Annals of Library and Information Studies
Vol. 68, September 2021, pp. 318-325

Publication pattern expressed by scientific position, service tenure, and age – A comparative analysis with working women scientists of science and technology laboratories of India

Bhaskar Mukherjee

Professor & Principal Investigator (NSTMIS-DST), Department of Library and Information Science,
Banaras Hindu University, Varanasi, Uttar Pradesh (INDIA) -221005, Email: mukherjee.bhaskar@gmail.com

Received: 01 May 2021; revised: 25 June 2021; accepted: 12 July 2021

This study investigates the effect of scientific position, service tenure, and age of women scientists of various research laboratories of the Ministry of Science and Technology, Government of India on the research productivity. Drawing on a sample of 902 women scientists of various research laboratories, with their 22,617 publications extracted from Web of Science & Scopus databases, the results show that CSIR scientists have more women per laboratory, DST women scientists have more publication per scientists and DBT women scientists received more citations. The majority of the publications were published by scientists who have post-doctoral or doctorate degrees and most of the papers were published by the women scientists between age 31 and 40. However, per scientist publication reveals that there is a continuous increase of publication with the increase of service and physical age. Therefore, better funding opportunities for young researchers and retaining experienced women scientists for more years may be important to increase women's participation in science.

Keywords: Women Scientists; Scientometrics; Women in S&T

Introduction

According to the All India Survey of Higher Education-2018-19[1], the total female enrolment in higher education, including diploma, graduate, post-graduate, and Ph.D. were estimated at 18.2 million which is almost 48.6% of the total. Of the total enrolments, 24.64 lakhs were enrolled in Bachelor of Science, 5.95 lakhs were enrolled in Bachelor of Technology, 3.12 lakhs in Bachelor of Engineering, and 4.25 lakhs in Master of Science. However, after completing a master's degree only 0.97 lakhs pursued Ph.D. in Engineering, 0.82 lakhs in Science, and 0.66 lakhs in medical science. While the nationwide figure of women in higher education indicates they constitute the majority in India, they are a minority in the scientific discipline. As per UNESCO Institute for Statistics, up to 2015, only 13.9% of females pursued research. This data is based on full-time equivalents (FTE) of the total persons that are employed in R&D (UIS Fact Sheet No. 55, June 2019 http://uis.unesco.org). According to Global Gender Gap Index, 2020, India's rank is 112th of the total 153 countries. It was 108th in 2018. As per this report, it would take nearly a hundred years to close the gender gap in various fields in India compared to the time it would take time in other countries.

As every nation is moving towards a knowledge society, multi-skilled, highly creative, and innovative inter-disciplinary teams are needed for globally competitive scientific research. While inequalities waste potential, excellence requires diversity. In the coming days, employers will need to become more competitive by investing in and developing staff for research and development, and using them wisely and more effectively. Therefore, irrespective of gender, the best employees are becoming vital for any organization in the context of skill shortage. Importantly, recent social and economic changes have enhanced women's position in society. Women are increasingly determining various policy decisions and heading organizations. As soon as they become more significant in science disciplines, as individuals and as policy makers, it should augur well for the Indian science system.

Research activities of scientists are influenced by the input-output process, where the input consists of human and financial resources which enhance or hinder the research activities, the output is measured by tangible entities like publication, patents, books, etc. and intangible entities like knowledge, skill, competencies, etc. Although both input and output are important for quality research, the most commonly used indicators to measure the quality of researchers in science and technology are their outputs - the results of the research that appears in the forms of an article in qualitative journals.

According to the "List of Indian Institutes with Research areas" prepared by DST (dst.gov.in) for their Research Training Fellowship-Developing Countries Scientist's (RTF-DCS) program, currently, there are 216 research institutes actively contributing to the development of science in India. These institutes are functioning under the respective ministry of the government. One such ministry is the Ministry of Science & Technology.

