

A bibliometric analysis of diarrhoeal disease research in Bangladesh

Asma Khatun¹ and S.M. Zabeed Ahmed²

¹M.Phil. Programme, Department of Information Science and Library Management, University of Dhaka, Dhaka, Bangladesh, Email: muckta_202@yahoo.com

²Professor, Department of Information Science and Library Management, University of Dhaka, Dhaka, Bangladesh, Email: smzahmed@yahoo.com

Quantitative analysis is carried out to identify the literature growth, authorship pattern, collaboration and journal distribution on diarrhoeal disease research in Bangladesh based on data obtained from *PubMed*, *Web of Science* and *Scopus* databases. Well-established bibliometric laws, such as Lotka's law and Bradford's law are employed to further explore the characteristics of diarrhoeal literature. Bradford-Zipf distribution is applied to determine the core journals on diarrhoeal disease research in Bangladesh. Moreover, a comparison was made to determine the strength of diarrhoeal research in Bangladesh using *h-index* on bibliographic data from *Scopus*. The result shows increasing R&D activities on diarrhoeal research in Bangladesh. Lotka's law and Bradford distribution do not apply to diarrhoeal disease research in Bangladesh. The *h-index* count indicates that Bangladesh tops the diarrhoeal research impact list in South Asia region.

Introduction

Bangladesh is the seventh most populous country in the world and the population is increasing at an annual growth rate of 1.6 percent¹. With a land area of 143,998 sq. km., it is one the most densely populated countries in the world (1,127 persons per sq. km.). Agriculture is the main occupation in Bangladesh which provides employment to about three-quarters of its population. The country often faces natural disasters causing acute disruption in the food supply resulting in severe malnutrition of the most vulnerable groups. An estimated 50 percent of the total population in Bangladesh suffers from malnutrition. This particularly affects women and young children and nearly half of all children under six years show some symptoms of chronic malnutrition². The deplorable condition of public health is one of the major drawbacks hindering the overall development of the country.

The rural population represents about 75 percent of the total population in Bangladesh. The vast majority of them face poverty and lack hygiene. The housing conditions are deplorable and most people lack proper knowledge for healthcare and hygienic practices. Despite the fact that 85 percent of the rural population have access to hand pump water (tube well) within 150 meters of their households, 97 percent people use it for drinking purpose and 26 percent use it for all

domestic purposes, and only 46 percent wash their hands properly before taking meal and after defecation³. On the other hand, only 32 percent people in rural areas have access to improved sanitation facilities⁴. The lack of hygienic and environmental sanitation practices combined with limited use of safe water, constantly threat public health of the country. About 80 percent of all diseases are related to unclean water to which children are found to be most vulnerable. An estimated 21 percent of all deaths among children under five are related to diarrhoea in Bangladesh⁵.

Bibliometrics, a term introduced by Pitchard⁶, uses mathematics and statistical techniques to quantify productivity distribution and yield of communication output and allows for predicting and studying scientific progress. A bibliometric study on diarrhoeal disease research in Bangladesh is not yet available. Therefore, this study was conducted to understand Bangladesh's strength and capability in diarrhoeal disease research. It examines the growth of diarrhoeal disease research in Bangladesh over time and identifies the degree of collaboration, prolific researchers, authorship pattern and core journals. Finally, the *h-index* for diarrhoeal research in Bangladesh and that of its neighbouring countries was computed to find out the strength of the research outputs.

Objectives of the study

This paper aims to apply bibliometric techniques to analyze the growth and size of diarrhoeal disease research in Bangladesh: The objectives of the study are:

- To find out authorship collaboration and prolific authors;
- To examine Lotka's law using full productivity of authorship;
- To find out the core journals using Bradford distribution; and
- To calculate the *h*-index for diarrhoeal research in South Asian countries.

