00	0.19
7	2013	216	171	45	1794	8.31	0.69	0.26
8	2014	224	178	46	1306	5.83	0.49	0.26
9	2015	290	221	69	992	3.42	0.29	0.31
10	2016	297	167	130	433	1.46	0.12	0.78
	<b>Total</b>	<b>2619</b>	<b>2107</b>	<b>512</b>	<b>31373</b>	<b>11.98</b>	<b>1.00</b>	<b>0.24</b>

(TP-Total Publications; TNCP- Total Number of Cited Publications; TNUCP- Total Number of Uncited Publications; TNC- Total Number of Citations; CPP- Citations per paper; RQI- Relative Quality Index)

**Results:**

**Yearly distribution and its growth**

A total number of 2619 published literatures are found during the study period. The highest number of productivity were recorded in the year 2012 with 355 (13.55%) publications followed in the year 2016 with 297 (11.34%) and 2010 with 295 (11.26%) publications respectively. The lowest numbers of published literatures were recorded in the year 2007 with 196 (7.48%) publications. Table 1 shows that there is a steady growth in productivity from the beginning of the study period until 2010, then it dips in the year 2011 and shows some rise in 2012 and again dips in 2013. Then it shows some positive trends till the end of the study period. The Relative Growth Rate (RGR) ranged between 0.12 and 0.77 during the period of study. The Relative Growth Rate (RGR) shows decrease in trend throughout the study period, with slight variations between 2014 and 2015. The Doubling Time of articles ranged between 0.90 and 5.93.

### Authorship Pattern

It is observed from the table that there are 310 (11.84%) single authored publications during the study period and the remaining 2309 (11.84%) of the total productivity were by multi authored publications, which shows that collaborative research works dominated in the field of Andrology. The overall productivity comprises of 284(10.84%) two authored contributions, 283(10.81%) three authored and 294(11.34%) four authored contributions. More than half of the total publications 1445 (55.17%) were contributed by five and more than five authors. The table further reveals that a minimum of 10140 authors contributed to the overall productivity at an average of 3.87 authors per paper and the average number of article per author is 0.26 during the study period. The Degree of Collaboration (DC) varies between 0.82 and 0.92. The average value of DC stood at 0.88 during the study period. The Collaboration Index (CI) varies between 4.10 and 4.37 with an average value of 4.26.

### Citation Analysis

In the overall 42994 productivity during the study period, 2107 (80.45%) were cited and the remaining 512 (19.55%) publications were yet to get citations. The cited publications yielded 31373 citations. A maximum of 5656 citations were yielded by the published literature of the year 2010 followed by 4761 citations of 2009 and 4484 of 2011 publications respectively. A lowest number of 433 citations were received for the published literature of the year 2016. The average citation per paper (CPP) is 11.98 citations during the study period. The Relative Quality Index (RQI) varies between 0.12 and 1.72 during the study period. The average value of RQI is one. During the study period the value of RQI is average and above for its publications between 2007 and 2012 and it is below the average value between 2013 and 2016. The Uncited/cited ratio varies between 0.12 and 0.78 with an average value of 0.24 during the study period.

Table 5 displays the top 20 highly cited research outputs during the study period. An article “World Health Organization reference values for human semen characteristics” published by Cooper T.G., et al., in Human Reproduction Update published in the year 2009 received a maximum of 646 citations.

**Table 5 – Highly Cited papers on Andrology Literature**

Year	NoA	Author/s	Title of the Publication	Source Title	Citations
2009	11	Cooper T.G., et al.,	World Health Organization reference values for human semen characteristics	Human Reproduction Update	646
2008	2	Turner T.T., Lysiak J.L.	Oxidative stress: A common factor in testicular dysfunction	Journal of Andrology	219
2009	4	Heufelder A.E., Saad F., Bunck M.C., Gooren L.	Fifty-two-week treatment with diet and exercise plus transdermal testosterone reverses the metabolic syndrome and improves glycemic control in men with newly diagnosed type 2 diabetes and subnormal plasma testosterone	Journal of Andrology	182
2009	4	Traish A.M., Guay A., Feeley R., Saad F.	The dark side of testosterone deficiency: I. metabolic syndrome and erectile dysfunction	Journal of Andrology	180
2009	3	Aitken R.J., DeJuliis G.N., Mclachlan R.I.	Biological and clinical significance of DNA damage in the male germ line	International Journal of Andrology	178
2010	6	Kalinchenko S.Y., et al.,	Effects of testosterone supplementation on markers of the metabolic syndrome and inflammation in hypogonadal men with the metabolic syndrome: The double-blinded placebo-controlled Moscow	Clinical Endocrinology	178

