

BRIEF COMMUNICATIONS

Mapping the health research landscape in Sub-Saharan Africa: a study of trends in biomedical publications*

Karen J. Hofman, MD; Christine W. Kanyengo, MALS; Barbara A. Rapp, PhD; Sheldon Kotzin, MLS, FMLA

See end of article for authors' affiliations.

DOI: 10.3163/1536-5050.97.1.007

INTRODUCTION

The process of research begins with grant-writing and concludes with publication. According to a recent study, in resource-poor settings, in-country national research and publications change clinical practice [1]. One way to promote the visibility of these publications is for them to be peer reviewed and indexed in MEDLINE/PubMed. This process is fundamental not only to scientific progress, but to promoting the widespread communication of novel discoveries from low- and middle-income countries to the rest of the world.

Worldwide scientific publishing activity over the past decade indicates that most countries in Sub-Saharan Africa (SSA) have low levels of publication [2]. In a recent analysis, 31 of the world's 193 countries produce 97.5% of the world's most cited papers. South Africa, at number 29, is the only Sub-Saharan African country on this list [3], but little is known about the comparative volume of publications among the different countries in SSA.

This study examined authorship in MEDLINE-indexed journal publications by Sub-Saharan African first authors as one metric of high-quality health research output. MEDLINE is the bibliographic database of the National Library of Medicine (NLM) at the US National Institutes of Health. Publication trends over a decade were tracked with two key objectives in mind:

- to approximate the research publishing landscape in the region, with special attention paid to country-specific (i.e., national) journals and
- to contrast the publication volume of the most productive country in SSA with publishing practices of other comparable countries outside the region.

METHODS

In the first phase of the study, the authors obtained information from NLM's *List of Journals Indexed* <<ftp://nlmpubs.nlm.nih.gov/online/journals/lsiweb.pdf>> to identify those journals indexed in the MEDLINE/PubMed database that were published in

SSA countries. Exploratory searches were first conducted in the Author Affiliation field to identify address-specific search terms for each country, and country-specific search strategies were developed. Searches were then performed to retrieve citations to research papers only with first author affiliations for each SSA country. Editorials, letters, and news items were excluded for the study. Author affiliation information for secondary authors is not included in MEDLINE/PubMed.

Searches were limited by publication date to each year from 1995 to 2004. Similar searches were conducted for New Zealand, Mexico, Croatia, and Turkey. The second phase of the study examined specific topics of research among the research publications, focusing on the five major causes of death in the top-ten producing countries, as determined by the World Health Organization. These were HIV/AIDS, malaria, parasitic diseases, cancer, and cardiovascular disease [4]. The number of articles published on each of the five topics was obtained by searching MEDLINE/PubMed using Medical Subject Headings (MeSH) at the most general level for each topic and including all narrower terms. Both human and nonhuman studies were included. Each MeSH search was combined using Boolean "AND" logic with the same country searches used to determine publication rates by country over the ten-year period.

RESULTS

Publication volume

Publication volume from SSA was 29,370 during the study period. Approximately 40% of MEDLINE-indexed publications from SSA were generated by South African authors, followed by Nigerian (16%) and Kenyan (7%) authors. Zimbabwean, Senegalese, and Ethiopian authors each contributed 3%. Authors from the rest of SSA each produced less than 2.5% of the total volume. The 10 countries with the lowest publication volume published fewer than 20 articles each over the decade (Table 1, online).

Between 1995 and 2004, the annual number of articles indexed in MEDLINE by first authors from the top-ten SSA producing countries grew 41% from 2,073 to 2,929 (Table 2). With the exception of Zimbabwe, upward trends were observed in each of the top-ten producing countries. The annual number of citations by Nigerian authors doubled and tripled in Uganda.

Comparison countries

Publication rates in South Africa were compared with rates in 3 other developing countries (Turkey, Croatia, and Mexico) and with New Zealand. Countries were chosen on the basis of several factors, including total expenditure on health as percent of gross domestic product in 2005 similar to that of South Africa (5.7%–8.9%) [5]. With the exception of New Zealand, a high-income country with a small population, the others

* No special funding was received for this work.



Supplemental Tables 1, 3, 4, and 5 and Figure 1 are available with the online version of this journal.

