

Biomedical and health sciences publication productivity from Malaysia

Hazmir Zainal* & Awang Ngah Zainab†

*Tun Sri Lanang Library, Universiti Kebangsaan Malaysia and †Faculty of Computer Science & Information Technology, University of Malaya, Malaysia

Abstract

Background: The aim of this study was to examine Malaysian contributions in the field of biomedical and health sciences.

Methods: In this study, 3697 publications affiliated to Malaysian addresses from the SCi database between 1990 and 2005 were sampled. This study also explored publication productivity trends, authorship and collaboration pattern, core journals used, and citations obtained.

Results: Main contributions were journal articles (73.3%). Most authors (63.7%) contributed only one article and 16.1% produced over 30–68 publications. Multi-authored works were the norm. The productive authors were named either first or second in publications. There were active collaborations with authors from Asia-Pacific countries (35%) and Europe (30%). The majority of publications were contributed by institutions of higher learning (87%). Core journals used follow quite close to Bradford's zonal ratios of 44:152:581. The active research areas were identified. About 71.3% of publications received citations especially those published from 1995 to 1999.

Conclusion: This study helped librarians identify active researchers, active research areas and journals relevant to biomedical and health sciences researchers and useful when producing reports to university management and planning medical collection policies and deciding on journal subscriptions and cancellations.

Keywords: bibliometrics, citation analysis, health sciences, medicine, publication productivity.

Key Messages

Implications for Practice

- Publication productivity of faculty in mainstream journals is useful for university administrators when evaluating university performance yearly or over a range of years. The generation of this information is often entrusted to librarians.
- Bibliometrics report produced by librarians in a field is used by university management to justify decisions for new appointments, contract renewals, tenureship, and annual incentives.
- Identifying core journals in a field help librarians determine the extent of use, and when compared with existing holdings and journal cost can be used to decide on new subscription and cancellation.
- Librarians could design support service based on research groups indicated by the analysis of articles among fields of research.

Implication for Policy

- Skills in applying bibliometrics to produce reports for management is becoming necessary for medical librarians and should be included in library and information science curriculum, either as an elective or embedded in the research methodology courses.

Correspondence: Awang Ngah Zainab, Faculty of Computer Science & Information Technology, University of Malaya, Malaysia. E-mail: zainab@um.edu.my

Introduction

Bibliometrics is often used to study published literature in medical and its related fields to indicate how knowledge is disseminated, transferred and used.^{1,2} Books, monographs, reports, theses and periodical articles are used as the unit of analysis, to study article productivity and citations. This is based on the premise that frequently cited papers have some influence in a field compared with those less or not cited.³ Examples of bibliometrics studies carried out in the field of biomedical and health sciences are Nwagwu⁴ on biomedical literature published by Nigerian researchers, Falagas, *et al.*⁵ and Lee⁶ in the field of parasitology, Soteriades and Falagas⁷ in the fields of preventive medicine, environmental medicine, epidemiology and public health, Kailash *et al.*⁸ on malarial literature, Keiser & Utzinger⁹ and Glover & Bowen¹⁰ on tropical medicine and international health articles. Most of the above studies examined the pattern and growth of publications and the number of times they were cited. This study aimed to examine Malaysian publications, the authorship pattern and the citations received in the field of biomedical and health sciences (BHS) retrieved from the Science Citation Index (SCI) database.

A 2010 report¹¹ published by the Ministry of Science, Technology and Innovation Malaysia found a total of 22 276 Malaysian publications listed in SCOPUS from 2001 to 2009. SCOPUS was used for the data source because it provided wider coverage of journals (13 000) from 4000 international publishers.¹² The report¹¹ also indicated that the number of citations received by Malaysian medical publications was high (13 200 citations). However, the ratio of total citations to total publication revealed that the average impact of publications in other fields such as chemistry, biochemistry, genetics, molecular biology and engineering far outperformed publications in medicine as in those fields every one publication received 4–5 citations compared with the ratio of 1:3 citations in BHS. To understand further, the characteristics of Malaysian publications in BHS fields, a study of a larger data source from 1990s up to 2005 was felt to be useful. The SCI database was chosen because for over 40 years it has been the only database that provided productivity and citation data for journals considered to be of some influence,

which are most likely to be cited as well as reflect the international scientific activity in a field.^{13–15} Moreover, 1467 of 8901 journal titles indexed in *Web of Science* are not covered by SCOPUS.¹⁶

Objectives

Among other indicators, the number of papers produced by a scientist from a given institution is a measure of both his productivity as well as his institution's publication output. This study aimed to examine the publication outputs contributed by and authorship patterns of Malaysian researchers in the field of BHS, the core journals used to publish, the extent of collaborative works as well as citations received by the publications.