The Ministry of Science and Technology of the Government of India has three major departments including the Department of Scientific and Industrial Research (DSIR), the Department of Biotechnology (DBT), and the Department of Science and Technology (DST). There are also the 37 research laboratories and 6 research units functioning under Council of Scientific and Industrial Research (CSIR), 19 under DST, and 15 under DBT. CSIR labs work the domains of physical, chemical, biological, engineering and information sciences. The DBT institutes specialize in biological science and DST labs mainly specialize in earth sciences, astrophysics, nano-sciences, etc.

In the Union Budget of 2020-21, the Government of India allocated Rs. 14,793.66 crores, almost 8% increase in Compound Annual Growth Rate (CAGR) as compared to 2019-20 to 2021-22 (https://prsindia.org/budgets/parliament/demand-for-grants-2021-22-analysis-science-and-technology). With government support, the R&D sector is expected to exhibit robust growth. As in 2020, the 13th edition of the Global Innovative index (GII) ranked India in the 48th position among 131 countries and with such government support, it is expected that India will likely rank 25th within the next 10 years.

Women and Indian Science

The reasons for women's under-representation in science have been explained from different perspectives. Longino[2] (1989) revealed that we should focus on "science as a practice rather than as content, as a process rather than a product, hence not on feminist in science but on doing science as feminist". Doing science as a feminist requires not only new methodologies but also institutional conditions for such work. Subhramanium[3] explored the epistemological challenges of studying gender in natural and physical science and developed methodological tools to study the human and non-human, life and non-life. Chandra[4] established a relationship between science, gender, and patriarchies in the Indian context from a multi-disciplinary perspective. They explained how science and technology have impacted Indian women, going beyond the problems of women scientists in institutions and offers a pioneering contribution to both science and women's studies. From a social perspective, Thomas[5] identified the complexities of everyday life by taking women scientists of the Indian Institute of Science (IISc) and the way they engage with the identity of scientists. The author explored on the issue of how silencing of socio-cultural identities shaped the imagination of science and how merit, the passion of doing science among women, and caste affect the growth of Indian science.

Although the women's representation in Indian science is not what it is expected to be, it does not mean that there aren't successful and renowned women in the field of science. Janaki Ammal specialized in cytogenetics and phytogeography, conducting chromosome studies on a wide range of garden plants and was awarded the Padma Shri in 1957. Anandibai Joshi is the first Indian woman to have obtained a degree in western medicine. Asima Chatterjee is well known for her development of cancer medicine, anti-epileptic and anti-malarial drugs. She was the first woman to be named a Doctor of Science by an Indian university. Sunetra Gupta studies infectious diseases, like the flu and malaria, using mathematical models. She has been awarded the scientific medal by the zoological society of London and the Royal Society Rosalind Franklin Award for her scientific research. Dr. Indira Hinduja, a gynaecologist, pioneered the gamete intra-fallopian transfer leading to the birth of India's first Gamete intra-fallopian transfer (GIFT) baby. Aditi Pant, an oceanographer, was the first Indian woman to have visited the icy terrain of Antarctica in 1983. She worked in the CSIR-National Institute of Oceanography and the CSIR-National Chemical Laboratory. Dr. Suman Sahai, a recipient of the Padma Shri, studied the effects of genetically modified crops and address the problems faced by the farmers of India.

Godbole and Ramaswamy[6] in *'Lilavati's Daughters: The Women Scientists of India'* wrote brief biographical and autobiographical sketches of about one hundred women scientists from India. However, a larger segment of Indian women scientists has remained underrepresented.

Review of literature

Some empirical studies like Simonton's model[7] of creativity suggest that individuals have an initial 'creative potential' that decreases over time. Kuhn[8] also suggested that young researchers have a fresh look at scientific problems and are more likely to cause a scientific revolution. Studies have shown that the publication rate has been found to increase within the hierarchy of positions: senior staff is more prolific while people in lower positions tend to publish fewer publications[9]. However, the proportion of female researchers decreases within the hierarchy of positions. Particularly in higher positions, there are few females while there is more gender balance among Ph.D. students[10].

