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A SCIENTOMETRIC ANALYSIS OF GLOBAL FORENSIC SCIENCE RESEARCH PUBLICATIONS

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A SCIENTOMETRIC ANALYSIS OF GLOBAL FORENSIC SCIENCE RESEARCH PUBLICATIONS

ABSTRACT

A scientometric study of forensic science literature from the year 1975 to 2011 is carried out to find out the growth in forensic science literature, authors' productivity, the top ranking source journal and the country-wise productivity. The data for the study is obtained from the *SCOPUS* database. The 13626 number of results retrieved are analysed using excel worksheets. Google Scholar database is used as a data source for citation analysis of the authors who are found highly productive in the *SCOPUS* data. *Publish or Perish* (PoP) software is used for the citation analysis. It is found forensic science literature has seen an explosive growth during the period of study. Bruce Budowle is the author who has contributed the highest number of articles. The three journals, *Journal of Forensic Sciences*, *Forensic Science International* and *Science & Justice* contribute almost half of the total forensic science literature. The United States of America contribute 30% forensic science literature. FBI Laboratory is the only forensic science laboratory in the top ten affiliating institutions.

KEYWORDS: Scientometrics, Forensic Science, Research Productivity, Authorship Productivity, SCOPUS, Google Scholar, Publish or Perish (PoP)

INTRODUCTION

Forensic science refers to the application of principles and methods of specialized scientific and technical knowledge to criminal and civil legal questions and presenting the finding in an unbiased and objective way in courts of law. According to Saferstein (2001) "Forensic science is the application of science to those criminal and civil laws that are enforced by police agencies in a criminal justice system." Thus forensic science is related to the police agencies and to the judiciary.

Forensic sciences include, but are not limited to pathology, psychiatry, psychology, odontology, toxicology, molecular biology, entomology. A forensic scientist must be skilled in applying the principles

and techniques of the physical and natural science to the analysis of the many types of evidence that may be recovered during crime investigation. Due to the interdisciplinary nature of the field, forensic literature are not limited to core forensic science journal but also can be found in interrelated disciplines of anthropology, chemistry, engineering, entomology, dentistry and physics, among others.

SCIENTOMETRICS

The field of Library and Information Science (LIS) has developed several quantitative methods to study the various aspects of subjects. The metrics of LIS are increasing day by day starting from Librametrics, Bibliometrics, Scientometrics, Informetrics, Webometrics, Netometrics to Cybermetrics.

The origin of the term *scientometrics* goes back to the year 1969, when two Russian scientists Nalimov and Mulechenko coined the Russian term *naukometriya* the Russian equivalent of scientometrics (Nalimov and Mulechenko, 1969). However, the advent of scientometrics as a discipline was in 1978, when the journal *Scientometrics* was founded by Tibor Braun in 1978. Scientometrics defines its content as “Scientometrics includes all quantitative aspects of the science of science, communication in science, and science policy.” (Wilson, 1999)

The focus of scientometrics is the measurement of science and is therefore concerned with the growth, structure, interrelationship and productivity of scientific disciplines. Tague-Sutcliffe defines “Scientometrics is the study of the quantitative aspects of science as a discipline or economic activity. It is part of the sociology of science and has application to science policy-making. It involves quantitative studies of scientific activities, including, among others, publication, and so overlaps bibliometrics to some extent.” (Tague-Sutcliffe, 1992)

NEED AND SIGNIFICANCE OF THE STUDY

Scientometric studies have increasingly been used over the last few years. These studies are useful to understand the evolution of literature or trends in particular fields or within a geographical area.

However, in forensic science, scientometrics have barely been used. Alan Wayne Jones is the only author to have worked on bibliometric analysis of forensic science literature. His interesting work is mainly focused on most highly cited articles, most prolific authors and impact factors. (Sauvageau, Desnoyers and Godin, 2009)

REVIEW OF LITERATURE

Jones (2003) reviewed the impact factors of forensic science and toxicology journals and opined that the impact factors of these journals are low because the visibility and size of the circulation of these journals are low. During 2005, Jones identified with the help of Web of Science (WoS) the most highly cited papers published in the *Journal of Forensic Sciences* between 1956 and 2005. The most highly cited paper was by Kasai, Nakamura and White concerning DNA Profiling. Again Jones (2007) analysed the forensic science journals, their development and distribution and their current status as reflected in the journal impact factor. He concluded that the relatively low impact factors of forensic science journals are due to the small size of the field, fewer active researchers and less pressure to publish.