Methodology

This study obtained data from the SCI published from 1990 to 2005. It is assumed that the 15-year period would project a better picture on the trends and pattern of publications and the citations received. The data were confined to records with country name and institutional addresses in Malaysia. The results were then limited to main fields of research (FOR) based on subject categories listed in the *Malaysian Research and Development Classification System*, 5th edition¹⁷ which comprises 15 main fields that follow international systems for naming fields of research. All records authored by Malaysian authors were identified and converted into Microsoft Excel files to generate tables and figures. A thorough clean-up of authors' names were carried out to remove duplicates due to misspelling and disparity arising from varied forms of names used by authors.

Works by joint authors affiliated to non-Malaysian affiliation were excluded from authorship analysis but used to calculate collaborative factors. Data collated were used to generate the following information: (a) total and trends of contributions in BHS fields between 1990 and 2005; (b) Malaysian authorship pattern and productivity; (c) institutional contributions; (d) collaboration patterns; (e) core journals used by BHS researchers to publish; (f) subject areas of the research publications; and (g) citations received by the publications. Regression analysis is used to display and forecast trends.

Microsoft Excel was used to generate ranked list of productive authors, institutions, authorship and collaboration pattern. The number of times a paper was cited was based on a sample of 62 papers which accounted for 5788 citations (23% of total citations obtained by Malaysian publications), with each paper receiving between 50 and 300 citations. Analysis of citations will identify the yearly distribution, the highly cited papers and subjects covered.

Results

Total publication productivity in biomedicine and health sciences

A total of 3697 publications affiliated to Malaysian addresses were retrieved, which comprise 2710 (73.3%) journal articles; 461 (12.5%) meetings/conference abstracts, 270 (7.3%) letters and 256 (6.9%) other type of publications. Journals as the preferred channel to communicate research results was similarly observed by Salina and Shaheen.¹⁸ The trendline ($y = 19.337x + 66.7$, $R^2 = 0.8219$) indicated an upward trend, especially during the 8th Malaysian 5-year economic plan (2001–2005) and this trend is expected to continue in the future. The increase in output may be attributed to an increase in R&D allocations to universities, government ministries and medical research institutions under the 9th and 10th Malaysia Plan.^{19,20}

The authorship pattern

A total of 4178 unique authors contributed to the 3697 publications with the majority, 2661 (63.9%) authors contributed only one article each and collectively produce 72.0% of total publications (Fig. 1). About 1502 (35.8%) authors contributed between 2 and 28 articles (collectively produce 11.0%, 422 of total articles) and 15 authors (0.3%) contributed 30 to as high as 68 publications (collectively produce 17.0%, 614) of total publications. The 15 most productive authors collectively produced an average of 40.9 papers per year and each wrote two or more papers. This is higher than the total average of 0.8 papers per year (3697 papers/4178 authors).

Multi-authorship were the norm with 2–4 authorship predominating and constituting 55.4 percent of total authorship types. Only 10.7% of total

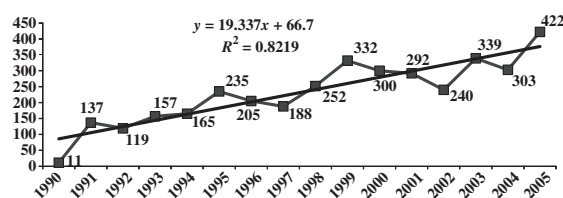


Figure 1 Total and trends of publications between 1990 and 2005

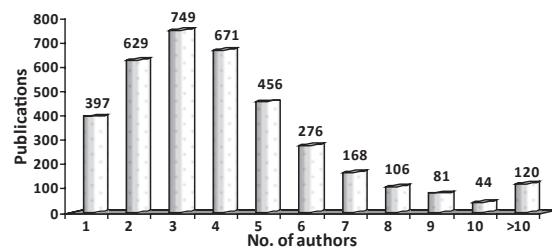


Figure 2 Types of authorship pattern contributing to 3697 publications

publications had a single author. A total of 164 publications were mega authored, a term coined by Sen²¹ to indicate publications with 10 or more authors (Fig. 2). This predominance in joint authorship was similarly indicated by Udofia²² in tropical diseases studies, Biradar and Thippeswamy²³ in paediatric papers, Weeks *et al.*²⁴ in prestigious medical journals, Cesar *et al.*²⁵ in AIDS literature, and Hashimah²⁶ in *Medical Journal of Malaysia*. The predominance of multi-authored works may be attributed to larger team size and multi-faceted nature of research in BHS researches.²⁷

