

A bibliometric perspective with research trends and global productivity on the modernization of andrology from the founder of modern clinical andrology Edward Martin to the present

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Abstract. – OBJECTIVE: The number of studies in the field of andrology is increasing day by day, but a bibliometric study covering the entire literature on andrology has not yet been conducted. This bibliometric study aims to shed light on the question of where we came from and where we are going in andrology from past to present. It also aimed to summarize the intellectual structure of andrology to reveal global productivity and identify and map the latest trends of scientific articles published in the field of andrology.

MATERIALS AND METHODS: 16,659 articles published between 1980 and 2022 were extracted from the Web of Science and analyzed using various statistical methods. Bibliometric network visualization maps revealed trending topics, global productivity, the most influential studies, and international collaborations. Spearman's correlation analysis was used for determining correlations.

RESULTS: The top three productive countries were United States of America (3,452; 20.7%), China (2,300; 13.8%), and Germany (1,069; 6.4%). The top two most productive authors were Agarwal A. (n=130) and Nieschlag E. (n=130). The most productive institution was the Egyptian Knowledge Bank (n=422). From past to present, the most studied subjects were testis, male infertility, spermatozoa, testosterone, infertility, erectile dysfunction, spermatogenesis, sperm, prostate cancer (PCA)/neoplasms, oxidative stress, fertility/fertilization, semen, rat(s), apoptosis, azoospermia, sperm motility, human and varicocele.

CONCLUSIONS: The trend topics that have been researched more in recent years include erectile dysfunction, oxidative stress, prostate cancer, sperm quality, sperm parameters, infertility, premature ejaculation, diabetes mellitus, obesity, prognosis, sperm DNA fragmentation/damage, antioxidant, asthenozoospermia, varicocelelectomy, COVID-19, inflammation, prostaticectomy, metabolic syndrome, hypogonadism, benign prostatic hyperplasia, lower urinary tract symptoms, meta-analysis, sexual dysfunction,

peyronie's disease, and proliferation. We identified the research leadership of China, Japan, Turkey and India, in addition to Western countries, such as the USA and European countries.

Key Words:

Andrology, Research trends, Bibliometric analysis, Scientometric analysis, Citation analysis.

Introduction

Although it is a structure with different cultural foundations, today, andrology can be defined as a unitary medical discipline that deals with the pathophysiology of the reproductive system throughout the entire life cycle of the male subject from development towards maturity to aging¹.

Although it is known that Edward Martin diagnosed and successfully treated obstructive azoospermia in 1902 for the first time in history, the history of modern andrology as a clinical science dates back to the mid-1900s. The term "andrology" was first used in 1951². Since then, this field has continued to develop with local and worldwide congresses, educational courses, articles, case reports, and reviews published in many quality journals. As a result, it has reached the level of today's modern andrology. There is no doubt that it will continue to evolve over time and will become more modern in the future than it is today.

As a result of the rapid increase in the scientific literature in recent years, bibliometric analysis has become a widely used quantitative research method for evaluating the literature^{3,4}. By providing structured information, bibliometric analyses offer summary analyses of articles published in a research field or topic, revealing critical information and offering a different perspective for future research^{5,6}.

When we look at the literature, bibliometric analyzes were performed at specific date intervals and on specific subjects including assisted reproductive technology⁷, erectile dysfunction^{8,9}, male infertility¹⁰ and spermatogenesis¹¹ at specific date intervals and on specific subjects, but no bibliometric study has been conducted in which every scientific approach that covers andrology in general, dealing with the development process and contributing to the shaping of today's modern andrology. This bibliometric study aims to shed light on the question of where we came from and where we are going in andrology from past to present. For this purpose, it was aimed to summarize the intellectual structure of the andrology, to reveal global productivity, and to identify and map the latest trends by analyzing the social and conceptual links between various research factors (countries, institutions, authors, and subjects) of scientific articles published in the field of andrology between 1980 and 2022.

Materials and Methods

Research Strategy

WoS (Web of Science by Clarivate Analytics) database was used to obtain bibliometric information on articles published on andrology. The publication period of the articles to be analyzed was determined as 1980-2022. In our search strategy, we did not search for words that include andrology in the article title using keywords, and instead we obtained all the articles published in the Andrology research field directly in WoS. Researchers can use the following codes to obtain partially similar documents: “*WC = (Andrology) and Document Types: Article and Publication years: 1980-2023*” (Access date: 1 April 2023, Search results may change based on the date of access.)

Statistical Analysis

VOS viewer (Version 1.6.18, Leiden University) software, which is widely used in the literature, was used to analyze trend topics, map international relations, determine citation analyzes and create bibliometric network visualizations¹². VOSviewer is a software used for visualizing bibliometric analyses using network maps. It provides text mining features to create and visualize networks by analyzing the co-occurrence of keywords found in articles¹². Co-occurrence keyword analysis examines the presence of keyword pairs from different publications

to determine relationships between words used in texts³. While co-word analysis focuses on keywords in publications, co-citation analysis focuses on citations⁴. Co-citation analysis enables the mapping of the structure of a research field through citations between pairs of publications^{5,6}.