Methodology

This study analyzed only periodical articles on diarrhoeal disease research in Bangladesh. The articles were identified from *PubMed* (National Library of Medicine), *Web of Knowledge's Current Contents Connect* (Thomson Reuters) and *Scopus* (Elsevier). Data for the period 1971–2009 were downloaded for analysis. The search terms used to retrieve citations from *PubMed* were Bangladesh AND diarrhea. Both Bangladesh and diarrhea are MeSH terms and were used to retrieve maximum and relevant records from the database. For *Web of Knowledge* and *Scopus*, the search terms used were Bangladesh AND diarrh* as topic and keywords respectively. The total number of retrieved records was 1,521 (*PubMed* 488; *Web of Knowledge* 419; and *Scopus* 614). As the data were from three sources, duplicate records were removed and 711 unique records were retained for analysis.

Quantitative data on the literature growth, authorship pattern, collaboration, prolific authorship and journal distribution were calculated. Authorship collaboration is determined by the following formula⁷:

$$C = N_m / (N_m + N_s)$$

where,

C = degree of collaboration in a subject;

N_m = number of multiple-authored papers published during a period of time;

N_s = number of single-authored papers published during the same period.

We applied least squares (LS) and maximum likelihood (ML) methods to examine Lotka's Law⁸. Only personal authors were considered for the analysis. Authors were given "full credit" for every publication in which his or her name appears. Bradford's Law⁹ was applied to analyze the scattering of papers in different journals. Moreover, Bradford-Zipf distribution¹⁰ was employed to determine the core journals on diarrhoeal disease research in Bangladesh. For Bradford-Zipf, the columns were calculated as follows: column A – journal rank (i.e., 1 being the most productive journal; 2 the second most productive and so on), column B - number of submissions to the given journal title and column C – cumulative submission of articles, Column A was then plotted against column C using semi-log paper. Finally, *Scopus's* citation tracker was used to count the *h*-index of diarrhoeal research in Bangladesh and that of its neighbouring countries.

Results

Literature growth

This study found out 711 articles published during the period 1971-2009. Table 1 shows three-yearly distribution of diarrhoeal disease research in Bangladesh. The growth was slow initially but gradually picked up over time. From 1980 onwards, the number of articles increased sharply. An average of 18.23 articles were published per year.

Authorship pattern

A total of 1489 authors produced 711 papers with an average of 2.09 authors per article. The author data indicate that the authorship collaboration has gained momentum since the early 1980s. Table 2 demonstrates the degree of collaboration among diarrhoeal disease researchers of Bangladesh. There was no single-authored paper published during 2007-2009.

Table 3 lists the prolific authors identified in this study who produced twenty or more papers in the field. Most of these authors, however, were affiliated to International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B), an international health research institute located in Dhaka. ICDDR,B is a leading research institute on diarrhoeal disease and has been credited for its innovative works in

Table 1—Three-yearly distribution of articles

Year	No. of articles	Cumulative no. of articles	Percentage of articles	Cumulative percentage
1971-1973	4	4	0.56	0.56
1974-1976	10	14	1.41	1.97
1977-1979	10	24	1.41	3.38
1980-1982	34	58	4.78	8.16
1983-1985	43	101	6.05	14.21
1986-1988	51	152	7.17	21.38
1989-1991	62	214	8.72	30.10
1992-1994	66	280	9.28	39.38
1995-1997	38	318	5.34	44.73
1998-2000	49	367	6.89	51.62
2001-2003	90	457	12.66	64.28
2004-2006	105	562	14.77	79.04
2007-2009	149	711	20.96	100.00

Table 2—Degree of collaboration

Year	No. of multi-authored paper (N_m)	No. of single authored paper (N_s)	$N_m + N_s$	C
1971-1973	3	1	4	0.75
1974-1976	8	2	10	0.80
1977-1979	7	3	10	0.70
1980-1982	28	6	34	0.82
1983-1985	35	8	43	0.81
1986-1988	43	8	51	0.84
1989-1991	55	7	62	0.89
1992-1994	58	8	66	0.88
1995-1997	34	4	38	0.89
1998-2000	46	3	49	0.94
2001-2003	87	3	90	0.97
2004-2006	99	6	105	0.94
2007-2009	149	0	149	1.00
	652	59	711	

Table 3—Prolific authors (1971-2009)