Authors name positioning

The placement of authors' names in articles varies depending on the policies and tradition of the organisation in which the research is undertaken. Subramanyam²⁸ observed that it was common to find mega authored works in extensive laboratory or field work and found that the principal investigators name is almost always placed first. Zukerman²⁹ also observed the front position of principal authors and proposed that the first author named in any single publication was the main person responsible for the publication and the second author was either joint co-researcher or the main supervisor or collaborator for the research. In this study, a sample of 46 productive authors and their

publications were studied and it was observed that the majority (74%) of productive authors names were either placed first or second in more than 50% of their publications indicating their role as principal writer or the main collaborator in the research (Table 1).

Authors' affiliations in publications and the productive institutions

A total of 154 unique institutions with Malaysian work addresses were identified from 3074 publications and 623 publications were excluded as their affiliation status cannot be ascertained. Institutions of higher learning (IHL) both public and private dominated with over 87% of research publications (2675 of 3697 papers) indicating that the IHLs were active researching in the field as well as successful in making their contributions visible through the ISI indexed journals. The productive IHLs were University of Malaya (30.94% of total publications), Universiti Sains Malaysia (13.39%), Universiti Kebangsaan Malaysia (12.74%) and Universiti Putra Malaysia (10.66%). These four universities have been conferred the research university status under the 9th and 10th Malaysia Plan (2006–2010; 2011–2015). Publications from the government agencies and research institutions constituted 25.24% of total papers (776) and those from private agencies constituted 5–11% (157) of papers.

Research collaborations

The study identified 1753 (47.42%) papers with Malaysian–foreign collaborations. Malaysians actively collaborated with authors from the UK (highest number recorded), followed by United States, Japan and Singapore (Table 3). Regionally, Malaysia collaborated more with countries in the Asia-Pacific regions (32.3%) especially with Japan and Australia, followed by Europe (30.0%), especially with UK. A report published by MAS-TICS³⁰ supported this finding (Table 2).

Core journals

Journals (70%) were the main channel used by Malaysian BHS researchers to publish their research outputs. A total of 777 journal titles contributed

2710 articles. Plotting the titles in accordance with their cumulative frequencies revealed three zones of productivity in the proportion of 44:152:581. Zone

Table 1 Productive authors and their name position pattern in publications

Authors' names (<i>n</i> = 46)	No. publications	Percent positioned 1st & 2nd (%)
Goh, Khean Lee	68	80.8
Khalid Abdul Kadir	54	16.6
Yuen Kah Hay	44	75.0
Wong Kum Thong	43	79.0
Khatijah Yusoff	42	23.8
Puthuchear, Savithri	41	39.0
Boo, Nem Yun	40	82.5
Lam, Sai Kit	39	30.7
Looi, Lai Meng	38	65.7
Ng, Kwan Hoong	37	81.0
Chong, Huat Siar	36	69.4
Cheng, Hwee Ming	35	88.5
Peh, Suat Cheng	35	51.4
Chua, Kaw Bing	32	43.5
Yaakob Che Man	30	46.6
Jayaram, G.	28	89.2
Parasakthi, N.	28	60.7
Chan, Kit Lam	27	70.3
Gapor, A.	27	22.2
Lim, Lee Han	27	96.2
Mak, Joon Wah	27	29.6
Rosnah Zain	27	70.3
Ang, Hooi Hoon	26	96.1
Abdul Manaf Ali	25	44.0
Cheah, Phaik Leng	25	64.0
Hapizah M. Nawawi	25	60.0
Lye, Munn Sann	25	28.0
Peh, Kok Khiang	25	72.0
Yadav, M.	24	75.0
Ismail B.S.	23	91.3
Ismail R.	23	65.2
Lajis, Nordin	23	56.5
Mustafa, Mohd Rais	23	95.6
Ibrahim Abdul Razak	23	60.8
Tan, Chong Tin	23	56.5
Cheong, Soon Keng	22	59.0
Ghazali H.M.	22	59.0
Liam, Chong Kin	22	59.0
Tan, Si Yen	22	45.4
Tan, Wen Siang	22	63.6
Toh, Chooi Gait	22	86.3
Lee, Way Seah	21	90.4
Radu, Son	21	61.9
Sundram, Kalyana	21	66.6
Yeang, Hoong Yeet	21	61.9
Pang, Tikki	20	45.0

Table 2 Joint Malaysian (MY)–Foreign Collaborations in biomedical and health sciences (BHS) publications (N-1753)