Statistical analyses were conducted with SPSS (Version: 22.0, SPSS Inc., Armonk, NY, USA, License: Hitit University) software. Using the publication trend of previous years in the field of andrology, the Smoothing estimator, which also takes into account seasonal correction, was used in the Microsoft Office Excel software to predict the trend of future publications until 2030. World article productivity map in andrology was created using open access website (<https://app.datwrapp.de>). Before the correlation analysis, the assumption of normal distribution of the data was examined by Kolmogorov-Smirnov test and some graphical methods (Q-Q plot and histogram). The relationship between the productivity of articles in the field of Andrology and the Gross Domestic Product (GDP) and per capita GDP, which are the economic development indicators of the nations, were calculated by Spearman's rank correlation coefficient (data extracted from the World Bank¹³). In the correlation analysis, the statistical significance level was accepted as $p < 0.05$.

Results

As a result of the literature search, a total of 27,041 studies published in the field of andrology between 1980 and 2022 were found in the WoS database. These publications were distributed as follows: articles (16,659; 61.6%), meeting abstracts (3,374; 12.4%), proceedings papers (2,775; 10.2%), review articles (2,501; 9.2%), letters (417; 1.5%) and the remainder were in various publishing categories (Book, Book Chapters, Editorial Materials etc.). Bibliometric analyses were carried out with 16,659 articles in the article category. 96.8% (n=16,119) of these articles were published in English, and the remainder were published in other languages [French (n=222), Spanish (n=161), German (n=119), Portuguese (n=38)]. 94.8% (n=15,790) of the articles were indexed in the Science Citation Index Expanded (SCI-expanded) and 2.1% (n= 354) in the Emerging Sources Citation Index (ESCI). Few articles were indexed in other indexes [Conference Proceedings Citation Index, Book Citation Index and Social Sciences Citation Index (SSCI)].

Andrology and Multidisciplinary Research Areas

The other top 10 research areas where the articles indexed in the field of andrology are most tagged included urology/nephrology (2,849), reproductive biology (911), health care sciences services (294), obstetrics gynecology (284), medicine research experimental (131), developmental biology (71), oncology (48), physiology (46), multidisciplinary sciences (38), and toxicology (38).

Development of Publications by Years and Future Publication Trend

The line graph showing the variation in the number of studies published on andrology by years is presented in Figure 1. Since 2023 is not completed, it is not included in the forecast model. In order to determine the number of articles that can be published in 2023 and beyond, our estimation values for the results obtained with the Smoothing estimator by performing seasonal adjustment are shown in Figure 1. According to the estimation model results, it was estimated that 739 (Confidence Interval %: 562-916) articles on andrology will be published in 2023, and 823 (CI%: 636-1,010) articles will be published in 2030 (Figure 1).

Active Authors on Andrology

The most productive authors (with 60 or more articles) in the field of andrology research were Agarwal A. (n=130), Nieschlag E. (n=130), Schill WB. (n=92), Wang C. (75), Cooper TG. (68), Giwercman A. (67), Skakkebaek NE. (67), Zhang W. (67), Henkel R. (65), Maggi M. (65), Mostafa T. (65), Wang Y. (64), Check JH. (63), Franken DR. (61), and Kim SW. (60).

Institutions Active in Andrology

Institutions that contributed the most articles to the literature in the field of andrology research (addresses of institutions mentioned in more than 120 articles) were found as Egyptian Knowledge Bank (n=422), University of California System (n=281), Udice French Research Universities (n=253), University of Munster (n=243), Shanghai Jiao Tong University (n=235), Cairo University (n=220), Justus Liebig University Giesesen (n=191), Peking University (n=176), McGill University (n=170), University of Texas System (n=165), University of Copenhagen (n=163), Institut National De La Sante Et De La Recherche Medicale Inserm (n=161), Nanjing Medical University (n=159), Sapienza University Rome (n=157), Cleveland Clinic Foundation (n=154), Assistance Publique Hopitaux Paris (n=151), University of Florence (n=148), University of Hamburg (n=145), Harvard University (n=137), Huazhong University of Science Technology (n=133), Population Council (n=131), Karolinska Institutet (n=127), National Institutes of Health USA (n=122), and Rigshospitalet (n=122), respectively.

Active Journals on Andrology

A total of 16,659 articles in the field of andrology were published in 11 different journals. Table I shows these journals, the overall number of citations acquired by the journals, and the mean number of citations per article.

Countries Active in Andrology

The color density map illustrating the distribution of the number of studies according to the nations of the world and the bar graph showing the

Table I. The most productive journals on Andrologia

Journals	NA	C	AC	IF (2022)
Andrologia	4,488	50,783	11.3	2.5
Journal of Andrology	2,481	88,191	35.5	None*
International Journal of Andrology	2,024	59,741	29.5	None*
Archives of Andrology	1,741	21,231	12.2	None*
Asian Journal of Andrology	1,664	27,483	16.5	2.9
Andrology	1,217	17,039	14.0	4.5
Translational Andrology and Urology	834	3,309	4.0	2
Systems Biology in Reproductive Medicine	552	6,406	11.6	2.4
Basic and Clinical Andrology	348	875	2.5	2.4
Revista Internacional De Andrologia	314	533	1.7	0.8
World Journal of Mens Health	294	1,967	6.7	4.8

NA: Number of articles, C: Number of citation, AC: Average number of citations per article, IF: Impact factor. Journals are listed according to the number of articles. *These journals are not currently publishing. Journal of Andrology and International Journal of Andrology have been published as Andrology Journal since 2013. Archives of Andrology journal has been publishing as Systems Biology in Reproductive Medicine since 2008.