Sauvageau, Desnoyers and Godin (2009) studied the evolution of forensic science literature in two North American journals from 1980 to 2005 and found that forensic science literature in anthropology and DNA have increased significantly, while the contribution of questioned documents and ballistics have decreased. They also found out that the number of articles per year and the average numbers of authors per article have both increased almost two fold.

Jeyasekar and Saravanan (2012) conducted a scientometric study of forensic science to analyse the growth in literature, authorship productivity, the high ranking institution and country. It was found that the forensic science literature doubled between 2001 and 2011. In the same year, Jeyasekar and Saravanan carried out a scientometric analysis of the Indian forensic science literature for the period 2004 to 2011 using the Indian Citation Index (ICI) database. The study revealed that the forensic science

publications are found not only in the core journals but also found scattered among journals of allied fields. The All India Institute of Medical Sciences (AIIMS) is the top contributor of Indian forensic science literature. Jeyasekar and Saravanan (2013) carried out a bibliometric study of the Journal of Forensic Sciences and found that there is an increase in publications on digital and multimedia aspects of forensic science and the literature related to application of DNA technology in forensic science is also increasing. The mean degree of authorship collaboration is 0.91.

OBJECTIVES OF THE STUDY

The objectives of the present study are as follows:

1. To study the growth of forensic science research literature.
2. To identify the authors' productivity.
3. To examine the source journals which contribute the forensic science literature.
4. To analyse the country-wise and the affiliating institution-wise contribution.
5. To identify the most cited research article.

METHODOLOGY

The data for the study period 1975 to 2011 is retrieved from the *SCOPUS* database using "forensic science" as the keyword. *SCOPUS* is an international multidisciplinary database indexing over 15,000 international peer reviewed journals in Science and Technology, besides more than 500 international conference and seminar proceedings. So far *SCOPUS* is the single largest international multidisciplinary database in the world. The 13626 number of results retrieved are analysed using excel worksheets. *Google Scholar* database is used as a data source for citation analysis of the authors who are found to be highly productive in the *SCOPUS* data. *Publish or Perish* software is used for this citation analysis.

RESULTS AND DISCUSSIONS

Growth of Literature

The number of articles, the percentage and cumulative growth for the period from 1975 to 2011 are given in Table 1. Forensic science literature has grown exponentially during this period. This finding confirms to the Price's (1963) statement that "Once in ten years the number of articles in a field (particularly in science) doubles". The growth pattern is illustrated in Fig. 1. The cumulative growth is graphically illustrated in Fig. 2.

Table 1: Growth of literature

Year	No. of articles	Percentage of 13626	Cumulative Growth
1975	89	0.65	89
1976	52	0.38	141
1977	60	0.44	201
1978	51	0.37	252
1979	49	0.36	301
1980	61	0.45	362
1981	63	0.46	425
1982	78	0.57	503
1983	98	0.72	601
1984	87	0.64	688
1985	76	0.56	764
1986	65	0.48	829
1987	57	0.42	886
1988	79	0.58	965
1989	88	0.65	1053
1990	166	1.22	1219
1991	156	1.14	1375
1992	180	1.32	1555
1993	193	1.42	1748
1994	195	1.43	1943
1995	192	1.41	2135
1996	359	2.63	2494
1997	392	2.88	2886
1998	450	3.30	3336
1999	493	3.62	3829
2000	578	4.24	4407
2001	757	5.56	5164
2002	765	5.61	5929
2003	769	5.64	6698

2004	660	4.84	7358
2005	737	5.41	8095
2006	792	5.81	8887
2007	787	5.78	9674
2008	818	6.00	10492
2009	951	6.98	11443
2010	1008	7.40	12451
2011	1175	8.62	13626
Total	13626	99.99	13626

