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ScienceDirect
Acta Tropica 99 (2006) 155–159
ACTA TROPICA
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A bibliometric analysis of global trends of research productivity in tropical medicine

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Received 30 May 2005; received in revised form 18 May 2006; accepted 10 July 2006
Available online 2 October 2006

Abstract

The field of tropical medicine has a long history due to the significance of the relevant diseases for the humanity. We estimated the contribution of different world regions to research published in the main journals of tropical medicine. Using the PubMed and the Institute for Scientific Information (ISI) "Web of Science" databases, we retrieved articles from 12 journals included in the "Tropical Medicine" category of the "Journal Citation Reports" database of ISI for the period 1995–2003. Data on the country of origin of the research were available for 11,860 articles in PubMed (98.1% of all articles from the tropical medicine category). The contribution of different world regions during the studied period, as estimated by the location of the affiliation of the first author, was: Western Europe 22.7%, Africa 20.9%, Latin America and the Caribbean 20.7%, Asia (excluding Japan) 19.8%, USA 10.6%, Oceania 2.1%, Japan 1.5%, Eastern Europe 1.3%, and Canada 0.6%. The contribution of regions, estimated by the location of the affiliation of at least one author of the published papers (retrieved from the ISI database), was similar: Western Europe 36.6%, Africa 27.7%, Latin America and the Caribbean 24.4%, and Asia 23.3%. The mean impact factor of articles published in tropical medicine journals was highest for the USA (1.65). Our analysis suggests that the developing areas of the world produce a considerable amount of research in tropical medicine; however, given the specific geographic distribution of tropical diseases they probably still need help by the developed nations to produce more research in this field.

Keywords: Tropical medicine literature; 10:90 gap; International representation; Bibliometrics; Impact factor; Research and development; Research collaboration

1. Introduction

The field of tropical medicine has a long history that becomes evident from the fact that the first journal in the field was established in the late 19th century. Diseases that are common in the tropics represent some of the most common causes of death in the developing countries. Subsequently, the worldwide community invests resources into research related to the etiology, mechanisms, and treatment of such diseases.

Several investigators have provided data or commented on the problem of low research productivity by the developing nations (Galvez et al., 2000; Horton, 2000). The idea that the under-representation of developing areas of the world in the global research output poses a significant ethical issue for the humanity has been supported widely in the scientific community (Sumathipala

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doi:10.1016/j.actatropica.2006.07.011

et al., 2004). A special point relevant to this important issue is the transatlantic divide in publications of content relevant to developing areas of the world, i.e., the fact that compared with leading European journals, leading American journals publish a smaller proportion of papers with content of specific interest to the developing world (Raja and Singer, 2004).

A recent study examined the research published in six journals in the field of tropical medicine within a 3-year period produced by collaborations between investigators from countries in the lists of high, medium, and low human development index (Keiser et al., 2004). In addition, the citations patterns in tropical medicine journals as well as a bibliometric analysis of research published in one tropical medicine journal were recently published (Glover and Bowen, 2004; Schoonbaert, 2004). In this report we present data regarding the contribution of the major regions of the world regarding research productivity, published during a 9-year period in the major journals of the field of tropical medicine.

2. Methods

The methodology used was similar to other bibliometric studies published from our research team (Bliziotis et al., 2005; Falagas et al., 2005, 2006; Rosmarakis et al., 2005; Vergidis et al., 2005). For the purposes of our study we analyzed data from 12 journals included in the "Tropical Medicine" category of the Journal Citation Reports (JCR) database of the Institute for Scientific Information (ISI) (Institute for Scientific Information, 2004).

For the purposes of the study we classified the various countries into nine world regions: Western Europe, Eastern Europe, United States of America (USA), Canada, Latin America and the Caribbean, Africa, Japan, Asia (excluding Japan), and Oceania. In our study, Eastern Europe includes all formerly socialist economies of Europe. The rest of Europe plus Greenland is designated as Western Europe. This classification is based on a combination of geographic, economic, and scientific criteria (United Nations Statistical Yearbook, 2004).

The number of published articles was considered as an index of quantity of research productivity. The mean impact factor of the journals where the articles were published was considered as an index of quality of research productivity. Finally, the product of the number of articles published in a journal multiplied by the impact factor of the journal, for the year studied, was used to evaluate the combined quantity and quality of research productivity. The sum of these products from all journals for each world region within a year was designated as the "total product" for each region within the studied year.