Collaborating countries	No. papers
MY–Asia-Pacific	567 (32.3%)
MY–Japan	176
MY–Australia	175
MY–China	75
MY–India	59
MY–Taiwan	33
MY–Pakistan	17
MY–New Zealand	12
MY–Bangladesh	9
MY–Sri Lanka	7
MY–Nepal	4
MY–Middle East, Africa	21 (1.2%)
MY–Kuwait	6
MY–Ghana	4
MY–Sudan	4
MY–Iran	3
MY–South Africa	2
MY–UAE	2
MY–Southeast Asia	280 (16.0%)
MY–Singapore	133
MY–Indonesia	55
MY–Thailand	55
MY–Philippines	27
MY–Laos	4
MY–New Guinea	4
MY–Vietnam	2
MY–Europe	526 (30.0%)
MY–UK	278
MY–France	47
MY–Germany	33
MY–The Netherlands	28
MY–Switzerland	24
MY–Sweden	21
MY–Denmark	18
MY–Italy	18
MY–Belgium	17
MY–Austria	14
MY–Finland	14
MY–Romania	4
MY–Spain	4
MY–Hungary	3
MY–Norway	3
MY–Americana	339 (19.3%)
MY–USA	270
MY–Canada	58
MY–Mexico	5
MY–Argentina	3
MY–Columbia	3
MY–Other countries	20 (1.1%)
MY–Other countries (20,1 each)	20

1 comprises the core 44 titles (33.9%) which produced 920 articles (5.6%), zone 2 comprises the marginally productive titles (33.6%) producing 914 articles (19.6%) and zone 3 comprises 581 peripheral titles (32.3%) producing 876 articles (74.8%). The results conform to Bradfords law of scattering³¹ which stated that journal productivity in a given subject tend to be concentrated to a relatively small core of highly productive journals. Of the 777 titles, 697 (89.7%) have their impact factor (IF) listed in the JCR 2005 (Table 3).

Active fields of research

Authors and scholars in a discipline are usually the main contributors to the body of knowledge in the field and the publications produced reflect their research activity and revealed productivity as well as collaborating authors in the field.^{32,33} Research areas were identified based on the Malaysian Research Development Classification System (MRDCS), 5th edition.¹⁷ As shown in Table 4, 58.98% of publications were focused on three areas, clinical medicine, (especially in paediatrics, gastroenterology and oncology) pharmacology and medical microbiology.

Citations received

Of the 3697 Malaysian BHS publications, 2637 publications received citations (71.3%). In total, 24 742 citations were received and most of the citations were derived from journal articles and reviews (93.03% of total citations) (Table 5). This is similarly found in most science-based fields including BHS.³⁴

A total of 62 publications that have been cited between 50 and 300 times were extracted for further analysis. Collectively the 62 titles received 5788 citations or 23.4% of the total citations. The FOR which recorded the highest number of papers being cited were in clinical medicine, medical biochemistry and clinical chemistry. Four papers on *Nipah Virus*, related to the *Japanese Encephalitis* epidemics in Southeast Asia obtained 345 citations collectively, jointly authored by between 6 and 10 authors and published between 1999 and 2002. When the citations to the 62 articles were studied, it was found that 49 articles (6.31%) have been

Table 3 Journals publishing Malaysian articles based on ranked impact factors (JCR 2005)

Impact factor (IF)	Journal title	No. papers	Sum of papers
44.016	New England Journal of Medicine	2	2
23.878	Lancet	10	12
14.864	Trends in Ecology & Evolution	3	15
12.649	American Journal of Human Genetics	1	16
12.386	Gastroenterology	1	17
11.81	Journal of Clinical Oncology	2	19
9.2	Journal of the American College of Cardiology	2	21
9.052	British Medical Journal	4	25
8.689	American Journal of Respiratory & Critical Care Medicine	1	26
8.028	Diabetes	1	27
7.000–7.999	10 titles	24	51
6.000–6.999	9 titles	21	72
5.000–5.999	14 titles	38	110
4.000–4.999	34 titles	75	185
3.000–3.999	70 titles	188	373
2.000–2.999	148 titles	447	820
1.000–1.999	227 titles	899	1719
0.001–0.999	175 titles	737	2456
Not available	80 titles	254	2710
Total	777 titles	2710	