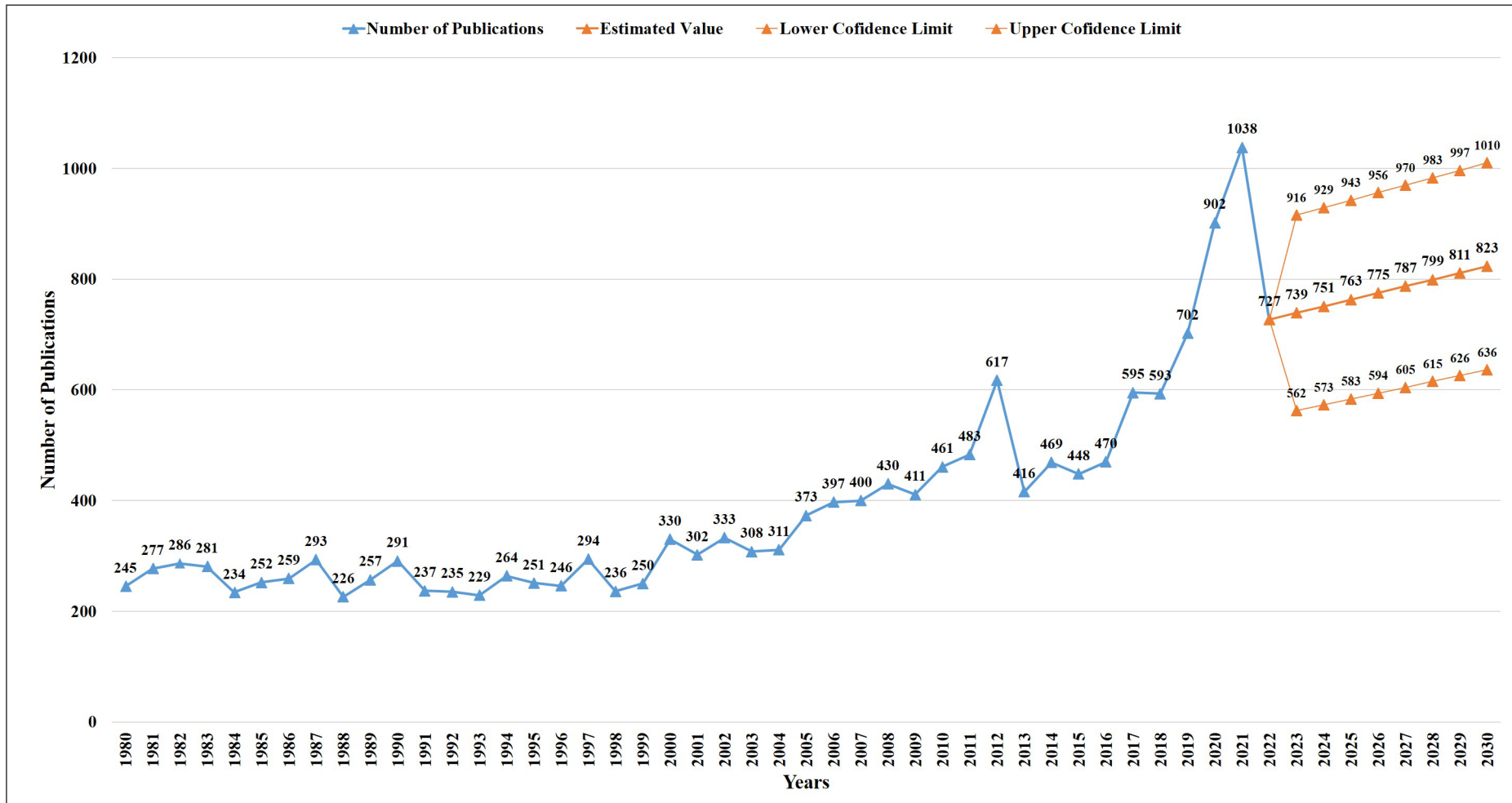


Figure 1. Bar graph showing the distribution of published articles on andrology over the period 1980-2022 and the trend forecast until 2030.

top 25 most productive countries that contributed 200 or more articles to the literature are presented in Figure 2. Top 25 contributing countries included USA (3,452; 20.7%), China (2,300; 13.8%), Germany (1,069; 6.4%), Italy (975; 5.8%), Japan (779; 4.6%), Turkey (770; 4.6%), India (730; 4.3%), Spain (650; 3.9%), United Kingdom (647; 3.8%), France (640; 3.8%), Iran (466; 2.7%), Canada (457; 2.7%), South Korea (435; 2.6%), Egypt (428; 2.5%), Sweden (348; 2%), Australia (346; 2%), Brazil (293; 1.7%), Netherlands (267; 1.6%), South Africa (265; 1.5%), Denmark (259; 1.5%), Israel (258; 1.5%), Argentina (254; 1.5%), Taiwan (208; 1.2%), Finland (200; 1.2%) and Mexico (200; 1.2%).