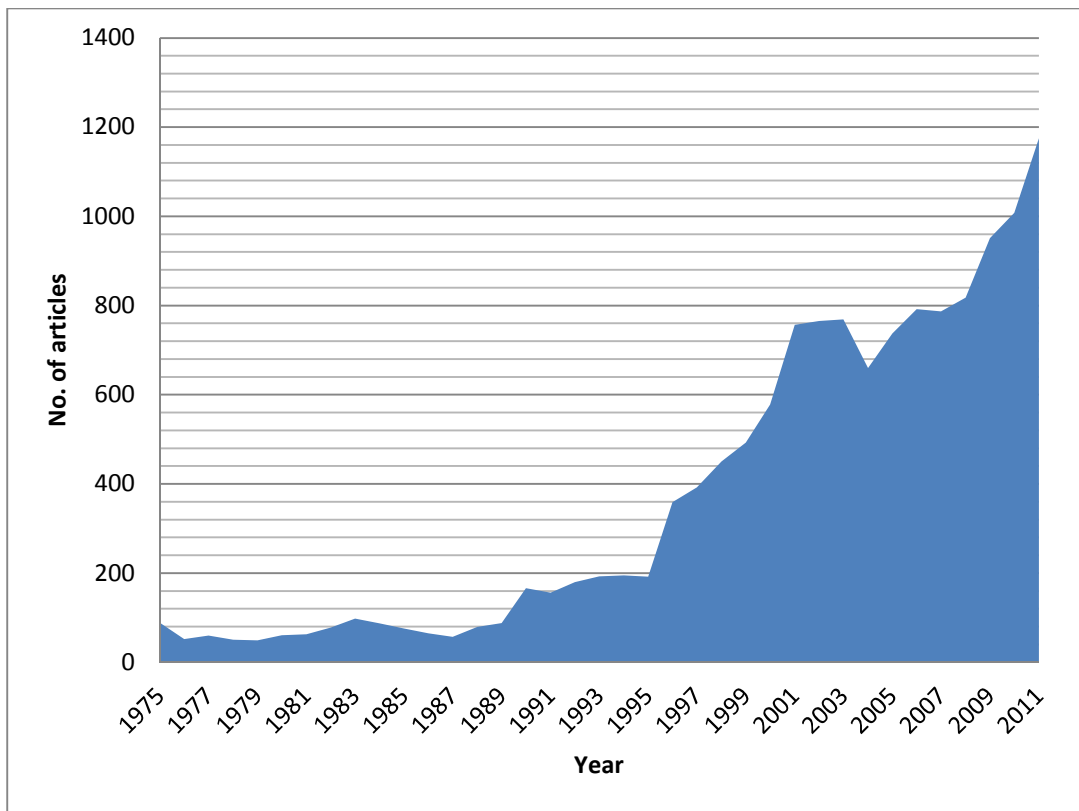


Fig. 1 Growth pattern

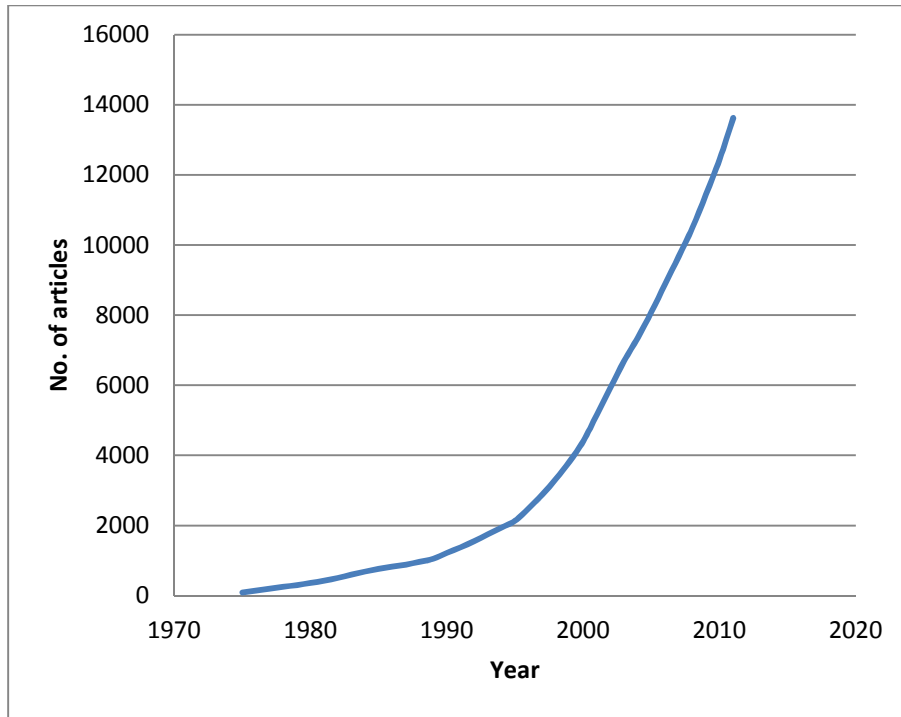


Fig. 2: Cumulative Growth

Authors' Productivity

Authors' productivity is studied based on their contributions in the field. If the authors have equal number of contributions then the same rank is assigned to them. The details are provided in Table 2.

