

# The Impact of Open Access Contributions: Developed and Developing World Perspectives

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**Abstract:** *The study explores the research impact of 'Open Access research articles' across the globe with a view to test the hypothesis that "OA research contributions emanating from developing countries receive equal citations (subsequently resultant research impact) as those from the developed world". The study covers 5639 research articles from 50 Open Access DOAJ based Medical Sciences journals covering the period from 2005 to 2006. The research impact of OA research publications measured by the citation counts varies from journal to journal and from country to country. Statistically significant difference is noted between the research impact of the developed and the developing world for OA research articles. The research articles from the developed countries receive higher number of citations (subsequently resultant research impact) compared to those of the developing world. The study may help and pave way for framing policies and strategies to increase the impact of research in the developing world.*

**Keywords:** *Open Access; research impact; DOAJ.*

## Introduction

Open Access (OA) to scientific literature means removal of barriers (including price barriers) from accessing scholarly work (Eysenbach, 2006). Open Access to scholarly literature has received increasing attention in the academic, research and publishing circles over the last decade and is a hot topic for deliberations and discussions. Many scholars, organizations and institutions across the globe are working towards the cause, as a result of which more and more of the scholarly literature is becoming openly accessible. The growth of OA movement is particularly in response to the enormous costs of many scholarly journals. With traditional journal publication methods, it is not uncommon for an institution to have to pay for an article twice. First they pay scholars to produce the work and then the institution pays to purchase the work back from the journal publisher (Corrado, 2005). In this situation, the open access movement gains worldwide support as an alternative and sustainable model of scholarly communications and accessing research literature. The number of OA journals publishing high quality, peer-reviewed research is growing. SPARC and SPARC Europe are in partnership with a number of these journals (Prosser, 2004). This is evident from DOAJ (Directory of Open Access Journals), listing fully peer-reviewed OA journals when launched in May 2003 with 375 items, now figure over with 6271 in 2011.

Giving all interested readers access accelerates research, enriches education, sharing learning among rich and poor nations and ultimately enhance return on investment in research (much of which comes from the world's tax payers) (Prosser, 2004). The developed world consists of information rich countries, enterprises and organizations. These enterprises control over the valuable information resources. The developing world is at the critical junctions where the development of technologies, economics and humanity largely depends on access to relevant and adequate information resources. The developing world consist of information poor least-developed countries, where the research institutions cannot afford to subscribe a wide array of primary literature due to resources crunch or limited budgetary provisions. As such, for the developing world open access movement has come as a boon (Ghosh & Das, 2006). Hence, the present study endeavors to make a comparative study of

research impact of OA articles between the developed and the developing world through citation analysis.

## Review of Literature

The failure of traditional scholarly communication model led to the development of institutional repositories (IRs) and OA journals (Prosser, 2003), as they can better serve the international research community by providing a fairer, more equitable and more efficient system of scholarly communication (Prosser, 2004). The OA journals and OA repositories are steps towards democratization of information and knowledge as they remove access restrictions (Ylotis, 2005). It is due to these benefits that OA is gaining momentum with support from library and professional groups, university faculties and even journal publishers (Falk, 2004), and is bringing great benefits to the academic world (McCulloch, 2006).

Open Access enriches the global knowledge base by incorporating the missing research from the developing world and improves the global knowledge flow (Chan & Costa, 2005), and at the same time it connects the developing world to the system of science by providing access to scientific literature published in the developed world (Haider, 2007). As a result, developing countries have embraced OA with a view to promoting the visibility of research done in these regions (Fernandez, 2006). The majority of authors in the developing world are not well informed on how they could enhance the visibility of their publications (Ramachandran & Scaria, 2004). However with the passage of time the proportion of authors publishing in OA journals has grown from 11% in 2004 to 29% in 2005 (Rowlands & Nicholas, 2005). As it is now well established that OA makes research papers more visible and increases their research impact (Lawrence, 2001; Antelman, 2004; Harnad & Brody, 2004; Hajjem, Harnad, & Gingras, 2005; Eysenbach, 2006; Hajjem, Gingras, Brody, Carr & Harnad, 2005), although with variations across disciplines (Tonta, Unal, & Al, 2007; Shafi, 2008; Shafi & Bhat, 2008).