Studies have also explained that women occupy fewer of the highest academic posts and are also less integrated with the scientific community as they are less visible in membership of the scientific associations or editorial board in research journals[11]. In a study by Husemann[12], it was observed that the female scientists suffer more, (their publicationism score = 2.577) on "publicationism"- an index of stress arising from the pressure to publish and further found that publicationism decreased with the increase of age (a drop of 0.19 index points).

The relationship between age and publication rate is curvilinear: the average production of publication increases with the age and reaches a peak at some point during career and then declines[9]. However, Kyvik[13] observed that the researchers with more recognition keep publishing frequently after their less-recognized colleges reached their peak.

The Government of India during the last few years has taken several initiatives to provide strong support to women scientists, by introducing various women scientist schemes/programmes, mainly for young scientists. It is important to understand how such policies affect the overall growth in science by the women working in research laboratories. Despite an increase in the proportion of women in science and engineering occupations over the past few years[14], how scientific position, service tenure, and age influence scientific publication rate are yet to be explored. We have, therefore, primarily taken up the research productivity issue focusing only on these areas with the women scientists working in various research organizations of Ministry of Science & Technology, Government of India. Furthermore, it will be useful to verify if publication of working women increase or decrease with the increase in age and position?

To the best of our knowledge, the research productivity of women in scientific research has not been analysed before. Therefore, the results of the present study may be used as an input for evidence-based policymaking, for implementing, monitoring, and evaluating women's participation in science.

Methodology

We first identified women working in research laboratories by visiting the laboratory websites. From the attached photographs on the staff page of the corresponding laboratories, we identified women scientists. In case photographs were unavailable, the given name of the scientists was examined. In general, women name in India mostly ends with 'i' or ''ee' or 'a'. Internet available tools "Baby name Guesser" (http://www.gpeters.com/name s/baby-names.php) and Gender API have also been explored. "Baby name Guesser" gives the likely gender and predicts gender ratio. A ratio of 3.0 or above was chosen as correct[15]. After deciding the gender, necessary information like designation, date of birth, position served over time, patents filed and granted, awards and achievements received, etc. have been noted from the official websites. In case the required information was incomplete, various official sources, like Annual Report, Fact-file, etc. as well as social network sites were consulted. Even after using these means, if the required information still remained incomplete, an online questionnaire was sent, followed by personal visits. A few scientists remained 'unidentified' and such profiles were excluded from the study.

The name of the identified scientists' along with their organization they are presently serving were used to search Scopus and Web of Science databases. Through this process, we gathered details of 902 women scientists and their 24322 publications. Fractional publication output has been measured as article equivalent per person per year. In this calculation, co-authored publications are fractionalized among the authors. To get normalized value, the following simple formula was sued:

$$X_{new} = (X - X_{minl)}) / (X_{maxl} - X_{minl})$$

where X is the set of the observed value of an individual scientist;

X_{minl} is the minimum value of $X_{scientists}$ of that laboratory

X_{maxl} is the maximum value of $X_{scientists}$ of that laboratory

Most databases do not allow searches by gender. In the present study, the author's gender was first identified from the official website. While searching the name in the databases, it was observed that the number of searched results against individual author were not the same. In many cases, the number of results of WoS was higher than Scopus. Therefore, to maintain exhaustibility, the highest results against individual authors were considered irrespective of databases. The searched results have been manually verified to confirm that the result is the correct representation of the population. The publication data was searched in the last two weeks of March 2020. However, publications up to December 2019 only were considered.

Results

The distribution of the population by laboratories in terms of the number of women scientists and their publication pattern is shown in Table 1. Considering only the unique and highest publications of a scientist from both the databases, a total of 24322 publications were identified. However, only 22617 (93%) publications are considered for final analysis. Publications that appeared as Articles, Conference proceedings, Book and Chapters in Books were considered as these are the main form of original publication. We excluded review publications for final analysis as it is known that reviews tend to get more citations than research papers[16].