The proportion of research articles published in the field of tropical medicine from each world region, for the period 1995–2003, was further evaluated by making use of the "ISI Web of Science" search engine. We collected data regarding the number of articles in which at least one author's institution was in the region examined, during the whole period to take into account studies of inter-regional cooperation.

3. Results

Twelve scientific journals were included, for the studied period, in the "Tropical Medicine" category of the ISI (*Acta Tropica*, *American Journal of Tropical Medicine and Hygiene*, *Annals of Tropical Medicine and Parasitology*, *Annals of Tropical Paediatrics*, *Bulletin de la Societe de Pathologie Exotique*, *International Journal of Leprosy and other Mycobacterial Diseases*, *Journal of Tropical Pediatrics*, *Leprosy review*, *Memorias do Instituto Oswaldo Cruz*, *Transactions of the Royal Society of Tropical Medicine and Hygiene*, *Tropical Doctor*, *and Tropical Medicine & International Health*). All journals were also included in the PubMed database for the same period, with the exception of *Tropical Medicine & International Health journal*, which was not included in PubMed during the period 1995–1996 (National Library of Medicine, 2004).

Data were available for 11,860 out of 12,090 articles (98.1% of all articles from the included journals) in the PubMed database. Data concerning the absolute and relative production of articles in each world region are presented in Table 1. Western Europe exceeds all other world regions in research publications in the field of trop-

Table 1
Number and mean impact factor of articles published in journals included in the "Tropical Medicine" category of "Journal Citation Report" database and indexed by PubMed, from different world regions, for the period 1995–2003

	Number of articles (%)	Mean impact factor
Western Europe	2688 (22.7)	1.21
Africa	2475 (20.9)	0.95
Latin America and the Caribbean	2451 (20.7)	0.90
Asia (excluding Japan)	2342 (19.8)	1.00
USA	1252 (10.6)	1.65
Oceania	249 (2.1)	1.32
Japan	177 (1.5)	1.46
Eastern Europe	150 (1.3)	0.68
Canada	76 (0.6)	1.35
Total	11860 (100)[a]	

[a] Total percentage was >100 due to rounding of the respective percentages of each region.

Table 2
"Total product" of articles (number of articles published multiplied by their impact factor) published in journals included in the "Tropical Medicine" category of "Journal Citation Report" database and indexed by PubMed, from different world regions, for the period 1995–2003

World areas	1995	1996	1997	1998	1999	2000	2001	2002	2003	1995–2003
Western Europe	232	260	365	350	454	341	371	430	442	3246
Africa	153	207	269	320	286	272	239	299	317	2362
Latin America and the Caribbean	139	152	191	277	318	217	283	330	300	2207
Asia (excluding Japan)	171	189	253	238	307	249	276	302	355	2341
USA	170	246	198	264	269	180	201	228	311	2068
Oceania	40	35	44	40	24	29	34	39	45	328
Japan	20	21	30	43	40	15	23	25	42	259
Eastern Europe	6	5	11	7	7	10	5	15	35	101
Canada	13	5	15	8	18	6	13	10	15	103
Total (for all regions)	946	1120	1375	1547	1723	1320	1445	1678	1860	13015

ical medicine for the period studied, with Africa ranking second and Latin America and the Caribbean third.

The contribution of different world regions, including inter-regional collaborations, as estimated by the location of the affiliation of at least one author of the published papers, was: Western Europe 36.6%, Africa 27.7%, Latin America and the Caribbean 24.4%, Asia 23.3%, USA 17.5%, Oceania 3.2%, Japan 2.1%, Eastern Europe 1.5%, and Canada 1.1% (data retrieved from "ISI Web of Science").

The mean impact factors of research articles, from the defined world regions, are also displayed in Table 1. Articles from the USA have the highest mean impact factor (1.65). Our estimation for combined quantity (based on data from PubMed searches) and quality in research production in the field of tropical medicine is presented in Table 2. As shown, Western Europe ranks first with a product of 3246 (articles multiplied by the impact factor). In addition, Oceania, Canada, Japan, and Eastern Europe are the areas with the lowest research productivity in the field of tropical medicine, with the first two regions presenting a constant total product throughout the study period. Another finding was the almost global decrease in tropical medicine research productivity observed in 2000 compared to 1999, both in quantity (from a total of 1509 articles in 1999 it decreased to 1345 in 2000) and quality (the mean impact factor of all articles published in the category, based on the impact factor of journals in tropical medicine for the relevant year, fell from 1.24 in 1999 to 1.06 in 2000).