Rank	Author Name	No. of contributions
1	Faruque A S	99
2	Sack D A	65
3	Fuchs G J	62
4	Nair G B	50
5	Black R E	49
6	Qadri F	43
7	Baqi A H	42
8	Salam M A	41
9	Albert M J	38
10	Sack R B	34
11	Yunus M	34
12	Faruque S M	33
13	Mahalanabis D	32
14	Roy S K	27
15	Zaman K	27
16	Alam N H	25
17	Clemens J D	24
18	Rahman M	22
19	Talukder K A	20
20	Wahed M A	20

developing oral rehydration solution (ORS) and zinc therapy in treating diarrhoea in the developing countries. The Centre has also been playing a key role in knowledge diffusion and creating awareness among rural dwellers about how to treat diarrhoeal patients. As a result, a villager even in the remotest area in Bangladesh now knows how to make a simple oral saline at home and about its availability in small village shops or tea stalls.

Author productivity and Lotka's law

Lotka's law describes the frequency of publications by the authors in a given subject¹¹. Table 4 presents author productivity data for Lotka's law. Of the 1489 unique author names, 904 (60.71%) produced one article, 238 (15.98%) produced two articles, 109 (7.32%) produced three papers and so forth. The number of authors who produced more than ten articles is quite small (only 4.43%) and hence has not been considered.

Using least-squares method,^{12,13} the values of n and C are found to be 2.0362 and 0.6203 respectively. The ML fitted method,¹⁴ using Lotka Program¹⁵ found n and C values as 2.2307 and 0.6795 accordingly (Figure 1). The follow-up Kolmogorov-Smirnov tests¹⁶ for both methods, however, show that the literature does not follow the original Lotka distribution. Hence, we conclude that Lotka's law of scientific productivity does not apply to diarrhoeal disease research of Bangladesh.

Table 5 shows that the majority of journals 99 (65.55%) were published in the USA and UK. There were six countries which had only one journal publishing in the area. Although diarrhoea is a major

disease in Bangladesh, only four journals were published in this area.

Bradford's law distribution and core journals

Bradford stated that "if scientific journals are arranged in order of decreasing productivity of articles on a given subject, they may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucleus, when the numbers of periodicals in the nucleus and succeeding zones will be as 1:n:n²..."¹⁷

The journal distribution shows that there was a tremendous scattering of literature in the subject. The data show that the first zone or nucleus contains eight journals which covered about one-third of the total papers, followed by second zone with 20 journals accounted for another one-third and the third zone with 123 journals covered the remaining third. The scattering of papers in various journals with eight journals representing the nucleus and $n=2.25$ as multiplier, however, does not follow Bradford distribution as shown in Table 6. Figure 2 shows the Bradford-Zipf's plot for journal ranks and their cumulative number of publications on diarrhoeal research in Bangladesh during 1971-2009.

Altogether there were 151 journals represented by the 711 papers. Out of these, 22 journals published ten or more papers, 36 journals published three to nine papers, and the remaining 118 papers are scattered among 93 journals (Table 7). In a Bradford-Zipf distribution, core journals are those that lay on the initial curved part of the "S"-shaped plot until it tangentially becomes a straight line. Here, in Figure 1, the slope of the curve also decreases slightly after the

Table 4—Author productivity for Lotka's law

No. of articles	No. of authors	Estimated with $n=2.0362$	LS $n=2.0362$ (standardized)	Estimated with ML $n=2.2307$	ML $n=2.2307$ (standardized)
1	904	904.00	931.34	904.00	997.43
2	238	220.40	227.06	192.60	212.51
3	109	96.53	99.45	77.96	86.01
4	54	53.73	55.36	41.03	45.28
5	38	34.11	35.15	24.94	27.52
6	24	23.53	24.25	16.61	18.33
7	24	17.19	17.71	11.78	12.99
8	9	13.10	13.50	8.74	9.65
9	16	10.31	10.62	6.72	7.42
10	7	8.32	8.57	5.31	5.86
	1423	1381.23	1423.00	1289.70	1423.00