Table 2: Top contributors

Rank	Author	Contribution
1	Budowle, B.	166
2	Hou, Y.P.	79
3	Byard, R.W.	74
4	Wu, J.	64
5	Roux, C.	55
5	Buckleton, J.S.	55
6	Li, Y.B.	54
7	Thali, M.J.	53
8	Robertson, J.	49
8	Madea, B.	49
9	Parson, W.	48
10	Carracedo, A.	46

Bruce Budowle is the top contributor with 166 articles to his credit. Six of these twelve authors (50%) are from the field of forensic genetics/DNA. DNA Fingerprinting is one of the recently developing fields of study in forensic science. This is in conformity with the findings of Sauvageau (2009) and also with the findings of Jeyasekar and Saravanan (2013) discussed in the review of literature that the literature related to DNA Technology.

Comparison of Authors' Productivity Based on SCOPUS and Google Scholar

The highly productive authors obtained from SCOPUS database is further compared with Google Scholar. The chart showing the numbers of papers of these authors are given in Fig. 3. It is very clear that the number of papers is substantially high for all the authors except Y.P.Hou in *Google Scholar*. This is mainly because *Google Scholar* covers journals and web resources that are not included in *SCOPUS*.

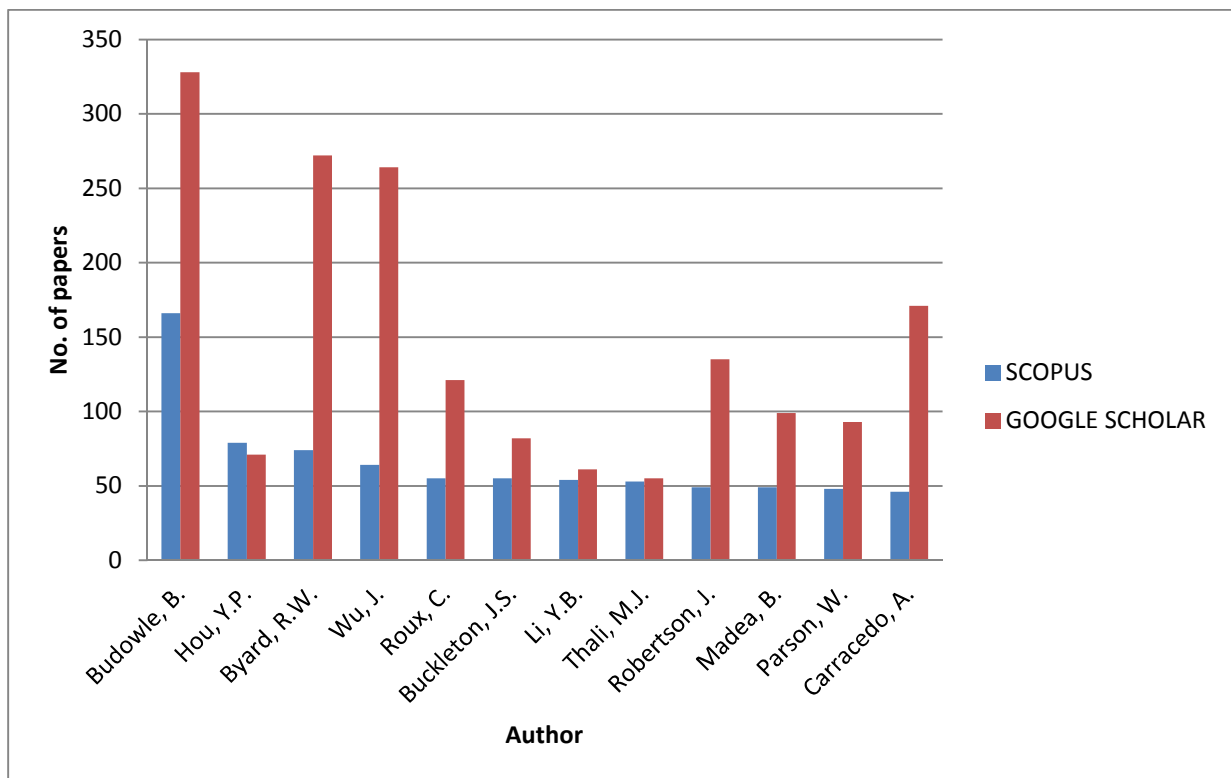


Fig 3: Comparison of SCOPUS and Google Scholar

Authors' Impact

The impact of the twelve authors discussed in the preceding paragraph is analysed using Harzing's *Publish or Perish* Software. *Publish or Perish* is a software program that retrieves and analyses academic citations. It uses *Google Scholar* to obtain the raw citations, then analyses these and presents the total number of papers, total citations, h-index, g-index, etc. *Google Scholar* generally provides a higher citation count than the *WoS* or *SCOPUS* databases because it includes citations from all academic publications regardless of where they appeared. Hence, *Google Scholar* provides a more comprehensive picture of recent impact. The details of authors' impact are given in Table 3.

Table 3: Authors' impact

Author	Papers	Citations	h-index	g-index	e-index
Budowle, B	328	10155	52	89	62.96
Hou, Y.P	71	293	6	15	13.6
Byard, R.W	272	3692	26	45	30.79
Wu, J	264	1273	19	30	19.54
Roux, C	121	1427	22	32	20.22
Buckleton, J. S	82	1388	20	34	23.15
Li, Y.B	61	267	5	15	13.45
Thali, M.J	55	1419	25	36	24.02
Robertson, J	135	2336	24	45	33.88
Madea, B	99	1513	24	34	21.26
Parson, W	93	3163	26	54	42.31
Carracedo, A	171	4127	32	59	44.06