## Problem

The research carried out in developing countries representing 80 percent of the world's population is largely invisible to international science because of economic constraints. It is believed that the low research impact of research output of the developing countries is due to its poor visibility (Fernandez, 2006). The OA has overcome that barrier between the developing and the developed world to a large extent. However, it remains to be seen whether the OA research contributions from the developing world receive the same amount of citations (and the resultant research impact) as those from the developed world especially during the recent decade.

## Objectives

The following objectives are put forth for the study:

- To assess the research impact of OA journal articles across countries;
- To compare the research impact of OA journal articles across developed and developing world;
- To verify the hypothesis drawn.

## Scope

The scope of the study is limited to Open Access articles appearing in English language 'OA' journals in the field of Medical Sciences, as it has been found that Open Access journals are much popular in the field of Medical Sciences, in comparison to other fields (Bhat, 2008; Bhat, 2009).

## Methodology

The directory of Open Access journals ([www.doaj.org](http://www.doaj.org)) is used to select OA journals in the field of Medical Sciences. DOAJ listed 416 journals in this field (January, 2011). Mono-lingual (English

language) journals having back issues available since 2005 reduced the number to 142 journals (93 from the developed world and 49 from the developing world). 25 journals from each group were selected randomly using function “sample” of ‘R’ software (R Development Core Team, 2011). The classification of countries into developed and developing economies is taken from UN Human Development Index and IMF report.

The total number of articles published in OA journals in 2005 and 2006 were identified for all the 50 journals. The articles of each journal were arranged in chronological order, and a sample of 10 articles (five each from year 2005 and 2006) is randomly selected using function “sample” of ‘R’ software (R Development Core Team, 2011), thereby making a total of 500 articles (250 articles from each group).

With a view to show the evidence of broader international research impact beyond the indexed journals, Google Scholar is used for finding the citations instead of WOS and Scopus databases (although all the 50 journals covered by the study were found indexed in Scopus and some in WOS). It has been found that Google Scholar provided the largest citations compared to WOS and Scopus for recent articles of Journal of American Society for Information Science and Technology (Baur & Bakkalbasi, 2005). Also Google Scholar provided the highest number of unique citations for current oncology articles (Bakkalbasi, Baur, Glover, & Wang, 2006).

All the 500 articles were searched in Google Scholar for citations (March, 2011). The number of citations were recorded for each article (Table 1). The data is tabulated and analysed in a systematic order to reveal findings in accordance with the laid down objectives. Different standard statistical techniques are used to estimate various statistical tests and verification of hypothesis.

Table 1. Sampling statistics

S. No.	Country Group	No. of journals in DOAJ back issues since 2005	No. of OA journals (having in sample)	No. of articles			No. of articles taken for sample
				2005	2006	Total	
1.	Developed	93	25	888	1318	2206	250 (11.3)
2.	Developing	49	25	1633	1800	3433	250 (7.3)
	Total	142	50	2521	3118	5639	500 (8.9)

(The numbers in parentheses indicate percentage)

## Hypothesis

The present study focuses to test the hypothesis “OA research contributions emanating from developing countries receive equal citations (subsequently resultant research impact) as those from the developed world”.

## Results and Discussion

The total number of citations received by 500 Open Access research articles is 4543 (Mean=9.08, S.D.=14.95). The distribution of citations among the research articles is somewhat skewed as the Standard Deviation is greater than Mean (Table 2). Out of 500 research articles, 124 received no citations and 54 did one citation each. Out of 4543 citations, 1131 (24.89%) are recorded by just 20 OA research publications (Table 5 & 6).

Table 2. Citation count of OA articles

S. No.	Country Group	No. of articles			Sample	Citations	Mean	S.D.
		2005	2006	Total				
1.	Developed	888	1318	2206	250	3344	13.37	18.25
2.	Developing	1633	1800	3433	250	1199	4.79	8.81
	Total	2521	3118	5639	500	4543	9.08	14.95

The 250 research papers from 25 OA journals of the developed world received 3344 citations (Mean=13.37, S.D.=18.25). The average number of citations varies from 0.1 for *Acta Medica Nagasakiensia (Japan)* to 29.5 for *BMC Medical Informatics and Decision Making (UK)*. The standard deviation also varies from journal to journal with *Acta Medica Nagasakiensia (Japan)* having S.D. of 0.31 on one hand and *BMC Medical Research Methodology (UK)* having S.D. of 38.03 on the other hand. Out of 25 journals, 14 journals have S.D. greater than Mean. Forty-six (out of 250) articles received no citations and 8 articles received one citation each (Table 3). Ten research papers generated almost a quarter (22.51%, or 753 citations) of all citations (Table 5).