Total cooperation scores illustrating the cooperation of countries on Andrology were calculated. Countries with the highest scores for cooperation (scoring 180 and above), were USA (1,389), Germany (517), Italy (447), England in UK (430), China (400), Spain (395), France (295), Egypt (270), Sweden (258), Australia (238), Canada (225), South Africa (223), Denmark (219), Netherlands (211), Brazil (189) and Japan (181), respectively.

A high statistically significant correlation was determined between the number of articles published by countries on andrology and GDP and GDP per capita values ($r=0.705, p<0.001$; $r=0.699, p<0.001$; respectively).

Co-Citation Analysis in Andrology

There were a total of 266,300 publications cited in the references section of all 16,659 articles published in the field of andrology. Among these studies, the 11 most influential studies with 200 or more co-citations were World Health Organization (WHO)¹⁴ (Co-Citation, CC=740), WHO¹⁵ (CC=639), Lowry et al¹⁶ (CC=498), Laemmler¹⁷ (CC=290), WHO¹⁸ (CC=259), Jeyendran et al¹⁹ (CC=236), Bradford²⁰ (CC=234), Kruger et al²¹ (CC=215), Johnsen²² (CC=210), Cooper et al²³ (CC=206), and Kruger et al²⁴ (CC=200), respectively.

Citation Analysis in Andrology

Among the 16,659 studies published in Andrology, the most cited (more than 280 citations), and the most influential top 20 articles' titles, authors, journal names, publication years, total number of citations received, and average citation numbers per year are presented in Table II.

Past and Current Research Trends on Andrology

20,730 separate keywords were used in all 16,659 papers published in andrology. 97 keywords from at least 50 different papers from these keywords are presented in Table III. As a result of the cluster analysis, the visualization map showing the associa-

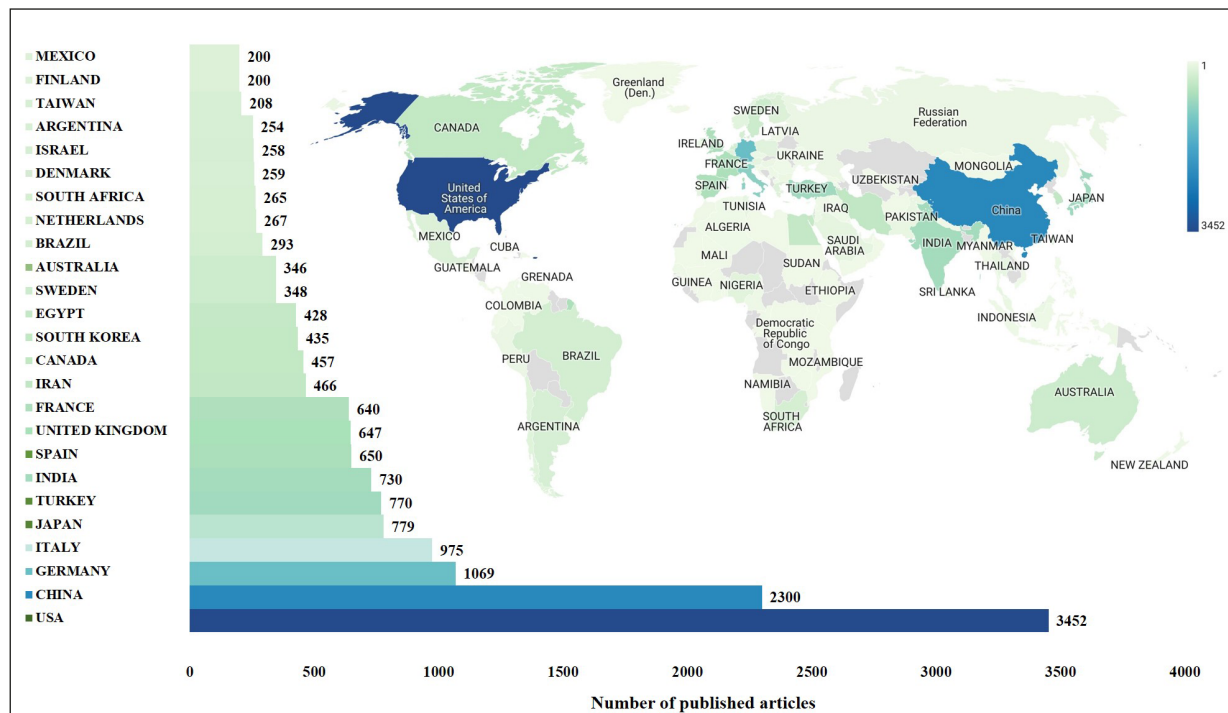


Figure 2. A color density-based bar graph showing the top 25 countries with the most published articles on andrology, and a color density-based world productivity map showing the distribution of published articles by country.

Table II. The top 20 most cited articles (more than 280 citations) on Andrologia.