			study		
2007	19	Martin RitzÅ©n E., et al.,	Nordic consensus on treatment of undescended testes	Acta Paediatrica, International Journal of Paediatrics	164
2009	3	Åayan S., Shavakhobov S., KadioÇlu A.	Treatment of palpable varicocele review in infertile men: A meta-analysis to define the best technique	Journal of Andrology	160
2009	4	Traish A.M., Saad F., Feeley R.J., Guay A.	The dark side of testosterone deficiency: III. Cardiovascular disease	Journal of Andrology	152
2011	9	Corona G., et al.,	Type 2 diabetes mellitus and testosterone: A meta-analysis study	International Journal of Andrology	142
2010	13	Barratt C.L.R., et al.,	Sperm DNA: Organization, protection and vulnerability: From basic science to clinical applications-a position report	Human Reproduction	141
2007	2	Zitzmann M., Nieschlag E.	Androgen receptor gene CAG repeat length and body mass index modulate the safety of long-term intramuscular testosterone undecanoate therapy in hypogonadal men	Journal of Clinical Endocrinology and Metabolism	140
2009	2	Zini A., Sigman M.	Are tests of sperm DNA damage clinically useful? Pros and cons	Journal of Andrology	137
2009	4	Corona G., Mannucci E., Forti G., Maggi M.	Hypogonadism, ED, metabolic syndrome and obesity: A pathological link supporting cardiovascular diseases	International Journal of Andrology	132
2010	8	Swan S.H., et al.,	Prenatal phthalate exposure and reduced masculine play in boys	International Journal of Andrology	131
2010	2	Bornehag C.G., Nanberg E.	Phthalate exposure and asthma in children	International Journal of Andrology	128
2010	4	Hatch E.E., Nelson J.W., Stahlhut R.W., Webster T.F.	Association of endocrine disruptors and obesity: Perspectives from epidemiological studies	International Journal of Andrology	110
2007	3	Sullivan R., Frenette G., Girouard J.	Epididymosomes are involved in the acquisition of new sperm proteins during epididymal transit	Asian Journal of Andrology	108
2009	3	Meeker J.D., Calafat A.M., Hauser R.	Urinary metabolites of Di(2-ethylhexyl) phthalate are associated with decreased steroid hormone levels in adult men	Journal of Andrology	108
2010	5	Poplinski A., et al.,	Idiopathic male infertility is strongly associated with aberrant methylation of MEST and IGF2/H19 ICR1	International Journal of Andrology	102

(NoA- Number of Authors)

### Geographical Distribution of Productivity

Table 6 depicts the geographical distribution of productivity and the top 16 countries which have contributed more than 50 publications to the Andrology literature were tabulated. It shows that the United States of America has contributed 612(23.37%) publications and ranked top among the countries in terms of publications followed by Italy with 235(8.97%) and China with 230(8.78%) publications occupies second and third positions respectively. The table further reveals that India ranked 14<sup>th</sup> among the countries with 63(2.41%) publications.

**Table 6 – Country wise Distribution of Productivity on Andrology**

S. No.	Name of the Country	Number of Publications	Share of Total Publications (%)
1	United States	612	23.37
2	Italy	235	8.97
3	China	230	8.78
4	Germany	214	8.17
5	United Kingdom	130	4.96
6	Spain	121	4.62
7	Canada	107	4.09
8	France	101	3.86
9	Brazil	87	3.32
10	Denmark	81	3.09
11	Australia	77	2.94
12	Japan	71	2.71
13	Turkey	67	2.56
14	India	63	2.41
15	Netherlands	60	2.29
16	Sweden	57	2.18
17	Others	306	11.68
	<b>Total</b>	<b>2619</b>	<b>100</b>

### Highly Preferred Journals

Table 7 presents the top 10 most preferred journals by the researchers in the field of Andrology to publish their productivity. “Andrology” is the most preferred journal among the researchers which published 542 (20.69%) research outputs, followed by “Journal of Andrology” with 463(17.68%) and “International Journal of Andrology” with 389 (14.85%) research outputs. From the study it seems that more than three fourth (78.31%) of the total publications published in the top ten most preferred journals in the area of study.