Table 3. Citation count of OA articles (Developed World Group)

S. No	Journal Title	Country	Number of articles			n	Cit.	X	S.D.
			2005	2006	Total				
1.	Acta Medica Nagasakiensia	Japan	30	35	65	10	1	0.1	0.31
2.	Archives of Medical Science	Poland	31	39	70	10	20	2.0	2.49
3.	Biomedical Research	Japan	40	39	79	10	8	0.8	1.47
4.	BMC Complementary and Alternative Medicine	UK	21	41	62	10	143	14.3	8.06
5.	BMC Medical Genetics	UK	43	88	131	10	203	20.3	21.58
6.	BMC Medical Informatics and Decision Making	UK	38	40	78	10	295	29.5	24.41
7.	BMC Medical Research Methodology	UK	37	61	98	10	246	24.6	38.02
8.	Cell Communication and Signaling	UK	14	8	22	10	73	7.3	5.86
9.	Communicable diseases intelligence	Australia	53	51	104	10	44	4.4	4.92
10.	Head & Face Medicine	UK	14	48	62	10	59	5.9	5.25
11.	International Journal of Behavioral Nutrition and Physical Activity	UK	16	44	60	10	276	27.6	19.62
12.	Journal of Applied Clinical Medical Physics	USA	41	38	79	10	59	5.9	8.15
13.	Journal of Biomedicine and Biotechnology	USA	38	22	60	10	174	17.4	18.66
14.	Journal of Circadian Rhythms	UK	15	16	31	10	38	3.8	3.04
15.	Journal of International Medical Research	UK	81	87	168	10	89	8.9	14.81
16.	Journal of Medical Internet Research	Canada	31	19	50	10	278	27.8	16.62
17.	Journal of Medical Investigation	Japan	48	41	89	10	47	4.7	4.05
18.	Journal of Negative Results in BioMedicine	UK	12	19	31	10	87	8.7	10.43
19.	Journal of Neuroinflammation	UK	29	33	62	10	80	8.0	7.54
20.	Journal of the American Board of Family Medicine	USA	52	65	117	10	270	27.0	13.49
21.	Korean Journal of Radiology	S. Korea	46	47	93	10	153	15.3	22.49
22.	Molecular Pain	UK	36	38	74	10	220	22.0	21.91
23.	Morbidity and Mortality Weekly Report (MMWR)	USA	11	266	277	10	262	26.2	33.46
24.	Upsala Journal of Medical Sciences	Sweden	19	27	46	10	59	5.9	9.97
25.	Virology Journal	UK	92	106	198	10	160	16.0	12.00
Total			888	1318	2206	250	3344	13.37	18.25

1199 citations are received by 250 articles of 25 OA journals from the developing world (Mean=4.79 & S.D. =8.81). The standard deviation varies from journal to journal (with 0.42 for the *Journal of Research in Medical Sciences, Iran* to 26.62 for the *Brazilian Journal of Medical and Biological Research, Brazil*), as also the average number of citations (with 15.6 for *Brazilian Journal of Medical and Biological Research, Brazil* to 0.2 for *Journal of Research in Medical Sciences, Iran*) (Table 4).

For the 15 journals (out of 25) the S.D. is higher than the Mean. Seventy-eight papers received no citations and 46 did one citation each. Ten research papers generated almost one third (31.52%, or 378 citations) of all citations (Table 6)

Table 4. Citation count of OA articles (Developing world group)