Bruce Budowle is not only a highly productive author in terms of contribution but also the high impact author with very high citation records and also an impressive h-index. During the period of study he has received 10155 citations. His h-index is 52, a clear high among his peers. The next highest is A. Carracedo with 4127 citations and h-index of 32.

Most Cited Papers

The top ten most cited papers obtained from *SCOPUS* is listed in Table 4. A paper entitled “Genetic variation at five trimetric and tetrametric tandem repeat loci in four human population groups” by Edwards A., et al. published in the journal *Genomics* in the year 1992 has received the highest citation count 817. Further, from titles it is inferred that seven out of the top ten papers belong to DNA Technology. This shows that more research activities are being carried on in newly developing fields.

Authors	Title	Year	Source title	Cited by
Edwards A., et al.	Genetic variation at five trimeric and tetrameric tandem repeat loci in four human population groups	1992	Genomics	817
Kress W.J., et al.	Use of DNA barcodes to identify flowering plants	2005	Proceedings of the National Academy of Sciences of the United States of America	404
Jobling M.A., et al.	The human Y chromosome: An evolutionary marker comes of age	2003	Nature Reviews Genetics	360
Lindoln P., Carracedo A.	Publication of population data of human polymorphisms	2000	Forensic Science International	354
Takats Z., Wiseman J.M., Cooks R.G.	Ambient mass spectrometry using desorption electrospray ionization (DESI): Instrumentation, mechanisms and applications in forensics, chemistry, and biology	2005	Journal of Mass Spectrometry	264
Kayser M., et al.	Characteristics and frequency of germline mutations at microsatellite loci from the human Y chromosome, as revealed by direct observation in father/son pairs	2000	American Journal of Human Genetics	232
Thali M.J., et al	Virtopsy, a new imaging horizon in forensic pathology: Virtual autopsy by postmortem multislice computed tomography (MSCT) and magnetic resonance imaging (MRI) - A feasibility study	2003	Journal of Forensic Sciences	231
Gill P., et al.	An investigation of the rigor of interpretation rules for STRs derived from less than 100 pg of DNA	2000	Forensic Science International	220
Novembre J., et	Genes mirror geography within Europe	2008	Nature	219

al.				
Jain A.K., Ross A., Pankanti S.	Biometrics: A tool for information security	2006	IEEE Transactions on Information Forensics and Security	212

Ranked List of Source Journals

The source journals are ranked based on the number of articles contributed. The list is given in Table 5.