Table 2
Volume of citations in the top-ten countries in Sub-Saharan Africa (1995–2004)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total
South Africa	1,043	1,057	1,099	1,099	1,116	1,302	1,360	1,338	1,333	1,446	12,193
Nigeria	351	345	390	320	398	476	537	635	603	672	4,727
Kenya	224	185	188	172	171	149	188	200	214	236	1,927
Zimbabwe	113	123	120	107	113	129	95	77	69	43	989
Senegal	57	92	85	106	116	115	92	115	114	89	981
Ethiopia	60	83	78	64	99	92	107	117	107	78	885
Tanzania	71	69	63	52	53	72	89	86	77	87	719
Uganda	31	44	58	36	72	58	87	100	85	99	670
Cameroon	57	46	57	47	56	55	86	87	83	90	664
Ghana	66	50	73	64	52	67	51	76	72	89	660
Total	2,073	2,094	2,211	2,067	2,246	2,515	2,692	2,831	2,757	2,929	24,415

are upper-middle income with a gross national income per capita similar to South Africa [5, 6]. South African authors experienced growth and volume of articles similar to that of both Mexico and New Zealand. Among these 5 countries, Turkish authors had the highest number of publications, followed by New Zealand and Mexico. From 1995 to 2004, publication volume by Turkish authors grew six-fold and doubled in Mexico, New Zealand, and Croatia (Table 3 and Figure 1, online).

Geographic distribution

Eighteen percent of authors from South Africa published their articles in the 7 MEDLINE-indexed South African journals, but the majority of South African authors published in European (46%) or North American journals (29%). By comparison, 32% of articles published by Nigerian authors appeared in 5 MEDLINE-indexed Nigerian journals, while 27% of articles by Kenyan first authors appeared in the 2 Kenyan journals. Ugandan authors published 8% of their articles in the country's only MEDLINE-indexed journal, launched in 2003 (Table 4, online).

Indexed journals

MEDLINE-indexed journals in SSA nearly doubled over the decade of the study; growing from ten in 1995 to nineteen in 2004. The number of indexed journals has now grown even further and is twenty-seven as of 2008. Seven of the eight countries with journals indexed in MEDLINE are among the top-ten producers of MEDLINE-indexed publications by SSA authors; the eighth being Madagascar, which had one journal indexed over the ten-year duration.

Topic of study

Using MeSH terminology, searches were conducted to identify the number of papers in the study set that dealt with the 5 major causes of death in each of the top-ten producing countries: HIV/AIDS, malaria, parasitic diseases, cancer, and cardiovascular disease (Table 5, online). The focus on HIV/AIDS was greatest among Ugandan authors (29%), while authors from Nigeria and South Africa published only 3% and 7% of their output on this topic, respectively.

Malaria received the most attention among first authors from Cameroon (15%) and the least among South African authors (1%). Parasitic disease was the most evenly distributed of the topics, discussed in 33% of Cameroonian papers and 5% of those by South African authors. The percentage of any countries' articles covering cancer was greatest in South Africa, at 9% of total volume. Within any countries' publications, Senegalese authors were most likely to have published articles on cardiovascular disease (10%).

Limitations

Several methodological limitations warrant comment. First, MEDLINE is only able to search the addresses of the first author, resulting in an underestimate of the total volume from the region. In addition, some papers may have been missed due to variations in institutional and city names, despite careful attention to search formulations, because journal practices vary with respect to the form of address published and/or the content of the Author Affiliation field is uncontrolled in MEDLINE/PubMed. Another remaining unanswered question relates to how many of these articles were exclusively authored by Sub-Saharan African researchers and how many were coauthored by collaborators from abroad. Finally, the impact factor of SSA research was not measured in this study.

DISCUSSION

Where Sub-Saharan African authors publish

The majority of authors from SSA publish in international journals rather than in national MEDLINE-indexed journals. This is particularly the case for South African researchers. The reasons for this are complex and vary from one country to another. Researchers may target international journals preferentially because they frequently assume that publication in international journals, rather than national journals, is the single most important factor in the promotion policies at most in-country academic institutions [7].