Table 1 — Publications, patents, awards & citations characteristics of women scientists (*based on highest publications of a scientists irrespective of databases)*

	CSIR	DBT	DST
Number of women scientists	618	106	178
Number of publications	14065	2516	6036
Average article per women scientist	22.75	23.73	33.91
Normalized publication count	0.09	0.06	0.15
Fractional Publication per women scientist	6.67	5.45	10.37
Median publication	15	15.5	27.5
Average Age of Article	7.54	7.95	9.53
Number of Patents & (Number of Scientists)	554 (227)	88 (44)	180 (54)
Number of Awards Received	153	66	58
Number of Citations received	259710	78659	123896
Average Citation per Article	18.74	31.26	20.43
Normalized Citation impact/scientist	0.08	0.09	0.08

CSIR has more women scientists per laboratory (14 women scientists/lab), DST scientists have more publications per scientist (average 34 publications) and DBT scientists received more citations (31 citations/articles).

Note: 65 Scientists of CSIR, 05 of DBT, and 12 of DST do not have any publication. Average age of articles is based on 2019 as the base year.

Pattern of publication by educational qualification, year of joining and current designation

Table 2 (A to C) gives the publication pattern of women scientists working in different laboratories. There is no single trend that can be explained. Most of the women scientists of CSIR & DST are doctorate (Ph.D.) while most DBT scientists are post-doctoral fellows. Most publications of DST and DBT have been contributed by scientists with a post-doctorate degree. The highest percentage of scientists of CSIR are those who joined during 2005 to 2009 however, the highest percentage of scientists of DBT and DST are those who joined during 2010 to 2014. CSIR & DST scientists who joined before the year 2000 have maximum publications, and in DBT institutes, scientists who joined during the year 2010 to 2014 have maximum publications. We see that a majority of the scientists in the three organization are quite young and they in the position of Scientists-C, however, Senior Scientists (Scientists-D) of CSIR, Senior Principal Scientist (Scientists F) of DBT, and Principal Scientists (Scientist-E) of DST have highest publications.

Progressive publications

An attempt has been made to understand the research productivity of women scientists in the different ages of their life. The average productivity per scientists counts, in its denominator, all scientists that are in our sample, irrespective of whether they have published at a given age, while the average productivity of 'active scientists' only includes in its denominator those who published at least one article per year after joining in the current organization at the year in question. Here each publication of a women scientists is also normalized with her age. It is to be noted here that the sum of scientists mentioned in

Table 2A — Pattern of publications in terms of educational qualification

Highest Educational Qualifications	CSIR			DBT			DST		
	NS.	Pub	PP	NS.	Pub	PP	NS.	Pub	PP
Post-Doc, RA, DM	105	2971	28.30	62	1576	25.42	77	3402	44.18
	17.0%	21.1%		58.5%	62.6%		43.3%	56.4%	
Ph.D., MD, D.Sc.	352	9334	26.52	40	933	23.33	81	2428	29.98
	57.0%	66.3%		37.7%	37.1%		45.5%	40.2%	
Master's Degree (ME, M. Tech, MSc., MBA)	105	893	8.50	0	0		6	33	5.50
	17.0%	6.3%		0	0		3.4%	0.5%	
Others (including MBBS, BE, B. Tech)	7	59	8.43	0	0		5	10	2.00
	1.1%	0.4%		0	0		2.8%	0.2%	
Unidentified	49	808	16.49	4	7	1.75	9	163	18.11
	7.9%	5.7%		3.8%	0.3%		5.1%	2.7%	