No	Article	Author	Journal	PY	TC	AC
1	Human exposure to phthalates via consumer products	Schettler ²⁵	International Journal of Andrology	2006	744	41.33
2	Spontaneous lipid-peroxidation and production of hydrogen-peroxide and superoxide in human-spermatozoa superoxide-dismutase as major enzyme protectant against oxygen-toxicity	Alvarez et al ²⁶	Journal of Andrology	1987	740	20
3	Carcinoma-insitu of the testis - possible origin from gonocytes and precursor of all types of germ-cell tumors except spermatocytoma	Skakkebaek et al ²⁷	International Journal of Andrology	1987	653	17.65
4	Significance of reactive oxygen species and antioxidants in defining the efficacy of sperm preparation techniques	Aitken et al ²⁸	Journal of Andrology	1988	563	15.64
5	Cryopreservation of mammalian sperm - what we ask them to survive	Hammerstedt et al ²⁹	Journal of Andrology	1990	528	15.53
6	DNA integrity in human spermatozoa: relationships with semen quality	Irvine et al ³⁰	Journal of Andrology	2000	516	21.5
7	Disruption of reproductive development in male rat offspring following in utero exposure to phthalate esters	Foster ³¹	International Journal of Andrology	2006	419	23.28
8	Di(2-ethylhexyl)phthalate (DEHP): human metabolism and internal exposure - an update and latest results	Koch et al ³²	International Journal of Andrology	2006	413	22.94
9	The sperm chromatin dispersion test: a simple method for the determination of sperm DNA fragmentation	Fernandez et al ³³	Journal of Andrology	2003	400	19.05
10	Lipid peroxidation and human sperm motility: protective role of vitamin e	Suleiman et al ³⁴	Journal of Andrology	1996	395	14.11
11	Reactive oxygen species and human spermatozoa .1. Effects on the motility of intact spermatozoa and on sperm axonemes	de Lamirande et al ³⁵	Journal of Andrology	1992	389	12.16
12	The effect of reactive oxygen species on equine sperm motility, viability, acrosomal integrity, mitochondrial membrane potential, and membrane lipid peroxidation	Baumber et al ³⁶	Journal of Andrology	2000	385	16.04
13	Impact of body mass index values on sperm quantity and quality	Kort et al ³⁷	Journal of Andrology	2006	342	19
14	EAA/EMQN best practice guidelines for molecular diagnosis of y-chromosomal microdeletions. State of the art 2004	Simoni et al ³⁸	International Journal of Andrology	2004	337	16.85
15	Evidence for increased lipid peroxidative damage and loss of superoxide-dismutase activity as a mode of sublethal cryodamage to human sperm during cryopreservation	Alvarez et al ³⁹	Journal of Andrology	1992	324	10.13
16	Localization of androgen and estrogen receptors in adult male mouse reproductive tract	Zhou et al ⁴⁰	Journal of Andrology	2002	294	13.36
17	Real-time fine morphology of motile human sperm cells is associated with IVF-ICSI outcome	Bartoov et al ⁴¹	Journal of Andrology	2002	294	13.36
18	Reduction of the incidence of sperm dna fragmentation by oral antioxidant treatment	Greco et al ⁴²	Journal of Andrology	2005	291	15.32
19	Emerging endocrine disruptors: perfluoroalkylated substances	Jensen et al ⁴³	International Journal of Andrology	2008	290	18.13
20	Sperm morphological diversity	Pitnick et al ⁴⁴	Sperm Biology: An Evolutionary Perspective	2009	284	18.93

PY: Publication year, TC: Total citation, AC: Average citations per year.

tion of keywords in the studies is shown in Figure 3A and the color density map showing the main focus centers is presented in Figure 3B The trend visualization map, which shows the usage of the keywords in the published articles by the years, obtained as a result of the keyword analysis carried out to determine past and current research trends, is shown in Figure 4. The citation visualization map showing the distribution of keywords according to the number of citations they receive is shown in Figure 5.

Discussion

When the publication trends of 1980-2022 in the field of andrology were examined, 3 different publication trends were observed, namely 1980-2004, 2005-2018, and 2019-2022. Between 1980 and 2004, a mean of 269 articles (with a range of 226-333) were published. By 2005, an increasing trend in the number of articles started and a mean of 469 articles (with a range of 373-617) were published

Table III. The 97 most frequently used keywords in published articles on Andrology.