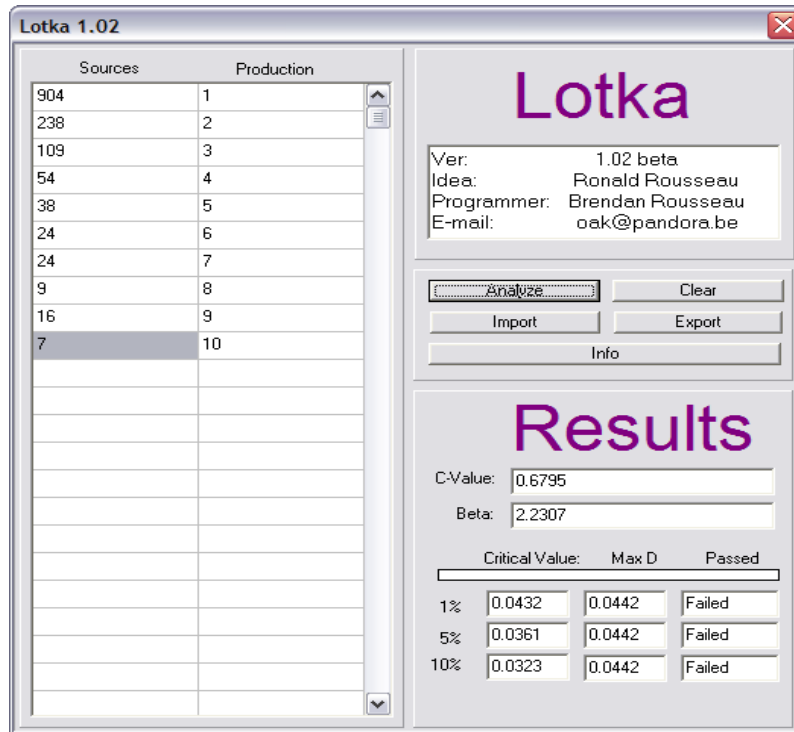


Fig. 1—Lotka program for analyzing diarrhoeal disease research in Bangladesh

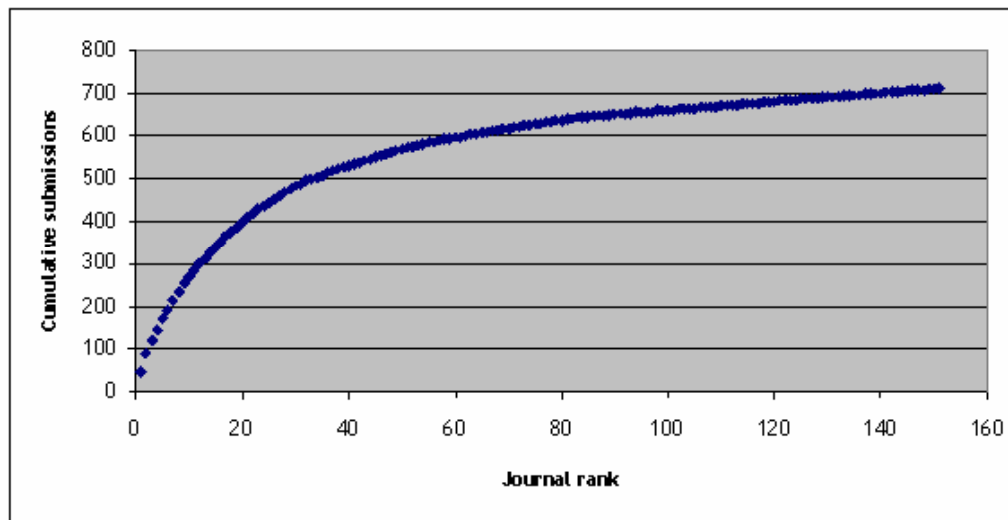


Fig. 2—Bradford-Zipf's distribution

8th journal, so these journals may be regarded as the core journals on diarrhoeal research of Bangladesh.