$s_i$ No	Journal Title	Country	No. of articles			$n$	Cit.	$X$	S.D.
			2005	2006	Total				
1.	Acta Medica Iranica	Iran	86	90	176	10	8	0.8	1.54
2.	African Health Sciences	Uganda	54	47	101	10	79	7.9	5.85
3.	African Journal of Health Sciences	Kenya	8	30	38	10	14	1.4	1.77
4.	Annals of African Medicine	Nigeria	34	42	76	10	12	1.2	1.13
5.	Biological Research	Chile	37	54	91	10	107	10.7	9.93
6.	Brazilian Journal of Medical and Biological Research	Brazil	200	170	370	10	156	15.6	26.62
7.	Chinese Medical Journal	China	197	217	414	10	84	8.4	7.91
8.	Clinics	Brazil	50	61	111	10	130	13.0	7.64
9.	Croatian Medical Journal	Croatia	96	76	172	10	111	11.1	14.53
10.	European Journal of General Medicine	Turkey	39	43	82	10	7	0.7	1.25
11.	Indian Journal of Medical Research	India	97	110	207	10	83	8.3	5.85
12.	Indian Journal of Medical Sciences	India	54	38	92	10	43	4.3	3.43
13.	Indian Journal of Palliative Care	India	20	8	28	10	25	2.5	3.77
14.	Iranian Biomedical Journal	Iran	32	33	65	10	18	1.8	2.20
15.	JK Science	India	45	41	86	10	9	0.9	0.99
16.	Journal of Medical Sciences	Pakistan	70	187	257	10	5	0.5	1.26
17.	Journal of Postgraduate Medicine	India	34	32	66	10	77	7.7	10.95
18.	Journal of Research in Medical Sciences	Iran	72	58	130	10	2	0.2	0.42
19.	Journal of the Association of Physicians of India	India	88	102	190	10	36	3.6	3.20
20.	Kathmandu University medical journal	Nepal	71	91	162	10	19	1.9	4.01
21.	Malaysian Journal of Medical Sciences	Malaysia	16	22	38	10	8	0.8	1.31
22.	Online Journal of Health and Allied Sciences	India	16	21	37	10	12	1.2	1.22
23.	Pakistan Journal of Medical Sciences	Pakistan	91	91	182	10	25	2.5	2.27
24.	Revista do Instituto de Medicina Tropical de Sao Paulo	Brazil	70	71	141	10	121	12.1	11.76
25.	Turkish Journal of Medical Sciences	Turkey	56	65	121	10	8	0.8	1.54
Total			1633	1800	3433	250	1199	4.79	8.81

The research articles from developed countries have received almost three times more citations than those from the developing nations. The journals from USA and UK have received more citations than those from Japan, Poland, Australia, and Sweden within the developed nations group. A few journals from the developing world have also received double digit mean citations. These include journals from the countries like Chile, Brazil and Croatia. It is interesting to note that the lowest research impact journal in the study is from a developed country i.e., Japan (*Acta Medica Nagasakiensis*).

The research impact of OA research publications varies a great deal from journal to journal and from country to country within the group. Whereas OA journals from the developing world have emerged during the last decade, most of the OA journals from the developed world are well established, and have lately switched to Open Access mode with their clientele. The OA research papers from the developing countries despite lagging behind their counterparts' vis-à-vis research impact have shown

good performance (which would not have been possible without Open Access). With improvement in quality of research in developing countries (as a result of economic development and liberal allocation of funds for R & D activities), the situation is going to improve further in the future.

Table 5. Top ten most cited articles (Developed world group)

$\mathcal{N}$	Article title	Country	Journal Title	Cit.
1.	Evaluation of QUADAS, a tool for the quality assessment of diagnostic accuracy studies/Penny F Whiting, Marie E Weswood, et al./ V6/ 2006	UK	BMC Medical Research Methodology	126
2.	Surveillance for Dental Caries, Dental Sealants, Tooth Retention, Edentulism, and Enamel Fluorosis --- United States, 1988--1994 and 1999--2002/ 2005	USA	Morbidity and Mortality Weekly Report (MMWR)	106
3.	IT-adoption and the interaction of task, technology and individuals: a fit framework and a case study/Elske Ammenwerth, Carola Iller, Cornelia Mahler/ V6/ 2006	UK	BMC Medical Informatics and Decision Making	73
4.	Cytogenetic abnormalities and fragile-x syndrome in Autism Spectrum Disorder/ Kavita S Reddy/ V6/ 2005	UK	BMC Medical Genetics	72
5.	False Positive and False Negative FDG-PET Scans in Various Thoracic Diseases /JM Chang, HJ Lee et al/ V7/ 2006	S. Korea	Korean Journal of Radiology	72
6.	Neuropathic pain develops normally in mice lacking both Nav1.7 and Nav1.8 /Mohammed A Nassar, Alessandra Levato, et al./ V1/ 2005	UK	Molecular Pain	71
7.	Dicer-Derived MicroRNAs Are Utilized by the Fragile X Mental Retardation Protein for Assembly on Target RNAs/ Isabelle Plante, Laetitia Davidovic, et al./ 2006	USA	Journal of Biomedicine and Biotechnology	66
8.	Extracting principal diagnosis, co-morbidity and smoking status for asthma research: evaluation of a natural language processing system/ Qing T Zeng, Sergey Goryachev, et al./ V6/ 2006	UK	BMC Medical Informatics and Decision Making	59
9.	Internet Interventions for Long-Term Conditions: Patient and Caregiver Quality Criteria/C Kerr, E Murray et al/ 7/ 2006	Canada	Journal of Medical Internet Research	55
10.	Pulmonary Hypertension Surveillance --- United States, 1980--2002/ 2005	USA	Morbidity and Mortality Weekly Report (MMWR)	53