Table 4 Research publications by field of research areas

Main fields of research (FOR)	No. papers (n = 3697)	Percent
F1100700-Clinical Medicine	1455	39.35
F1100400-Pharmacology	392	10.60
F1100300-Medical Microbiology	334	9.03
F1100200-Medical Biochemistry and Clinical Chemistry	248	6.71
F1100800-Public Health, Environmental, Occupational Health and Safety Research	245	6.63
F1100900-Nutrition (Clinical and Public Health Research)	230	6.22
F1102100-Dentistry	216	5.84
F1100100-Immunology	213	5.76
F1101100-Health Care System, Industries and Technologies	199	5.38
F1101000-Health Services Research (include Bioethics)	33	0.89
F1100500-Physiology	17	0.46
F1101300-Complimentary Alternative Medicine	2	0.05
F1102000-Anatomy	1	0.03
F1101400-Pharmacy	1	0.03
Others-Medicine (General, Internal)	111	3.00

cited 50 to 300 times. More than 150 citation were made to Malaysian articles published in foreign medical journals with good impact factors and the top ten being *Lancet* (729 times), *Journal of General Virology* (296 times), *New England Journal of Medicine* (291 times), *Nutrition* (242 times), *Genetics* (232 times), *Trends in Ecology & Evolution* (193 times), *Lipids* (183), *American Journal of Pathology* (179), *Journal of Clinical Microbiology* (152) and *British Medical Journal* (151).

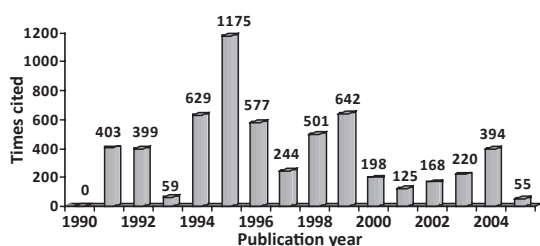
The chronological distribution of most cited papers by publication year indicates that the highest cited were papers published in 1995 (Fig. 3). In 1995, 10 papers on cancer-related studies were cited more than 50 times. Research related to hepatitis C, Typhoid and Salmonella virus related diseases jointly obtained 37% of total citations. In general, the results indicate that research in certain areas maybe a contributing factor to the number of citations received.

Discussion

This study is limited to 3697 publications extracted from the sc_i bearing Malaysian affiliation addresses

Table 5 Total citations received by Malaysian biomedical and health sciences (BHS) publications (1990–2005)

Publication type	Total publications (<i>n</i> = 3697)	Total no. cited (%)	Total no. not cited (%)	Total times cited (%)
Articles	2710	2254 (60.97)	456 (12.33)	21 769 (87.98)
Reviews	74	68 (1.84)	6 (0.16)	1250 (5.05)
Notes	131	111 (3.68)	20 (0.54)	878 (3.55)
Letters	270	136 (3.68)	134 (3.62)	600 (2.43)
Editorial materials	43	27 (0.73)	16 (0.43)	160 (0.65)
Meeting abstracts	461	41 (1.11)	420 (11.36)	85 (0.34)
Others	8	0	8 (0.22)	0
Total		2637 (71.33)	1060 (28.6)	–

**Figure 3** Most cited papers by publication year (*n* = 62)

and therefore cannot be generalised to medical literature covered by other databases such as SCOPUS and GOOGLE SCHOLAR. However, the study does give a clearer picture about the characteristics of the Malaysian BHS articles published in foreign channels especially those indexed by the SCI.

The total publications found in SCI between 1990 and 2009 showed yearly increase. The ratio of total citations with total publications (14 742 citations/3697 publications) was 1:7, an improvement from the result (1:3) previous reported.¹¹ This maybe attributed to the emphasis by universities for academics to publish in journals indexed by the ISI databases and SCOPUS. Information about trends and productivity reveals the intellectual output of BHS works published in SCI and is useful to university administrators when evaluating yearly performance of university faculties in the light of university ranking among Malaysian universities.

The authorship pattern of Malaysians publications in BHS indicated that the majority were one time contributors (63.7%) and only a small number of authors (16.1%) collectively published 40.9 papers per year over the period. This pattern corroborates with Lotka's law of scientific productivity which predicts that in any field only a small

number of authors are highly productive.³⁴ The predominance of multi-authored works especially between 2 and 10 is similarly found in other science-based studies^{35,36} and typify BHS research which were often multi-disciplinary and facilitated group rather than single research initiatives.³⁷ Authorship patterns reflect collaboration trends and help libraries design a more focused support service based on research groups through subject librarians.³⁸ Moreover, Malaysian authors mainly collaborated with authors from the UK, USA, Japan, Australia and Singapore. This may be because most Malaysian academics were academically trained in those countries and the Singaporean collaborators may be Malaysians practising or teaching in Singaporean universities.