Scopus and h-index

The *h*-index¹⁸ is used to measure both the scientific

productivity and the apparent impact of such productivity. Although *h*-index is generally applied to quantify the scientific output of a single researcher^{19,20}; Rousseau²¹ argued that the index can also be applied to any publication set. The *h*-index

Table 5—Geographical distribution of journals

Country	No. of journals	Percentage of journals	No. of articles	Percentage of articles
Australia	2	1.32	4	0.56
Bangladesh	4	2.64	88	12.38
Belgium	1	0.66	1	0.14
Brazil	2	1.32	2	0.28
Canada	3	1.98	4	0.56
Germany	4	2.64	6	0.84
Hong Kong	1	0.66	2	0.28
India	5	3.31	10	1.40
Italy	1	0.66	1	0.14
Japan	2	1.32	5	0.70
Netherlands	20	13.24	49	6.89
Pakistan	1	0.66	1	0.14
Saudi Arabia	2	1.32	2	0.28
Sweden	1	0.66	1	0.14
Switzerland	2	1.32	19	2.67
Thailand	1	0.66	8	1.12
UK	30	19.86	182	25.60
USA	69	45.69	326	45.85
	151	100.00	711	100.00

Table 6—Scattering of papers in journals

Zone	No. of papers	Observed no. of journals	Estimated no. of journals
1st	234	8	8
2nd	234	20	20
3rd	243	123	50

can be automatically calculated for a result list in most citation databases. Depending on what publications a database covers and analyzes, the calculation of *h*-index will produce different results. Since most citations were retrieved from *Scopus*, its citation tracker was used to count *h*-index for journal articles published on diarrhoeal disease of Bangladesh and its neighbouring countries (Table 8).

Discussion

While the developed countries have made substantial progress in controlling diarrhoeal disease in terms of health education, resources and manpower, they still lag behind. Countries like Bangladesh, with lack of safe water and poor sanitation, have long experienced the devastating state of mortality and morbidity due to diarrhoeal diseases. Controlling the fatal causes of mortality due to diarrhoeal diseases has now become

a chief concern of policy makers, health planners and researchers around the developing world. This has warranted further intensive research efforts to know more about currently known agents and new agents which cause or may cause diarrhoeal disease and to develop better ways and means for its treatment and control.

The growth of diarrhoeal disease research in Bangladesh indicates the increased R&D activities in the country from the early 1980s. Although there is a steady growth in the number of papers over the period of 1980-2009, still problems lie with the number of institutions involved in diarrhoeal disease research in the country and the number of locally published journals publishing in this area. The authorship collaboration data shows that the extent of collaboration has steadily increased since the 1980s. In fact, no single-authored article appeared during 2007-2009. The authorship data also indicates

Table 7—Ranking of contributing journals published three or more papers

Rank	Journal title	No. of articles	Cumulative no. of articles	Cumulative percentage
1	<i>Journal of Health, Population and Nutrition</i>	47	47	6.61
2	<i>Journal of Clinical Microbiology</i>	42	89	12.52
3	<i>Journal of Diarrhoeal Disease Research</i>	31	120	16.88
4	<i>Lancet</i>	26	146	20.53
5	<i>Journal of Tropical Pediatrics</i>	24	170	23.91
6	<i>American Journal of Clinical Nutrition</i>	23	193	27.14
7	<i>International Journal of Epidemiology</i>	22	215	30.24
8	<i>Transactions of the Royal Society of Tropical Medicine and Hygiene</i>	19	234	32.91
9	<i>American Journal of Tropical Medicine and Hygiene</i>	18	252	35.44
10	<i>Acta Paediatrica</i>	16	268	37.69
11	<i>Bulletin of World Health Organization</i>	16	284	39.94
12	<i>British Medical Journal</i>	15	299	42.05
13	<i>Journal of Medical Microbiology</i>	14	313	44.02
14	<i>Journal of Infectious Diseases</i>	14	327	45.99
15	<i>Epidemiology and Infection</i>	14	341	47.96
16	<i>Infection and Immunity</i>	12	353	49.65
17	<i>Journal of Tropical Medicine and Hygiene</i>	12	365	51.34
18	<i>American Journal of Epidemiology</i>	11	376	52.88
19	<i>Reviews of Infectious Diseases</i>	11	387	54.43
20	<i>Social Science Medicine</i>	11	398	55.98
21	<i>Tropical and Geographical Medicine</i>	11	409	57.52
22	<i>European Journal of Clinical Nutrition</i>	10	419	58.93
23	<i>Clinical Infectious Disease</i>	9	428	60.20
24	<i>Glimpse</i>	9	437	61.46
25	<i>Bangladesh Medical Research Council Bulletin</i>	8	445	62.59
26	<i>Journal of Medical Virology</i>	8	453	63.71
27	<i>Southeast Asian Journal of Tropical Medicine and Public Health</i>	8	461	64.84
28	<i>Emerging Infectious Diseases</i>	7	468	65.82
29	<i>Journal of Pediatric Gastroenterology and Nutrition</i>	7	475	66.81
30	<i>The Pediatric Infectious Disease Journal</i>	7	482	67.79
31	<i>Archives of Virology</i>	6	488	68.64
32	<i>Tropical Medicine and International Health</i>	6	494	69.48
33	<i>GUT</i>	5	499	70.18
34	<i>Journal of Ethno pharmacology</i>	5	504	70.89
35	<i>Journal of Nutrition</i>	5	509	71.59
36	<i>Pediatrics</i>	5	514	72.29
37	<i>Proceedings of the National Academy of Sciences of the United States of America</i>	5	519	73.00
38	<i>Public Health</i>	5	524	73.70
39	<i>Acta Paediatrica Supplements</i>	4	528	74.26
40	<i>Applied and Environmental Microbiology</i>	4	532	74.82
41	<i>Archives of Disease in Childhood</i>	4	536	75.39
42	<i>Diagnostic Microbiology and Infectious Disease</i>	4	540	75.95
43	<i>Journal of Applied Microbiology</i>	4	544	76.51
44	<i>Journal of Biosocial Science</i>	4	548	77.07
45	<i>Journal of Pediatric</i>	4	552	77.64