NS=Number of Women Scientists, Pub. Publications, PP=per scientist publication

Table 2B — Publications according to year of joining

Tenure of Service/Year of joining	CSIR		DBT		DST	
	NS	Pub	NS	Pub	NS	Pub
More than 20 years/Before 2000	116	3886	8	239	37	1936
	18.7%	27.6%	7.5%	9.5%	20.8%	32.1%
15 to 20 years/ 2000 to 2004	84	2613	15	410	18	737
	13.5%	18.6%	14.1%	16.2%	12.4%	16.0%
10 to 15 years 2005 to 2009	162	3768	15	447	34	1108
	26.2%	26.8%	14.1%	17.7%	21.3%	19.9%
5 to 10 year/2010 to 2014	129	2271	35	743	52	1582
	20.9%	16.1%	33.0%	29.5%	32.0%	25.9%
5 Years or Less/2015 onwards	116	1204	33	677	34	595
	18.8%	8.6%	31.1%	26.9%	11.8%	4.8%
Unidentified	11	323	0	0	3	78
	1.8%	2.3%	0.0	0.0	1.7%	1.3%

NS=Number of Women Scientists, Pub. Publications

Table 2C — Scientific position and Publications pattern

	CSIR		**DBT**		**DST**	
Current Position	**No.**	**Pub**	**No.**	**Pub**	**No.**	**Pub**
• Chief-Scientists and above [Inlcudes Scientists G, Emeritus Scientist, Scientist-G, Scientist-H, Staff Scientist VII, SERB Distinguished fellows, Senior Professor, Outstanding Professor, and National Chairs]	32 5.2%	1419 10.0%	8 7.5%	609 24.2%	20 11.2%	1370 22.7%
• Senior Principal Scientists [includes Scientist-F, Staff Scientist VI, Professor equivalent to Scientist F, Engineer F and other posts equivalent to Scientist F]	75 12.1%	2823 20.0%	25 23.6%	932 37.0%	25 14.0%	1068 17.7%
• Principal Scientists [includes Associate professor-II or full Associate professor equivalent to Principal scientist, Full Scientist E or Scientist E-II, Staff Scientist V, Professor E, and other posts equivalent to Principal Scientist]	115 18.6%	3076 21.9%	20 18.9%	336 13.4%	45 25.3%	1687 27.9%
• Senior Scientists [includes Scientist D, Scientist E-I equivalent to Scientist D, Associate Professor-I, Reader, Staff Scientist IV, and other posts equivalent to Senior Scientist]	167 27.0%	4215 29.9%	19 17.9%	245 9.7%	31 17.4%	908 15.0%
• Scientists [Scientist C, Assistant Professor, Staff Scientist III, Inspire Faculties, DBT-Biocare Scientist, Welcome Trust Intermediate fellows, and other posts equivalent to Scientist C]	222 35.9%	2470 17.6%	32 30.2%	361 14.3%	47 26.4%	953 15.8%
• Junior Scientists [includes Junior Scientists, Scientist B, Staff Scientist II, and other equivalent posts.]	7 1.1%	62 0.4%	2 1.9%	33 1.3%	10 5.6%	50 0.8%

Table 3 — Publications during the different span of service and age

	CSIR			DBT			DST		
Joining	N	(%T)	PS	N	(%T)	PS	N	(%)T	PS
Publications before joining currently serving organization	323	16.8	7.3	83	28.1	8.5	124	21.5	10.5
Publications after joining	521	80.9	21.8	95	71.9	19.0	164	77.2	28.4
Unidentified	11	2.3	-	0	0.0	-	03	1.3	-
# Active Scientists	319	86.3	30.8	71	92.0	23.5	127	93.6	34.4
A. Service age									
Publications within 5 years of joining	436	27.4	7.2	88	43.2	8.9	145	31.2	10.0
Publications during 6-10 years of joining	371	28.5	8.7	60	27.7	8.4	118	29.8	11.8
Publications during 11-15 years of joining	262	19.0	8.2	33	18.1	9.9	69	15.0	10.1
Publications after 15 years of joining	162	25.2	17.7	19	11.0	10.5	49	24.0	22.8
B. Physical age									
Publications up to 30 years of age	327	15.3	6.6	63	10.2	4.1	98	13.6	8.4
Publications between 31-40 years of age	467	37.7	11.4	89	39.0	11.0	136	36.9	16.4
Publications between 41-50 years of age	323	32.6	14.2	64	32.1	12.6	95	30.5	19.4
Publications more than 50 years of age	123	13.1	15.0	20	17.8	22.5	60	17.7	17.9
Unidentified	09	1.3	-	03	0.8	-	2	1.0	-