Keywords	NU	Keywords	NU	Keywords	NU
testis	973	androgen receptor	141	inflammation	71
male infertility	942	hypogonadism	135	sexual dysfunction	71
spermatozoa	739	reactive oxygen species	121	CASA	70
testosterone	695	cryptorchidism	118	gene expression	69
infertility	680	sperm morphology	116	vasectomy	68
erectile dysfunction	673	motility	115	diagnosis	67
spermatogenesis	602	dna fragmentation	112	progesterone	67
sperm	525	premature ejaculation	112	reproduction	67
prostate cancer (PCA)/neoplasms	452	penis	111	peyronie's disease	66
oxidative stress	394	capacitation	110	steroidogenesis	66
fertility/fertilization	349	mouse	109	polymorphism	65
semen	341	benign prostatic hyperplasia	101	varicocelectomy	64
rat(s)	327	sperm quality	100	sperm DNA fragmentation	63
apoptosis	322	male	96	prostatectomy	62
azoospermia	320	obesity	95	hypospadias	61
sperm motility	320	sperm parameters	93	meta-analysis	61
human	317	pregnancy	90	metabolic syndrome	60
varicocele	314	prognosis	89	COVID-19	59
intracytoplasmic sperm injection (ICSI)	254	human sperm	87	morphology	59
epididymis	224	flow cytometry	85	lower urinary tract symptoms	58
semen analysis	216	FSH	84	sperm concentration	57
seminal plasma	212	male fertility	84	cancer	56
acrosome reaction	208	asthenozoospermia	79	LH	56
androgen(s)	205	DNA damage	79	sperm count	56
cryopreservation	197	oligozoospermia	77	treatment	56
human spermatozoa	174	epidemiology	76	prostate-specific antigen	55
semen quality	174	immunohistochemistry	76	prostatitis	54
diabetes / diabetes mellitus	170	germ cells	75	sperm function	54
in vitro fertilization (IVF)	163	semen parameters	75	andrology	53
sertoli cell(s)	158	lipid peroxidation	74	proliferation	50
antioxidant(s)	156	nitric oxide	74	ultrastructure	50
prostate	155	testicular cancer	73		
leydig cell(s)	147	acrosome	71		

NU: Number of uses.

during the 2005-2018 period. By 2019, the trend of increase in the number of articles started for the second time and a mean of 842 articles (with a range of 702-1,038) were published in the period of 2019-2022. Considering the eight-year article prediction trend in 2023 and beyond, we can say that scientific productivity in the field of Andrology will continue with a linear increase trend.

When the article outputs of the world countries were examined, the majority of the literature in the field of andrology consisted of articles published by developed countries. China, Turkey, India, Iran, Egypt, South Africa, Argentina, and Mexico were among the top 25 countries that contributed the most to the literature in addition to developed countries. Most of these countries were developing countries or those with large economies. The high significant correlation between the GDP and GDP per capita values

of the countries and the number of articles they published shows that the economic size of the countries also has an effect on the outputs of global articles in the field of andrology. This finding has been emphasized in many bibliometric studies on different subjects in the literature³⁻⁶. When the total cooperation between the countries scores was evaluated, it was determined that the countries with the most intensive cooperation included USA, Germany, Italy, England in UK, China, Spain, France, Egypt, Sweden, Australia, Canada, South Africa, Denmark, Netherlands, Brazil and Japan. Iran, Egypt and South Africa stood out among both productive and cooperating countries. The productivity of these countries was limited in bibliometric studies on other subjects^{3,5,6}.

When all of the productive journals in andrology were evaluated according to the average number of citations they receive per article they

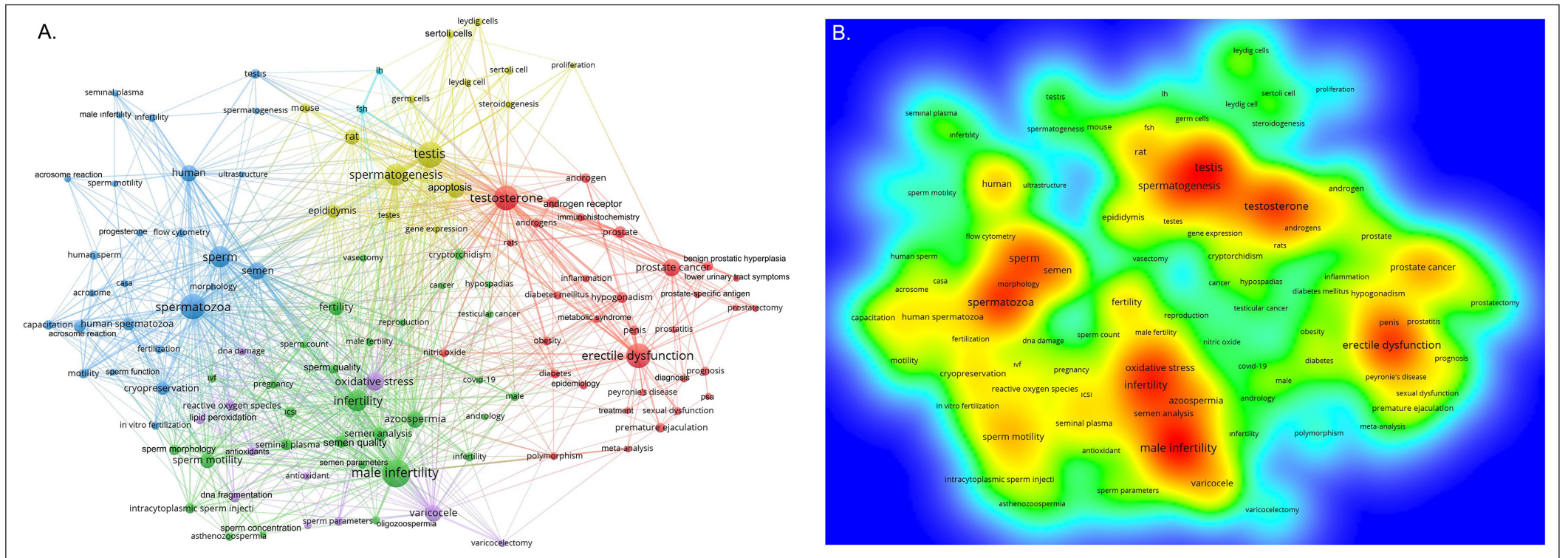


Figure 3. **A.** Network visualization map of a cluster analysis on andrology. Different clusters are indicated by different colors. The number of keyword uses is indicated by the size of the circle. **B.** Density visualization map of a cluster analysis on andrology. From blue to red (blue-green-yellow-red), the main focal points of the most researched topics in andrology are shown.