Contd...

Table 7—Ranking of contributing journals published three or more papers

Rank	Journal title	No. of articles	Cumulative no. of articles	...
				<i>Contd</i>
				Cumulative percentage
46	<i>Microbiology and Immunology</i>	4	556	78.20
47	<i>VACCINE</i>	4	560	78.76
48	<i>Annals of Tropical Medicine and Parasitology</i>	3	563	79.18
49	<i>Archives of Pediatrics and Adolescent Medicine</i>	3	566	79.61
50	<i>Australian Journal of Experimental Biology & Medical Science</i>	3	569	80.03
51	<i>Digestion</i>	3	572	80.45
52	<i>Health Policy and Planning</i>	3	575	80.87
53	<i>Indian Journal of Medical Research</i>	3	578	81.29
54	<i>Maternal and Child Health Journal</i>	3	581	81.72
55	<i>Nutrition Reviews</i>	3	584	82.14
56	<i>Phototherapy Research</i>	3	587	82.56
57	<i>PLoS Medicine</i>	3	590	82.98
58	<i>Scandinavian Journal of Infectious Diseases</i>	3	593	83.40
-	Other journals	118	711	100.00

Table 8—*h*-index for diarrhoeal research in Bangladesh and neighbouring countries (1971-2009)

Country	No. of citations retrieved	<i>h</i> -index
Bangladesh	614	44
Bhutan	4	3
India	1264	42
Myanmar	42	9
Nepal	94	25
Pakistan	205	19
Sri Lanka	42	10

that twenty authors had twenty or more publications to their credit. Most of them were affiliated to the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) which collaborates with academics and research institutes around the world to address public health-related issues. The authorship data, however, does not follow Lotka's law.

The publication pattern in journals shows that the diarrhoeal disease literature of Bangladesh is widely scattered. The scattering of papers, however, does not follow Bradford distribution. There are a few core journals devoted to diarrhoeal disease research alone. This is the reason why the literature is scattered over numerous journals. The Bradford-Zipf plot reveals core journals in the area, which represents the initial curved part of the "S"-shaped plot. This analysis is useful for collection development which has gained more relevance due to increasing costs of subscribing

and accessing international journals. Among the core journals identified in this study, only one journal is published in Bangladesh (*JHPN*). More local journals are needed which would increase the inspiration of native scientists to publish research in this area. Publication of such specialized journals will be helpful to identify the involvement and interest of the scientific community and practitioners working in the field. These journals also need to be indexed in bibliographic databases and made available online to provide more ready access to their content.