column N in CSIR, DST & DBT exceeds the total because we count publications of an individual scientist when she was in that age group. This means if a scientist's current age is 50 and her total publication is 45, we count, of these 45 publications, how many publications she made when she was below 30, from 31 to 40, from 41 to 50, and so on.

Note: N= Number of women Scientists, %T=Percentage of the total publications, PS=Publication/Scientist. Service age is calculated based on the date of joining in current position, Physical age is calculated based on the Date of Birth of the Scientist.

Table 3 presents the distribution of the number of scientists by service age (A) as well as physical age (B) and percentage of share to the total publications. Although the percentage of publication for A (counted using the date of joining) is based on the total publication after joining of a women scientist, the percentage of publication for B (counted using the date of birth) is based on the total publications of a scientist in her lifetime.

The results show that while women scientists of CSIR contributed the maximum percentage of their publications during 6 to 10 years of joining but women scientists of DBT and DST contributed most of their publications during the first 5 years of their joining. This may be because most of the scientists of these two laboratories have more post-doctoral fellows and they remained productive even after joining. On the other hand, it is observed that at the age between 30 and 40, the scientists of all three organizations contributed the highest percentage of publications.

Discussions and conclusions

The distribution of publications of women scientists across different types of laboratories reveals that there is no overall difference at the institutional level except for slightly higher publications by the scientists of DST than DBT or CSIR. When distinguishing between laboratories, the difference between medians is statistically insignificant at 0.05, in citation also the differences are nominal. The fractional count and normalization count also reveals the same. Therefore, it may be fair to conclude that on average women of different laboratories have the same performance.

When they published with other co-authors on average they produced 22 to 33 articles which is equivalent to 6 to 10 articles of their credit. Furthermore, a considerable number of patents, although it is as low as 0.9 patents per scientist, are granted under the credit of CSIR women scientists in recent time. It was also observed that several women scientists of DBT are the recipient of the various prestigious awards of the Government of India. These awards are conferred upon those who have made an outstanding contribution to Science. All these may be promising indicators related to the increased participation of women in different laboratories. Earlier a few seminal studies have shown a positive relationship between a scientific publication and patenting activities[17], one should keep in mind that publication and patenting are complementary and not competing activities of researchers[18]. Siegel[19] in this regard showed that organizational factors, particularly scientist's reward systems, and compensation, influence the productivity and technology transfer activities of a scientist and thus motivate the scientists to disclose their inventions.

The results also show that majority of the publications by scientists who have post-doctoral or doctorate degrees who at present make up the staff of the research laboratories. This suggests that researchers who are active in their younger years gain more scientific capital[20], thereby accessing more resources, which in turn, help them stay productive. We observed that during the first 10 years of the service age, women scientists produced more which decreased sharply thereafter but again began to increase after 15 years of service.

In terms of physical age, most papers were published between the age 31 and 40 and then decreased slowly with the increase of age. However, publication per scientist reveals that there is a continuous increase of publication with the increase of service and physical age. This may be because active scientists sustain their productivity at a high level throughout their careers. Longitudinal analysis following the career of cohort scientists during many decades could show conclusively that whether those older scientists who remain highly productive are the same as those who were productive at their younger age. Our data nonetheless shows that per scientists publication reaches its maximum during their fifties or after serving 15 years of service. The decline may be because after reaching a certain age, a few scientists are less active in research and they stop publishing. Therefore, it may be fair to say that science is a collective endeavour and as our data shows, scientists of all ages play an effective role in dynamics.