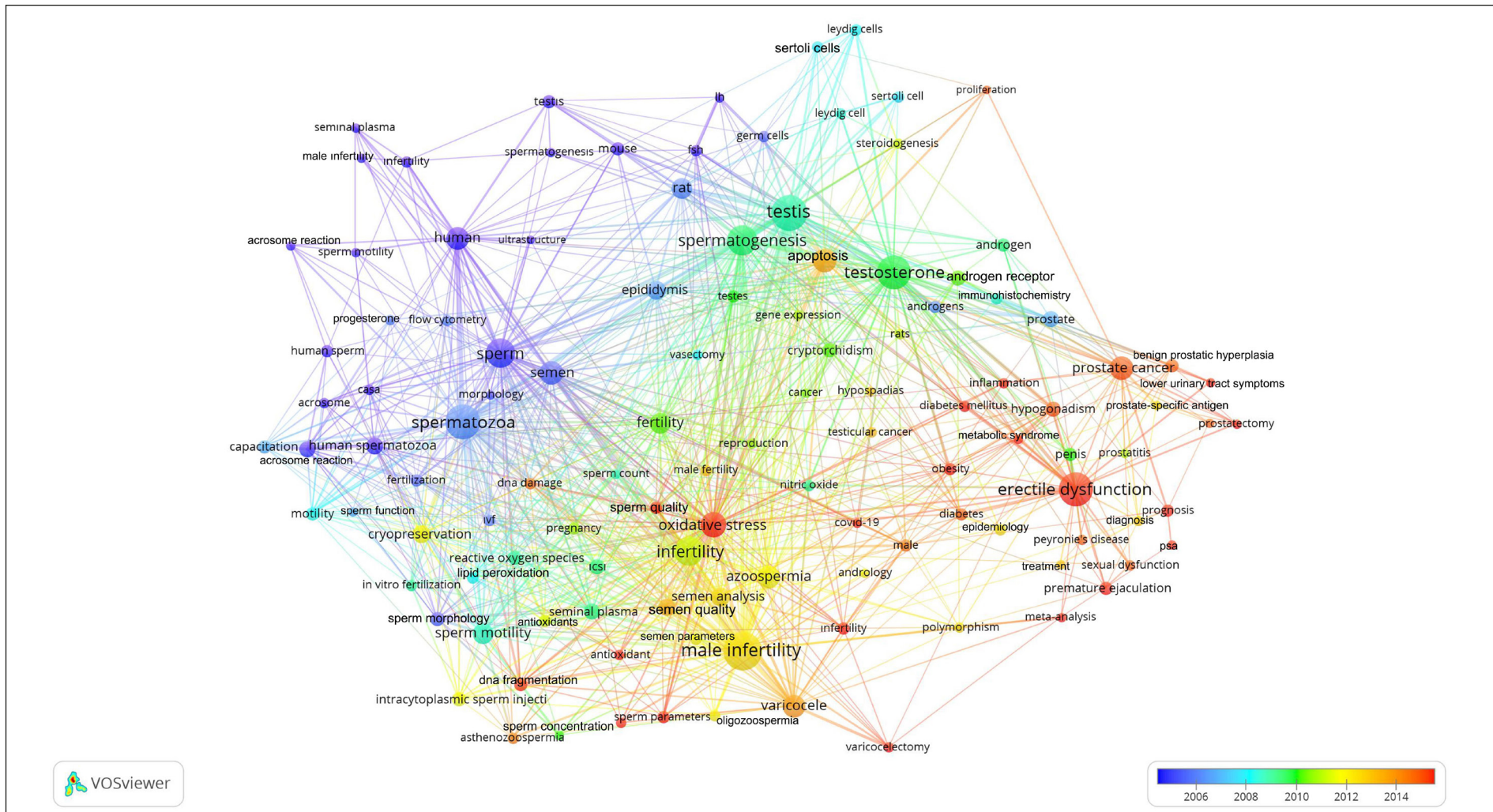


Figure 4. A network visualization map showing past and current trends on andrology. The indicator in the figure's lower right corner changes from blue to red (blue-green-yellow-red) as the topics' actuality increases. The number of keyword uses is indicated by the size of the circle.

publish, the most influential journals included Journal of Andrology (Average number of citations per article: 35.5), International Journal of Andrology (29.5), Asian Journal of Andrology (16.5), Andrology (14), Archives of Andrology (12.2), Systems Biology in Reproductive Medicine (11.6), Andrologia (11.3), World Journal of Mens Health (6.7), Translational Andrology and Urology (4), Basic and Clinical Andrology (2.5) and Revista Internacional de Andrologia (1.7), respectively. We can say that researchers who care about their articles having more impact after publication should consider these findings.