In Malaysian universities, promotional criteria require academics to show their active involvement in research as reflected by the position of their names as the first or second authors. Often librarians will be asked by university administrators to provide such evidence and the analysis about name placement of productive authors becomes necessary. In this study, the majority of the productive authors were mainly placed either first or second position among authors contributing to articles (75–95%), indicating their active roles as either writers or collaborators.

The identified core journals relevant for BHS researchers can be used by medical librarians when formulating their collection policies and deciding on journal subscription status. Journals' subscriptions comprise two-thirds of the total acquisition budget in most academic libraries and the rise in subscription rates place collection librarians in a dilemma about renewals and cancellations.

Identification of a core list of journals in disciplines would help support decisions.^{39–41} Domrowski⁴² produced core journals in embryology, anatomy and morphology to build collections needed by users and Devin and Kellogg⁴³ found that highly cited books and journals can be used as a guide to allocate budget. The journal citation information is also used to evaluate the use of a library's collection⁴⁴ and to calculate the cost-per-use⁴⁵ of a cited journal if selected. Tsay⁴⁶ found significant correlation between frequency of use and citation frequency for all titles used in the Veterans Hospital Library in Taipei, Taiwan. Zainab and Ng⁴⁷ compared journals ranked list based on citations with existing serials holdings to identify title overlaps and cost incurred in maintaining similar titles subscription among selected academic libraries. Koenig⁴⁸ used journal citations and impact scores to justify subscriptions, deselection, collection evaluation and collection building. Citation analysis therefore is useful for identifying user needs and justifying decisions about collections.⁴⁹

Higher citations were obtained by in older articles published between 1995 and 1999. Similar to findings in other medical related studies, the results infer that older articles in BHS continued to be cited even if they were more than 10 years old.^{50,51} This information is useful for librarians when deciding on the extent of back issues of journals to be retained or reshelfed or identify items not held by the library as a candidate for new subscriptions.⁵²

Bibliometric studies helped librarians identify the highly cited papers and the important journals, as well as the highly cited research areas.⁵³ In this study, the research area maybe a contributing factor to the number of citations received as those highly cited papers seem to converge in areas such as clinical medicine, nutrition, medical biochemistry and specifically in breakthrough areas such as the *Nipah virus*.

Conclusion

Malaysia has designated five of its universities as research universities to focus on research, innovations and publications in science, medical and technological fields. With this designation, the librarians of these universities are placed in an advisory position and are asked periodically by management to

provide citation and publication track report of academics and research group members before tenure-ship, hiring, renewal of contracts or remunerations can take place. Academics begin to expect librarians to be able to inform them about the core journals in their fields (especially those in the ISI databases). Librarians are beginning to be asked to brief management on the yearly citation and publication performance of the university faculty so that comparisons can be made with other regional universities. In most of these universities, the medical faculties are among the most active researchers. Therefore, reporting on the productivity and impact of medical research through citation analysis is becoming a necessary skill for medical librarians besides using bibliometric knowledge to make decisions on medical information and collections as well in handling bibliographical and acquisition services. These roles assumed by university and medical librarians suggest that perhaps, bibliometrics should be introduced in library school curriculum. Currently, all three library schools in Malaysia either offer a course in bibliometrics as an elective or embed it in the research methodology course. This study is an attempt to briefly highlight the publication and citation productivity of Malaysian medical authors in the ISI database, the database that is being used to gauge the performance of faculties and their members. This study reveals the publication and citation performance by institutions and identifies core journals and the fields of research to provide Malaysian medical librarians an overview of the pattern of Malaysia's contributions in the ISI databases.

References

- 1 Webster, B. M. International presence and impact of the UK biomedical research, 1989–2000. *Aslib Proceedings: New Information Perspectives* 2004, **57**(1), 22–100.
- 2 Lewison, G. Beyond output: new measures of biomedical research impact. *Aslib Proceedings* 2003, **2**, 32–42.
- 3 Tijssen, R. J. W., Visser, M. S. & Leeuwen, T. N. V. Benchmarking international scientific excellence: are highly cited research paper an appropriate frame of reference? *Scientometrics* 2002, **54**(3), 381–397.
- 4 Nagwu, W. A bibliometric analysis of productivity patterns of biomedical authors of Nigeria during 1967–2002. *Scientometrics* 2006, **69**(2), 259–269.
- 5 Falagas, M. E., Papastamataki, P. A. & Blioziotis, I. A. A bibliometric analyses of research productivity in parasitology