Trends in publication

Although SSA is often cited as being at the low end of the spectrum of health research publication [8, 9], this

analysis shows an upward trend among first authors publishing in the top-ten producing nations, with the exception of Zimbabwe. Much has been said about the huge human resource losses in SSA: 23,000 qualified academic professionals emigrate each year [10]. Surprisingly, the greatest workforce losses are from countries that also have the strongest publication record, including South Africa and Nigeria [11]. Similarly, despite losing 30% of medical graduates to "brain drain" [9], the percentage of articles by Ghanaian first authors increased by one-third over a decade. One possible explanation may be that migrating health professionals may not be representative of the major research workforce from these countries.

Research topics

Publication quantity alone does not reveal information about the quality of work or impact of the research that has been produced. Analysis of a specific topic of research may be a better indicator of national research environments. For example, a Wellcome Trust bibliometric analysis of malaria papers indicated that SSA authors have made major contributions to malaria research, with 17.2% of the world malaria publication output between 1995 and 1997. This contribution has been accomplished largely as a result of outside collaborations, especially with European authors who coauthored 68% of all articles [1].

Sub-Saharan African authors do publish relevant research. Regionally, parasitic disease has been found to be the most popular area of research, reflecting the high volume of parasitic disease. Concurrently in these same settings, rapid urbanization is taking place, which in turn leads to increasing rates of cancer and cardiovascular disease [12]. This trend is reflected in the volume of publications on these topics by South African authors and confirms previous studies indicating that 40% of publications from SSA are focused on chronic, non-communicable diseases [13].

Implications for research and public policy

Importance of national publications from Sub-Saharan Africa. The presence and growth of quality SSA journals indexed in MEDLINE shows a promising trend. National journals in the developing world are important because they have been shown to influence practice more than information published in North American or European journals [14]. Communicating health research data regionally in areas with shared diseases and local conditions is also likely to be effective with respect to improving health outcomes. Universities in SSA might acknowledge this by encouraging researchers to publish in MEDLINE-indexed national journals. These journals serve as an important resource for continuing medical education and, because of lower cost, may be more accessible to health care workers, especially in rural areas. It is also important to recognize that international and national

journals are not the sole repositories of good evidence. In resource-poor settings, the gray literature (i.e., research results that appear in monographs and reports) also plays a critical role. For example, a Wellcome Trust analysis in Africa has found that national unpublished research has a major impact on national policies for the treatment and control of malaria [1].

Role for national publications from Sub-Saharan Africa. More must be done to strengthen and promote high-quality publishing practices in national medical research journals in SSA to increase both visibility and readership. Since 2003, the Forum of African Medical Editors, established under the auspices of Tropical Disease Research at the World Health Organization, has explored innovative mechanisms for improving quality and dissemination of national medical publications. Similarly, the US National Institutes of Health, through the Fogarty International Center and the National Library of Medicine, has funded the Council of Scientific Editors <<http://www.councilscienceeditors.org>> to manage a nascent partnership program that pairs the editors of four Sub-Saharan African journals with partners at prominent UK- or US-based journals. The goal is to increase the number of African journals indexed in MEDLINE by building expertise among editors, promoting good business practices, and most critically, promoting training for authors and reviewers. Early results of this twinning project are encouraging [15].

Recommendations

In the future, studies might focus more specifically on the kind of research published in SSA, such as clinical versus epidemiological; the nature of the readership of SSA publications; and the ways priorities are set by SSA journal editorial boards. Finally Sub-Saharan African universities and research institutions might contemplate altering their practice of giving academic credit exclusively for publications in high-profile international journals and might consider giving equal weight to publishing in national journals that have been indexed in international, credible databases such as MEDLINE.

ACKNOWLEDGMENTS

The authors thank Milagros A. Ruiz at the John E. Fogarty International Center for research assistance and manuscript preparation and Lou Wave Snyder Knecht and Andy Harbert at the National Library of Medicine for assistance with search strategy formulation and automation.