**Table – 7 Most Preferred Journals on Andrology**

S.No.	Name of the Journal	Number of Publications	Share of Total Publications (%)
1	Andrology	542	20.69
2	Journal of Andrology	463	17.68
3	International Journal of Andrology	389	14.85
4	Asian Journal of Andrology	277	10.58
5	Translational Andrology and Urology	170	6.49
6	Fertility And Sterility	96	3.66
7	Zhonghua Nan Ke Xue (National Journal of Andrology)	35	1.34
8	Revista Internacional De Andrologia	29	1.11
9	Andrologia	28	1.07
10	Human Reproduction	22	0.84
	Others	568	21.69
	<b>Total</b>	<b>2619</b>	<b>100.00</b>



### Prolific Institutions

Table 8 represents the top fifteen highly contributed Institutions to the Andrology literature during the study period. “Rigshospitalet” is the highest contributed Institution among them with 58(2.21%) publications followed by “Universita degli Studi di Firenze” with 54(2.06%) publications and “McGill University” with 41(1.57%) publications. The study further reveals that the top fifteen Institutions have contributed to 510(19.47%) of the total published literature during the study period.

**Table 8 –Highly Published Organizations**

S.No.	Name of the Organization	Number of Publications
1	Rigshospitalet	58
2	Universita degli Studi di Firenze	54
3	McGill University	41
4	Westfalische Wilhelms-Universitat Munster	40
5	Cleveland Clinic Foundation	40
6	Universita degli Studi di Roma La Sapienza	40
7	Universitatsklinikum Munster	29
8	Universita degli Studi di Catania	29
9	Justus Liebig University Giessen	27
10	Baylor College of Medicine	26
11	University of Texas M. D. Anderson Cancer Center	26
12	Universita degli Studi di Padova	25
13	Ospedale Bellaria	25
14	Shanghai Jiaotong University	25
15	Erasmus University Medical Center	25
16	Other Institutions	2109
	<b>Total Publications</b>	<b>2619</b>

### Bibliographic Forms of Productivity

Table 9 depicts the share of bibliographical form on published literature of Andrology. The researchers preferred Journal articles as the most preferred form to publish their research outputs with 1843 (70.37%) publications followed by review articles with 440 (16.80%) publications. Nearly 87% of the total published literature was in the form of articles and review articles during the study period.

**Table 9 - Bibliographical Form of Publications**

S.No.	Type of the Document	Publications	Share of Total Publications (%)
1	Article	1843	70.37
2	Review	440	16.80
3	Other Forms	336	12.83
	<b>Total Publications</b>	<b>2619</b>	<b>100.00</b>

### Conclusion:

A total number of 2619 research outputs published in the field of Andrology during the study period. A steady growth was noticed in the annual productivity till the year 2010 and then there seem some fluctuations over the next three years. From 2014, the productivity shows

positive trend till the end of the study period. Nearly 88% of the total productivity was contributed by multi authored works which shows collaborated research work dominates in Andrology literature. Researchers in this field prefer collaborated works rather than an individual one. More than three fourth (80.45%) of the total publications received citations as on date of downloading the data with an average of 11.98 citations per paper for the overall productivity, which shows more number of quality publications was produced during the study period. The average value of uncited/cited ratio stood at 0.24. Article written by Cooper T.G., et al., on “World Health Organization reference values for human semen characteristics” in Human Reproduction Update published in the year 2009 received a maximum of 646 citations. United States of America has contributed 23.37% of the total productivity and ranked top in terms of publications. India contributed 2.41% to the total productivity and ranked 14<sup>th</sup> in contribution to the literature. The result also shows that considerable number of publications was produced by the researchers belongs to countries from Europe, Asia and North America. “Andrology” is the most preferred journal among the researchers which published 20.69% of the total productivity. The Organization “Rigshospitalet” has contributed the maximum number of publications and ranked top in prolific institutions with 58 publications. “Article” is being the most preferred form of communications by the researchers in this field with 70.37% of the total productivity was published in this form. From this study we have seen a considerable numbers of articles were being published in the field of Andrology in the last ten years which shows that more number of research activities is being taken place across the globe. We have seen plenty of bibliometric/scientometric studies were being carried out in the field of women related problems (Gynaecology) across the World but searching and finding an article based on bibliometric/scientometric study on Andrology literature is a rarest of rare issue. So we have taken up this study to highlight the research trends on this subject area to the World community even though we have certain limitations in the study such as the articles indexed in the Scopus database were only taken up for the study with ten year time span with the productivity refined to the subject area “Medicine”. There may be availability of some more number of published literatures across the World which may not be covered/indexed in the Scopus Database. Now more number of research works is being carried out in this area with the help of sophisticated bio medical instruments and advanced technology the medical practitioners are doing their best to curb infertility related problems in men. This study may pave way for more number of such studies with in this area with specific geographical distributions as well as studies based on research outputs indexed in other abstracting and indexing databases.

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