4. Discussion

The most important finding of our analysis is that developing areas of the world including Africa, Asia, and Latin America and the Caribbean may need more help by the developed countries to produce more research in the field of tropical medicine, with and without the collaboration with organizations and/or institutions from countries from the developed world regions. Although these regions produce a considerable amount of research papers, the fact that tropical diseases affect almost exclusively people in these regions indicates that even more research should be performed by scientists affiliated with these regions. However, we should note that in two recent bibliometric studies in the fields of Infectious Diseases and Microbiology, performed by our group (Bliziotis et al., 2005; Vergidis et al., 2005), we found that the proportions of articles produced by Africa, Asia, and Latin America were far lower (around 10% when research production from all three regions was summed up) than the respective proportions in the field of tropical medicine. Nevertheless, these two scientific fields (Infectious Diseases and Microbiology) include diseases with worldwide distribution and the contribution of Africa, Asia, and Latin America, although it should be much higher, is not expected to be as high as that in the field of tropical diseases.

In a recent publication that evaluated research published in five tropical medicine journals over a 50-year time span (1952–2002), the overall percentage of researchers affiliated with low human development index (HDI) countries was found to have decreased over the past 50 years and only a slight positive trend was observed over the last decade (Keiser and Utzinger, 2005). However, in the same paper, the proportion of research produced by researchers from countries with high HDI constantly decreased within the studied period whereas the opposite was true for countries with medium HDI. In addition, increase in research collaborations between countries of different HDI ranks was reported. Thus, overall the findings of the paper were somehow optimistic regarding the participation of developing countries in tropical medicine research.

Two other interesting findings of our study should be further discussed. First, Western European countries appear to produce more research and, even more importantly, make more research collaborations with other regions in the field of tropical medicine than the USA. This may be explained by the fact that Western Europe has a longer tradition in research in this field than the USA. The reasons for this difference may also include the fact that European countries had a lot of colonies in the developing areas of the world during the 19th and first part of 20th century (Mulligan, 1981). Second, a global decrease in tropical medicine research productivity was observed in 2000, compared to 1999. This may be explained at least in part by the great decrease in the number of articles published by the journal with the most articles annually in the field at that time, the *American Journal of Tropical Medicine and Hygiene*. This journal decreased the number of articles from 373 in 1999 to 191 in 2000. This decrease itself outweighs the difference in the number of articles published by the nine regions between 1999 and 2000 that was 164 articles.

Diseases of interest to the field of tropical medicine affect and kill millions of people in the developing areas and also have a considerable significance for the public health of countries of the developed world. However, it is interesting that the total number of publications in the field of tropical medicine compares rather unfavorably to other medical fields of major importance to humanity. For example, in two recent studies that we performed, we found that during the period 1995–2002 the total number of articles in the fields of Infectious Diseases and Microbiology were 45,232 and 76,118, respectively (Bliziotis et al., 2005; Vergidis et al., 2005). However, it should be mentioned that the tropical medicine literature has increased considerably during the last 50 years and that is a smaller discipline compared to the general fields of Infectious Diseases and Microbiology (Keiser and Utzinger, 2005).

The limitations of this study are very similar to those of other bibliometric studies published by our group (Bliziotis et al., 2005; Falagas et al., 2005, 2006; Rosmarakis et al., 2005; Vergidis et al., 2005). Thus, we would like to describe in detail here only two of them. The first is that the impact factor of the journals in which articles are published does not necessarily depict the quality of the articles. Various issues may be more important than the impact factor for the final choices of authors regarding the journal in which they want to publish. These include the focus of a scientific journal as well as language issues. It should be noted that the impact factor has often been criticized as a tool for measuring quality of scientific research (Gallagher and Barnaby, 1998; Gensini and Conti, 1999; Whitehouse, 2002). Yet, thus far, it has not been replaced by any other worldwide-accepted method (Garfield, 1955; Luukkonen, 1990).

A second important limitation is that the division of the world into different regions could be done in several alternative ways, based on various criteria (e.g. Canada could be grouped together with the USA, while Japan could be studied together with the rest of Asia). Another appropriate approach could be to divide the world based only on socio-economic indices such as the HDI (Keiser et al., 2004; Keiser and Utzinger, 2005). Nevertheless, we believe that our categorization incorporates geographic, economic, and, most importantly, scientific criteria (i.e., Canada and Japan represent powerful scientific world regions of their own).