When the analyzed articles were evaluated according to the total number of citations they received, it was determined that the most cited study was Schettler's²⁵ study titled "Human exposure to phthalates via consumer products" published in the International Journal of Andrology. The second most influential study was Alvarez et al's²⁶ article titled "Spontaneous lipid-peroxidation and production of hydrogen-peroxide and superoxide in human-spermatozoa superoxide-dismutase as major enzyme protectant against oxygen-toxicity" published in the Journal of Andrology. The third most influential study was Skakkebaek et al's²⁷ article titled "Carcinoma-insitu of the testis – possible origin from gonocytes and precursor of all types of germ-cell tumors except spermatocytoma" published in the International Journal of Andrology. Other influential studies were presented as a table in the results section.

When the articles are evaluated according to the average number of citations they receive per year, the most influential study was Rastrelli et al's article titled "Low testosterone levels predict clinical adverse outcomes in SARS-CoV-2 pneumonia patients" published in Andrology⁴⁵. The second most influential study was Schettler's research²⁵. The third most influential paper was Agarwal et al's article titled "Clinical utility of sperm DNA fragmentation testing: practice recommendations based on clinical scenarios" published in Translational Andrology and Urology⁴⁶. The fourth and fifth most influential studies were the articles of Guo et al⁴⁷ and Foster³¹.

According to the co-citation numbers of all analyzed articles, the most influential studies included WHO¹⁴, WHO¹⁵, Lowry et al¹⁶, Lammler¹⁷, WHO¹⁸, Jeyendran et al¹⁹, Bradford²⁰, Kruger et al²¹, Johnsen²², Cooper et al²³, and Kruger et al²⁴. We recommend researchers and clinicians working in this field to read these prominent publications first.

When the keyword analysis findings on andrology are evaluated, the most used keyword in articles from past to present were testis, male infertility, spermatozoa, testosterone, infertility, erectile dysfunction, spermatogenesis, sperm, prostate cancer (PCA)/neoplasms, oxidative stress, fertility/fertilization, semen, rat(s) were apoptosis, azoospermia, sperm motility, human and varicocele. When the keyword analysis findings carried out to identify trend topics were evaluated, it was seen that the trend topics (used in at least 50 different articles in recent years) included erectile dysfunction, oxidative stress, prostate cancer, sperm quality, sperm parameters, infertility, premature ejaculation, diabetes mellitus, obesity, prognosis, sperm DNA fragmentation, DNA damage, antioxidant, asthenozoospermia, varicocelectomy, COVID-19, inflammation, prostatic neoplasms, prostatectomy, metabolic syndrome, hypogonadism, benign prostatic hyperplasia, lower urinary tract symptoms, meta analysis, sexual dysfunction, peyronie's disease and proliferation. The most cited keywords from past to present were determined as fertilization, reactive oxygen species, human sperm, androgens, germ cells, DNA damage, flow cytometry, sperm motility, spermatogenesis, acrosome reaction, casa, epididymis, male fertility, sperm function, lipid peroxidation, antioxidants, sperm concentration, epidemiology, sperm motility, and sperm.

As a result of the literature review we conducted, we could not find a bibliometric study in which the field of Andrology was discussed holistically. It is an important advantage of our study that it is the first comprehensive bibliometric research in this field. Readers should be aware that our findings are based on WoS documents as of April 1, 2023, when the articles were downloaded, and all findings provide an analysis of articles from 1980-2022. Our findings should be interpreted considering that an article published in the field of Andrology before 1980 was not included in the analysis. Our preference for the WoS to obtain the articles may be considered a limitation. However, in some studies, it was stated that citation and co-citation analyzes could not be conducted in the PubMed, and some journals with low impact levels were also indexed in the Scopus³⁻⁶. The WoS database indexes the majority of articles in the SCI-expanded index⁵. In addition, WoS was mostly preferred in many bibliometric studies published in recent years³⁻⁶.

Conclusions

We presented an analysis of 16,659 articles in this study, which we have carried out in the field of Andrology, which has an increasing trend in the number of articles in recent years. It can be said that the trend topics that have been more researched in recent years included erectile dysfunction, oxidative stress, prostate cancer, sperm quality, sperm parameters, infertility, premature ejaculation, diabetes mellitus, obesity, prognosis, sperm DNA fragmentation, DNA damage, antioxidant, asthenozoospermia, varicocele, COVID-19, inflammation, prostatic neoplasms, prostatectomy, metabolic syndrome, hypogonadism, benign prostatic hyperplasia, lower urinary tract symptoms, meta-analysis, sexual dysfunction, Peyronie's disease and proliferation. In the field of Andrology, we identified the research leadership of China, Japan, Turkey and India in addition to Western countries, such as the USA and European countries (Germany, Italy, Spain, United Kingdom and France) that have large economies.

Conflict of Interest

The authors declare that they have no conflict of interest.

Ethics Approval

This article does not contain any studies with human participants or animals performed by any of the authors, therefore, ethics approval is not applicable.

Informed Consent

Informed consent is not required in this study.

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Authors' Contributions

All authors contributed to the study's conception and design. All authors read and approved the final manuscript. Musa Ekici: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. Emre Demir: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. Cemil Aydın: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Data Availability

All data associated with this paper are available from the corresponding author upon reasonable request.

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