- by different world regions during a 9-year period (1995–2003). *BMC Infectious Diseases* 2006, **6**(1), 56.
- 6 Lee, C. S. Bibliometric analysis of the *Korean Journal of Parasitology*: measured from *SCI*, *PubMed*, *Scopus*, and *Synapse Databases*. *Korean Journal of Parasitology* 2009, **47**, S155–S167.
 - 7 Soteriades, E. S. & Falagas, M. E. A bibliometric analysis in the fields of preventive medicine, occupational and environmental medicine, epidemiology and public health. *BMC Public Health* 2006, **6**(1), 301.
 - 8 Kailash, C. G., Kumar, S., Madhavi, Y. & Bahl, M. Bibliometrics of global malaria vaccine research. *Health Information and Libraries Journal* 2009, **26**(1), 22–31.
 - 9 Keiser, J. & Utzinger, J. Trends in the core literature on tropical medicine: a bibliometric analysis from 1952–2002. *Scientometrics* 2005, **62**(3), 351–365.
 - 10 Glover, S. W. & Bowen, S. L. Bibliometric analysis of research published in tropical medicine and international health 1996–2003. *Tropical Medicine and International Health* 2004, **9**(12), 1327–1330.
 - 11 Malaysian Science and Technology Information Centre. *Malaysian Science and Technology Indicators Report 2008*. Kuala Lumpur: Malaysian Science and Technology Information Centre (MASTIC), 2010.
 - 12 Szarina, A. *A Bibliometric Study of Science and Technology Knowledge Productivity in Malaysia: Interim Report*. Shah Alam: Bibliometric Special Interest Group, Faculty of Information Studies, Universiti Teknologi MARA, 2003.
 - 13 Bosman, J., van Mourik, I., Rasch, M., Sieverts, E. & Verhoeff, H. *Scopus Reviewed and Compared*. Utrecht: Universiteitsbibliotheek, 2006.
 - 14 Gavel, Y. & Iselid, L. *Web of Science and Scopus: a journal title overlap study*. *Online Information Review* 2008, **32**(1), 8–21.
 - 15 Carpenter, M. P. & Narin, F. The adequacy of the *Science Citation Index (SCI)* as an indicator of international scientific activity. *Journal of the American Society for Information Science and Technology* 1981, **32**(6), 430–439.
 - 16 Ball, R. & Tunger, T. Science indicators revisited – *Science Citation Index* versus *Scopus*: a bibliometric comparison of both citation databases. *Information Services & Use* 2006, **26**, 293–301.
 - 17 MASTIC (Malaysian Science and Technology Information Centre). *Malaysian Research and Development Classification System (MRDCS)*, 5th edn. Kuala Lumpur: MASTIC, 2007.
 - 18 Salina, Z. & Shaheen, M. The information needs and seeking behaviour of the IMR biomedical scientists. *Malaysian Journal of Library & Information Science* 2001, **5**(1), 25–41.
 - 19 Economic Planning Unit. 9th Malaysia Plan, 2006–2010. Putra Jaya: Economic Planning Unit, Prime Ministers Department, 2006, p.258. Accessible at: <http://www.utusan.com.my/utusan/SpecialCoverage/RMK9/english/cover.pdf>. Accessed date: 27.9.2010.
 - 20 Economic Planning Unit. *10th Malaysia plan, 2011–2013*. Putra Jaya: Economic Planning Unit, Prime Ministers Department, 2010, p.225. Accessible at: http://www.epu.gov.my/html/themes/epu/html/RMKE10/rmke10_english.html. Accessed date: 27.9.2010.
 - 21 Sen, B. K. Mega-Authorship from a bibliometric point of view. *Malaysian Journal of Library & Information Science* 1997, **2**(2), 9–18.
 - 22 Udofia, U. I. Bibliometric studies on African trypanosomiasis research literature: a review of authorship pattern. *Annals of Library & Information Studies* 2002, **49**(2), 45–49.
 - 23 Biradar, B. S. & Thippeswamy, K. Information use pattern of pediatrician: a bibliometric study. *SRELS Journal of Information Management* 2004, **41**(1), 107–120.
 - 24 Weeks, W. B., Wallace, A. E. & Surott Kimberley, B. C. Changes in authorship patterns in prestigious US medical journals. *Social Science & Medicine* 2004, **59**, 1949–1954.
 - 25 Cesar, A. M. C. & Mijangos-Nolasco, A. Bibliometric analysis of AIDS literature in Central Africa. *Scientometrics* 2002, **54**(2), 309–317.
 - 26 Hashimah, H. A citation analysis of the *Medical Journal of Malaysia*, 1997. Dissertation (MA): University of North London, 1997.
 - 27 Satyanarayana, K. & Ratnakar, K. V. Authorship patterns in life sciences, preclinical basic and clinical research papers. *Scientometrics* 1989, **4**, 363–371.
 - 28 Subramanyam, K. Bibliometric studies of research collaboration: a review. *Journal of Information Science* 1983, **6**, 33–38.
 - 29 Zukerman, H. A. Patterns of name ordering among authors of scientific papers: a study of social symbolism and its ambiguity. *American Journal of Sociology* 1968, **7**(4), 276–291.
 - 30 MASTIC. *Science and Technology Knowledge Productivity in Malaysia: Bibliometric Study 2003*. Kuala Lumpur: Malaysian Science and Technology Information Centre, 2004.
 - 31 Bradford, S. C. Sources of information on specific subjects. *Journal of Information Science* 1985, **10**, 176–180.
 - 32 Joswick, K. E. Article publication patterns of academic librarians: an Illinois case study. *College & Research Libraries* 1999, **60**(4), 340–349.
 - 33 Oyeniyi, J. O. & Bozimo, D. O. The relationship between author collaboration and productivity: a study of sorghum literature in Nigeria. *African Journal of Library, Archives and Information Science* 2004, **14**(1), 29–36.
 - 34 Lotka, A. J. The frequency distribution of scientific productivity. *Journal of the Washington Academy of Science* 1926, **16**, 317–323.
 - 35 Narang, A. *Indian Journal of Pure and Applied Mathematics: a bibliometric study*. *Annals of Library and Information Studies* 2004, **51**(1), 28–38.
 - 36 Ullah, M., Butt, I. F. & Haroon, M. The *Journal of Ayub Medical College: a 10-year bibliometric study*. *Health Information and Libraries Journal* 2008, **25**, 116–124.
 - 37 Cleanton-Jones, P. & Myers, G. A method for comparison of biomedical publication quality across ISI discipline categories. *Journal of Dental Education* 2002, **66**(6), 694–696.
 - 38 Liu, Z. Trends in transforming scholarly communications and their implications. *Information Processing & Management* 2003, **39**(6), 889–898.