A comparison was made of the diarrhoeal diseases research in Bangladesh with that of its neighbouring countries. Considering the *h*-index scores, it can be said that though the amount of publications on the subject is low but the index indicates that Bangladesh tops the diarrhoeal research impact list in the region. A strong network in the region is now needed as an

important means to share general and technical information among the scientists working on diarrhoeal diseases control and prevention programmes.

Conclusion

Diarrhoeal disease forms one of the major health problems in Bangladesh today because of its high morbidity and mortality rate. This study found that scientific productivity in the field of diarrhoeal diseases experienced a significant rise during the period 1971-2009. With its large population affected by diarrhoea, research output in terms of scientific papers on diarrhoeal disease in Bangladesh needs more focused R&D efforts. Nationwide involvement of academic and research institutions will yield better research output and R&D solutions.

This is the first attempt to apply bibliometric techniques to analyze diarrhoeal disease research in Bangladesh. More research is needed for the purpose of evaluating diarrhoeal research particularly in other South Asian countries. Such studies would be helpful in assessing the strengths and weaknesses of R&D efforts and priorities for diarrhoeal research. Regional and international collaborative projects will produce improved research output and exchange of information in this field.

Acknowledgement

We are grateful to the anonymous referee for the comments and suggestions which we believe have greatly improved the paper.

References

1. Population Reference Bureau, *World Population Data Sheet* (PRB Publications; Washington, DC), 2009.
2. World Bank, *Poverty in Bangladesh: Building on Progress*, Report 24299-BD (Poverty Reduction and Economic Management Sector Unit South Asia Region, World Bank), 2002.
3. NGO Forum for Drinking Water, Social Mobilization for Sanitation Project, 1998. Available at: <http://www.hic-net.org/document.php?pid=2747> (accessed 17 November 2010).
4. World Health Organization, *World Health Statistics 2009*, (WHO; Geneva), 2009.
5. Ibid
6. Pitchard A, Statistical bibliography or bibliometrics, *Journal of Documentation*, 25 (4) (1969) 348-349.
7. Subramanyam K, Bibliometric studies of research collaboration: a review, *Journal of Information Science*, 6 (1983) 33-38.
8. Lotka A J, The frequency distribution of scientific productivity, *Journal of the Washington Academy of Sciences*, 16 (12) (1926) 317-323.
9. Bradford S C, *Documentation* (Crosby Lockwood; London), 1948.
10. Brooks B C, The derivation and application of the Bradford-Zipf distribution, *Journal of Documentation*, 2(1968) 247-265.
11. Lotka A J, *op.cit.*
12. Pao M L, Lotka's law: a testing procedure, *Information Processing & Management*, 21 (4) (1985) 305-320.
13. Pao M L, An empirical examination of Lotka's law, *Journal of the American Society for Information Science*, 37 (1) (1986) 26-33.
14. Nicholls P T, Bibliometric modelling processes and the empirical validity of Lotka's law, *Journal of the American Society for Information Science*, 40 (6) (1989) 379-385.
15. Rousseau B. and Rousseau R., Lotka: a program to fit a power law distribution to observed frequency data. *CYBERmetrics*, 4(2000) (1) paper 4.
16. Burrell Q L, The Kolmogorov-Smimov test and rank-frequency distributions, *Journal of the American Society for Information Science*, 45 (1) (1994) 59.
17. Bradford S C, *op.cit.*
18. Hirsch J E, An index to quantify an individual's scientific research output, *Proceedings of the National Academy of Sciences of the United States of America*, 102 (2005) 16569-16572.
19. Oppenheim C, Using the h-index to rank influential British researchers in Information Science and Librarianship, *Journal of the American Society for Information Science and Technology*, 58 (21) (2007) 297-301.
20. Meho L I and Rogers Y, Citation counting, citation ranking, and h-index of human-computer interaction researchers: a comparison of Scopus and Web of Science, *Journal of the American Society for Information Science and Technology*, 59 (11) (2008) 1711-1726.
21. Rousseau R, New developments related to the Hirsch index, *Science Focus*, 1 (2006) 23-25.