Table 5: Top ranking source journals

Rank	Journal	No. of articles	Percentage of 13626
1	Journal of Forensic Science	4497	33.00
2	Forensic Science International	1544	11.33
3	Science & Justice (Journal of Forensic Science Society)	718	5.27
4	Z Zagadnien Nauk Sadowych	169	1.24
5	Legal Medicine	167	1.23
6	American Journal of Forensic Pathology	145	1.06
7	International Journal of Legal Medicine	136	1.00
8	Journal of the Canadian Society of Forensic Science	127	0.93
9	Australian Journal of Forensic Science	126	0.92
10	Journal of Forensic Identification	102	0.75
	Total	7731	56.73

Journal of Forensic Sciences with 4497 articles i.e., 33% of the total contribution is the top most source journal. This is followed by *Forensic Science International* with 11.33% percent of the total contribution (1544 articles). *Science & Justice* with a contribution of 5.27% (718 articles) is the third ranked journal. These three journals together contribute approximately half (49.6%) of the total literature output. Apart from these core forensic science journals, general science periodicals like *Nature* (67 articles) and *Science* (54 articles) have also contributed to the total forensic science literary output. Similarly, scientific journals of other fields like *Proceedings of SPIE* (81 articles), *Analytical Chemistry* (56 articles), *Journal of Chromatography A* (54 articles) have contributed to forensic science literature. Since forensic

science is a multi-disciplinary subject forensic science literature does not pertain only to core forensic science journals but can also found in peripheral, related and general science journals.

Country-wise Contributions

Twenty one countries have contributed more than 100 articles during the period of study. These countries and the percentage of their contribution are listed in Table 6.

Table 6: Country-wise contribution

Rank	Country	Contribution	Percentage of 13626
1	United States	4197	30.80
2	United Kingdom	1511	11.10
3	Germany	789	5.79
4	Australia	672	4.93
5	Japan	581	4.26
6	Canada	577	4.23
7	China	511	3.75
8	India	414	3.04
9	Italy	394	2.90
10	France	370	2.72
11	Switzerland	339	2.49
12	Spain	279	2.05
13	Poland	194	1.42
14	Netherlands	184	1.35
15	Sweden	177	1.30
16	New Zealand	169	1.24
17	Turkey	164	1.20
18	Israel	153	1.12
19	Austria	144	1.06
20	Brazil	127	0.93
21	Belgium	120	0.88
	Total	12066	88.56

The United States of America has contributed 4197 articles (30.80% of the total contributions). The United Kingdom is ranked second in terms of total contribution to the forensic science literature during

the period of study. It has contributed a total of 1511 articles, which is 11.10% of the total contribution. These two countries together have contributed 41.9% of the total forensic science literature output.

Affiliating Institution

Table 7 shows the ten top ranking Institutions of the world in terms of the number of contribution in forensic science literature.

Table 7: Affiliating institution-wise contribution

Rank	Affiliation	Contribution	Percentage of 13626
1	Forensic science Service, Birmingham	196	1.44
2	The FBI Academy	142	1.04
3	Universität Lausanne Schweiz	132	0.97
4	Sichuan University	125	0.92
5	Forensic science Centre, Adelaide	97	0.71
6	FBI Laboratory	93	0.68
7	National Research Institute of Police Science	90	0.66
7	University of Strathclyde	90	0.66
8	Netherlands Forensic Institute	85	0.62
9	University of Adelaide	83	0.60
9	Institute of Forensic Research	83	0.60
10	Michigan State University	80	0.59
	Total	1296	9.49

Forensic Science Service, Birmingham is the highest contributor with 196 articles (1.44%) followed by FBI Academy with 142 articles (1.04%). Except for the sixth ranked FBI Laboratory, all other institutions are either research institutions or educational institutions. The policy of not giving incentives for research publications might be the contributing factor for less scientific productivity among the forensic scientists, as most of them are working in government controlled laboratories (Jones, 1998). Cash incentives, promotions and higher status may give an impetus to research in the government controlled laboratory set-up. This can help in the growth of research publications output and also the impact factor of journals as well as the authors.

CONCLUSION

Forensic science literature has doubled in a period of ten years confirming the statement of Derek de Solla Price. Bruce Budowle is the author who has contributed the highest number of articles. He has received the most number of citations during the period of study and his h-index obtained from *Google Scholar* is as high as 52. *Journal of Forensic Sciences* is the top ranking source journal. It contributes 33% of the total forensic science literature during the period of study. The three journals, *Journal of Forensic Sciences*, *Forensic Science International* and *Science & Justice* contribute almost half of the total forensic science literature. Forensic science literature is found scattered not only in the core journals but also in the journals of other allied subjects. The United States of America has contributed the maximum number of articles. The United Kingdom is the second high productive country. Rest of the world contributes only about 58% of forensic science literature. Most of the contributions come from the educational and research institutions. The FBI Laboratory is the only forensic science laboratory in the top ten contributors. Cash incentives, promotions and higher status may go a long way in promoting research in the government controlled laboratory set-up.

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