REFERENCES

1. Beattie P, Renshaw M, Davies C. Strengthening health research in the developing world: malaria research capacity

- in Africa [Internet]. The Wellcome Trust; 1999 [cited 2 Feb 2006]. <<http://www.wellcome.ac.uk/assets/wtd003224.pdf>>.
2. Horton R. North and south: bridging the information gap. *Lancet*. 2000 Sep;355(9222):2231-6. DOI: 10.1016/S0140-6736(00)02414-4.
 3. King DA. The scientific impact of nations: what different countries get for their research spending. *Nature*. 2004 Jul;430(6997):311-6. DOI: 10.1038/430311a.
 4. Mathers CD, Bernard C, Iburg K, Inoue M, Ma Fat D, Shibuya K, Stein C, Tomijima N. The global burden of disease in 2002: data sources, methods and results [Internet]. World Health Organization [cited 23 Jun 2008]. <<http://www.who.int/healthinfo/paper54.pdf>>.
 5. World Health Organization. Countries [Internet]. The Organization [cited 3 Jun 2008]. <<http://www.who.int/countries/en/>>.
 6. The World Bank Group. Data and statistics: country classification [Internet]. The Group [cited 3 Jun 2008]. <<http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20421402~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html>>.
 7. Gaillard J, Tullberg AF. Questionnaire survey of African scientists. MESA Impact Studies report no. 2 [Internet]. Stockholm, Sweden: International Foundation for Science; 2001 May [cited 21 Aug 2008]. <http://www.ifs.se/Publications/Mesia/MESIA_2_Questionnaire_Africa_english.PDF>.
 8. Paraje G, Sadana R, Karam G. Public health: increasing international gaps in health-related publications. *Science*. 2005 May;308(5724):959-60. DOI: 10.1126/science.1108705.
 9. Perez-Iratxeta C, Andrade MA. Worldwide scientific publishing activity. *Science*. 2002 Jul;297(5581):519. DOI: 10.1126/science.297.5581.519b.
 10. Pang T, Lansang MA, Haines A. Brain drain and health professionals. *BMJ*. 2002 Mar;324(7336):499-500. DOI: 10.1136/bmj.324.7336.499.
 11. Hagopian A, Thompson MJ, Fordyce M, Johnson KE, Hart LG. The migration of physicians from Sub-Saharan Africa to the United States of America: measures of the African brain drain. *Hum Resour Health*. 2004 Dec;2(1):17. DOI: 10.1186/1478-4491-2-17.
 12. Sodjinou R, Agueh V, Fayomi B, Delisle H. Obesity and cardio-metabolic risk factors in urban adults of Benin: relationship with socio-economic status, urbanisation, and lifestyle patterns. *BMC Public Health*. 2008 Mar 4;8:84. DOI: 10.1186/1471-2458-8-84.
 13. Hofman K, Ryce A, Prudhomme W, Kotzin S. Reporting of non-communicable disease research in low- and middle-income countries: a pilot bibliometric analysis. *J Med Libr Assoc*. 2006 Oct;94(4):415-20.
 14. Page J, Heller RF, Kinlay S, Lim LL, Qian W, Suping Z, Kongpatanakul S, Akhtar M, Khedr S, Macharia W. Attitudes of developing world physicians to where medical research is performed and reported. *BMC Public Health*. 2003 Jan;3(6). DOI: 10.1186/1471-2458-3-6.
 15. Goehl TJ. Access denied. *Environ Health Perspect*. 2007 Oct;115(10):A482-3. DOI: 10.1289/ehp.10729.

AUTHORS' AFFILIATIONS

Karen J. Hofman, MD (corresponding author), hofmank@mail.nih.gov, Director, Division of International Science Policy, Planning and Evaluation, The John E. Fogarty International Center, National Institutes of Health, 16 Center Drive, MSC 6705, Bethesda, MD 20892-6705; **Christine W. Kanyengo, MALS**,

ckanyengo@yahoo.com, Head, Medical Library, School of Medicine, University of Zambia, Box 50110, Lusaka, Zambia; **Barbara A. Rapp, PhD**, rappb@mail.nlm.nih.gov, Chief, Office of Planning and Analysis, Office of Health Information Programs and Development, National Library of Medicine, National Institutes of Health, 8600 Rockville Pike, MSC 3811, Bethesda, MD 20894-3811; **Sheldon Kotzin, MLS, FMLA**, kotzins@mail.nlm.nih.gov, Associate Director for Library Operations, National Library of Medicine, National Institutes of Health, 8600 Rockville Pike, MSC 3814, Bethesda, MD 20894-3814

Received April 2008; accepted August 2008