In conclusion, we performed an analysis to provide estimates of research productivity in the field of tropical medicine by different world regions. Compared to other, also important, fields of medicine, it is evident that more efforts, especially from the financially stronger nations, should be done to increase the research production in the field of tropical medicine, a field with major impact on the worldwide burden of disease.

References

Bliziotis, I.A., Paraschakis, K., Vergidis, P.I., Karavasiou, A.I., Falagas, M.E., 2005. Worldwide trends in quantity and quality of published articles in the field of infectious diseases. BMC Infect. Dis. 5, 16.

Falagas, M.E., Karavasiou, A.I., Bliziotis, I.A., 2005. Estimates of global research productivity in virology. J. Med. Virol. 76, 229–233.

Falagas, M.E., Papastamataki, P.A., Bliziotis, I.A., 2006. A bibliometric analysis of research productivity in parasitology by different world regions during a 9-year period (1995–2003). BMC Infect. Dis. 6, 56.

Gallagher, E.J., Barnaby, D.P., 1998. Evidence of methodologic bias in the derivation of the Science citation index impact factor. Ann. Emerg. Med. 31, 83–86.

Galvez, A., Maqueda, M., Martinez-Bueno, M., Valdivia, E., 2000. Scientific publication trends and the developing world. Am. Sci. 88, 526.

Garfield, E., 1955. Citation indexes for science; a new dimension in documentation through association of ideas. Science 122, 108–111.

Gensini, G.F., Conti, A.A., 1999. The impact factor: a factor of impact or the impact of a (sole) factor? The limits of a bibliometric indicator as a candidate for an instrument to evaluate scientific production. Ann. Ital. Med. Int. 14, 130–133.

Glover, S.W., Bowen, S.L., 2004. Bibliometric analysis of research published in Tropical Medicine and International Health 1996–2003. Trop. Med. Int. Health 9, 1327–1330.

Horton, R., 2000. North and South: bridging the information gap. Lancet 355, 2231–2236.

Institute for Scientific Information, 2004. SCI: Science Citation Index-Journal Citation Reports, 1994–2003. The Institute for Scientific Information, Philadelphia.

Keiser, J., Utzinger, J., Tanner, M., Singer, B.H., 2004. Representation of authors and editors from countries with different human development indexes in the leading literature on tropical medicine: survey of current evidence. BMJ 328, 1229–1232.

Keiser, J., Utzinger, J., 2005. Trends in the core literature on tropical medicine: a bibliometric analysis from 1952–2002. Scientometrics 62, 351–365.

Luukkonen, T., 1990. Bibliometrics and evaluation of research performance. Ann. Med. 22, 145–150.

Mulligan, H.W., 1981. Tropical medicine and research in British territories overseas. Trans. R. Soc. Trop. Med. Hyg. 75, 9–11.

National Library of Medicine, 2004. Index Medicus Database (PubMed). Bethesda, Maryland.

Raja, A.J., Singer, P.A., 2004. Transatlantic divide in publication of content relevant to developing countries. BMJ 329, 1429–1430.

Rosmarakis, E.S., Vergidis, P.I., Soteriades, E.S., Paraschakis, K., Papastamataki, P.A., Falagas, M.E., 2005. Estimates of global production in cardiovascular diseases research. Int. J. Cardiol. 100, 443–449.

Schoonbaert, D., 2004. Citation patterns in tropical medicine journals. Trop. Med. Int. Health 9, 1142–1150.

Sumathipala, A., Siribaddana, S., Patel, V., 2004. Under-representation of developing countries in the research literature: ethical issues arising from a survey of five leading medical journals. BMC Med. Ethics 5, 5.

United Nations, 2004. United Nations Statistical Yearbook, 48th issue. United Nations, New York, Part 2, pp. 33–132.

Vergidis, P.I., Karavasiou, A.I., Paraschakis, K., Bliziotis, I., Falagas, M.E., 2005. A bibliometric analysis of global trends of research productivity in microbiology. Eur. J. Clin. Microbiol. Infect. Dis. 24, 342–346.

Whitehouse, G.H., 2002. Impact factors: facts and myths. Eur. Radiol. 12, 715–717.