Table 6. Top ten cited articles (Developing world group)

$\text{S. No.}$	Article	Country	Journal Title	Cit.
1.	Geographic distribution of hepatitis C virus genotypes in Brazil/ Campiotto, S.; Pinho, J.R.R.; et al./ V38/ 2005	Brazil	Brazilian Journal of Medical and Biological Research	89
2.	Challenges of DNA Profiling in Mass Disaster Investigations/ Antonio Alonso, Pablo Martín, et al. /V46/ 2005	Croatia	Croatian Medical Journal	46
3.	Conversion from laparoscopic to open cholecystectomy: Multivariate analysis of preoperative risk factors/ M Tayeb, SA Raza et al./ V51/ 2005	India	Journal of Postgraduate Medicine	38
4.	Posaconazole treatment of refractory eumycetoma and chromoblastomycosis/ Negroni, Ricardo; Tobón, Angela; et al /V47/ 2005	Brazil	Revista do Instituto de Medicina Tropical de Sao Paulo	35
5.	A Rapid and Efficient Method for Purifying High Quality Total RNA from Peaches ( <i>Prunus persica</i> ) for Functional Genomics Analyses/ Meisel, Lee; Fonseca, Beatriz; et al/ V38/ 2005	Chile	Biological Research	32
6.	Evolutionary standard base excess and serum lactate level in severe sepsis and septic shock patients resuscitated with early goal-directed therapy: still outcome markers?/ Park, Marcelo; Azevedo, Luciano Cesar Pontes; et al./ V61/ 2006	Brazil	Clinics	30
7.	Depressive Symptomatology among University Students in Denizli, Turkey: Prevalence and Sociodemographic Correlates/ Mehmet Bostanci, Osman Ozdel, et al./ V46/ 2005	Croatia	Croatian Medical Journal	28
8.	Development and potential of a biomimetic chitosan/type 60 collagen scaffold for cartilage tissue engineering / SHI De-hai, CAI Dao-zhang, et al./ V118/ 2005	China	Chinese Medical Journal	28
9.	Blastocystis hominis and other intestinal parasites in a community of Pitanga City, Paraná State, Brazil/ Nascimento, Solange Aparecida; Moitinho, Maria da Luz Ribeiro/ V47/ 2005	Brazil	Revista do Instituto de Medicina Tropical de Sao Paulo	27
10.	Molecular and pathological basis of aceruloplasminemia/ Kono, Satoshi; Miyajima, Hiroaki/ V39/ 2006	Chile	Biological Research	25

## Testing Hypothesis

The Chi square ( $\chi^2$ ) test is carried out to test the null hypothesis “OA research contributions emanating from developing countries receive the equal citations (subsequently resultant research impact) as those from the developed world”.

$$\chi^2 = \sum (O-E)^2/E$$

E = Expected citations

O = Observed citations

The value of  $\chi^2$  is 1012.73. At 1 df (degree of freedom) this is highly significant at .05 level of significance. Thus the null hypothesis “OA research contributions emanating from developing countries receive equal citations (subsequently resultant research impact) as those from the developed world” is rejected and it is concluded that OA research contributions emanating from developing countries receive fewer citations (subsequently resultant research impact) as those from the developed world.

## Conclusion

The research impact of Open Access research articles varies from country to country and from journal to journal within countries. The research papers from the developed countries receive more citations (and the resultant research impact) compared to research publications from the developing countries.

Since the present study is limited to OA research publications in the field of Medical Science, there is a need to verify the trend on a large canvas covering different disciplines, including Social Sciences. As the visibility problem has no relevance in the Open Access environment, the underlying factors for low research impact of research papers from the developing world need to be ascertained and rectified. The reasons could be many like the quality of research, peer review system, etc. It may also be due to the fact that a large number of authors from the developing countries still prefer well established journals from the developed world for disseminating their research output. Besides Open Access, rigorous peer review standards will have to be enforced by the journals emanating from the developing world to ensure maximal research impact of their publications at par with their counterparts in the developed world.

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