- 39 Pancheshnikov, Y. A comparison of literature citations in faculty publications and student theses as indicators of collection use and a background for collection management at a university library. *Journal of Academic Librarianship* 2007, **33**(6), 674–683.
- 40 Chung, H. K. Evaluating academic journals using impact factor and local citation score. *Journal of Academic Librarianship* 2007, **33**(3), 393–402.
- 41 Broadus, R. The applications of citation analyses to library collection building. *Advances in Librarianship* 1977, **7**, 299–335.
- 42 Dombrowski, T. Journal evaluation using *Journal Citation Report* as a collection tool. *Collection Management* 1988, **10**(3/4), 175–180.
- 43 Devin, R. B. & Kellog, M. The serials/monograph ratio in research libraries budgeting in light of citation studies. *College & Research Libraries* 1990, **51**, 40–54.
- 44 Line, M. Rank lists based on citations and library uses as indicators of journal usage at individual libraries. *Collection Management* 1978, **2**, 113–116.
- 45 Kelland, J. & Yonge, A. Citation as a form of library use. *Collection Management* 1994, **2**, 81–100.
- 46 Tsay, M. Y. The relationship between journal use in a medical library and citation use. *Bulletin of the Medical Library Association* 1998, **86**(1), 31–39.
- 47 Ng, S. L. & Zainab, A. N. Availability and overlaps of quality computer science journal holdings in selected university libraries in Malaysia. *Malaysian Journal of Library & Information Science* 2003, **8**(1), 45–63.
- 48 Koenig, M.E. Citation analysis for the arts and humanities as a collection management tool. *Collection Management*, 1978, **2**, 247.
- 49 Enger, K. B. Using citation analysis to develop core book collections in academic libraries. *Library & Information Science Research* 2009, **31**, 107–112.
- 50 Willet, P. A. A bibliometric analysis of the *Journal of Molecular Graphics and Modelling*. *Journal of Molecular Graphics and Modelling* 2007, **26**, 602–606.
- 51 Tsay, M. Y. Library journal use and citation age in medical science. *Journal of Documentation* 1999, **55**(5), 543–555.
- 52 Sylvia, M. J. Citation analysis as an unobstrusive method for journal collection evaluation using psychology student research bibliographies. *Collection Building* 1998, **17**(2), 20–28.
- 53 Omatayo, B. O. A content analysis of *Ife Psychologia*, 1993–2002. *International Information & Library Review* 2004, **36**, 95–103.

Received 6 May 2010; Accepted 21 April 2011