Our results have science policy implications. At a time when the government is re-evaluating the policy of retirement age, the fact that older scientists play an effective role in the productivity of scientific literature cannot be neglected. Moreover, if the turning point at the age 31 to 40 are relatively stable in a truly longitudinal sense or similar cohort in other subjects and gender, then providing better funding opportunities to younger scientists would give them more lead time to strong productivity before settling into a plateau.

Acknowledgments

This work is based on DST-sponsored ongoing project no. DST/NSTMIS/05/323/2017-2018. Author thanks NSTMIS (DST), the Government of India, for providing financial assistance.

References

1 Ministry of Human Resource Development (MHRD), Govt. of India, *All India Survey on Higher Education* (2018-2019). New Delhi, 2019. Available at: http://aishe.nic.in/aishe/viewDocument.action?documentId=263

2 Longino H, Can there be a feminist science? Feminism and science, Nancy Tuana (ed), (1989) Bloomington: Indiana University Press.

3 Subramaniam B, Stories we tell: Feminism, science, methodology, *Economic & Political Weekly*, l1(18) (2016) 57

4 Sumi Krishna, Understanding gender and science in India: Institutions and beyond. In: Feminists and Science: critiques and changing perspectives in India, New Delhi, (2017) SAGE Stree, p. 1

5 Thomas R, Narratives in feminist sociology of science: Contextualizing the experience(s) of women scientists in India. (2018) In: Re-imagining Sociology in India, Routledge India, pp. 22.

6 Godbole R M, Ramaswamy R, *Eds*., *Lilavati's Daughter: Women Scientists in India*. The Association of Academies and Societies of Sciences in Asia, (2015). Available at: www.interacademies.org/File.aspx?id=28016

7 Simonton D K, Creative productivity and age: A mathematical model based on a two-step cognitive process. *Developmental Review*, 4 (1) (1984) 77-111.

8 Kuhn T S, The structure of scientific revolutions: University of Chicago Press. Original edition, 1962.

9 Aksnes D W, Rørstad K, Piro F and Sivertsen G, Are female researchers less cited? A large-scale study of Norwegian scientists, *Journal of the American Society for Information Science and Technology*, 62 (4) (2011) 628–636.

10 European Commission, She Figures 2012: Gender in research and innovation, 2012, http://ec.europa.eu/research/science-society/document library/pdf 06/she-figures-2012 en.pdf

11 Puuska H M, Effects of scholar's gender and professional position on publishing productivity in different publication types. Analysis of a Finnish university. *Scientometrics*, 82 (2) (2010) 419–437.

12 Husemann M, Rogers R, Meyer S and Habel J C, "Publicationism" and scientists' satisfaction depend on gender, career stage, and the wider academic system, *Palgrave Communications*, 3 (1) (2017) 1-10.

13 Kyvik S, Age and scientific productivity. Differences between fields of learning, *Higher Education*, 19 (1990) 37–55.

14 Gupta N and Sharma A K, Women academic scientists in India, *Social Studies of Science*, 32 (5-6) (2002) 901-915.

15 Mimouni M, Zayit-Soudry, S. Segal, O. Barak, Y. Nemer A.Y. Shylman S et al., Trends in authorship of articles in major ophthalmology journals by gender, *Ophthalmology,* 123 (2016) 1824–1828.
16 Sigogneau A, An analysis of document types published in journals related to physics: Proceeding papers recorded in the Science Citation Index database, *Scientometrics,* 47 (3) (2000) 589–604.
17 Agrawal A and Henderson R, Putting patents in context: Exploring knowledge transfer from MIT, *Management Science*, 48 (1) (2002) 44-60.
18 Jensen K and Murray F, Intellectual property landscape of the human genome, *Science*, 310 (5746) (2005) 239-240.
19 Siegel D S, Waldman D and Link A, Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study, *Research Policy*, 32 (1) (2003) 27-48.
20 Bourdieu P, The specificity of the scientific field and the social conditions of the progress of reason, *Social Science Information,* 14 (1975) 19–47.