

Africa's neglected area of human resources for health research – the way forward

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Building the skills for doing, managing and delivering health research is essential for every country's development. Yet human resources for health research (HRHR) are seldom considered in Africa and elsewhere. Africa's health research capacity has grown considerably, with potential to increase this growth. However, a systemic way of defining, co-ordinating and growing the HRHR needed to support health systems development is missing. Reviewing the status of HRHR in Africa, we assert that it consists of unco-ordinated, small-scale activities, primarily driven from outside Africa. We present examples of ongoing HRHR capacity building initiatives in Africa.

There is no overarching framework, strategy or body for African countries to optimise research support and capacity in HRHR. A

simple model is presented to help countries plan and strategise for a comprehensive approach to research capacity strengthening. Everyone engaged with global, regional and national research for health enterprises must proactively address human resource planning for health research in Africa. Unless this is made explicit in global and national agendas, Africa will remain only an interested spectator in the decisions, prioritisation, funding allocations, conduct and interpretation, and in the institutional, economic and social benefits of health research, rather than owning and driving its own health research agendas.

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Limited capacity in low-resource regions hampers quality research, and building human resources for health research (HRHR) capacity is critical for system strengthening. Little has been written about the complex topic of HRHR,¹ and this is the first attempt to position the potential of HRHR for Africa. It is important to include HRHR in 'no health without research' debates and to mobilise the international community to support Africa's potential to address the gaps in this area.

The capacity for health research in Africa has grown considerably,²⁻¹⁰ with great potential to build on this growth. However, a systemic way of defining, co-ordinating and growing the HRHR needed to support health systems development is missing. We reflect on the status of HRHR capacity in Africa, highlighting the absence of an overarching framework, strategy or body focused on building African HRHR capacity. Resources should be directed towards building HRHR capacity at all stages of the research process, at all levels in the system, and across multiple national sectors.

No health without research

High-quality research is critical for identifying, prioritising and addressing the health needs of a population. The *World Health*

Report 2012 will centre on the essential role of research in improving health outcomes. Health research drives development, as it generates the knowledge needed to improve health systems performance and, ultimately, health and health equity.^{11,12} Strengthening the capacity of health research systems therefore directly affects the ability of nations to improve their health outcomes.^{13,14} Despite this awareness, a mismatch remains between the increased disease burden in low- and middle-income countries (LMICs),¹⁵ and their technical and human capacity to use existing knowledge or generate new knowledge to address major health challenges.^{16,17}

The Commission on Health Research for Development produced its report, *Health Research: Essential Link to Equity in Development* in 1990.¹⁸ Work leading up to this report demonstrated that health research was not given its proper role in improving health, equity and development in LMICs. The Commission recommended that LMICs should spend 2% of their health programme budgets on health research, and that donors should match this with an allocation of 5% of their (externally provided) health programme funding. These percentages have repeatedly been recommended in subsequent publications, forums and declarations, but allocation of these funds has been difficult to measure and has rarely been achieved.¹⁹

No research without capacity

Four global commissions^{18,20-22} have extensively referred to the need for research to prioritise and address the health problems they were mandated to examine. Despite this, all but one of the reports¹⁸ fail to explicitly refer to the need for enhanced research capacity in LMICs. Capacity is defined here as the ability of people, organisations and societies to manage their affairs successfully.²³ A framework for capacity strengthening may focus on different levels, systems, or processes involved in the broad activity of research.²⁴ Human resource development is an essential building block to strengthen capacity at all levels within the research system, and at all stages during the research process.²⁵

Research capacity strengthening (RCS) enables LMICs to identify health research priorities and develop strategies relevant to local contexts.^{12,26} If countries are to achieve their own and international health and development goals such as the millennium development goals (MDGs), there must be substantial investment in the capacity

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to carry out multidisciplinary research in the context of national health research systems.^{23,27,28} However, evidence of impact or returns on investment in HRHR are not immediately tangible^{29,30} (or easily measurable³¹⁻³⁴) and, given the magnitude of the challenges facing under-resourced LMICs, the attention of national governments and international donors has largely been directed elsewhere.³⁵

As research and innovation is increasingly recognised as important for development, it is not surprising that debates in science, technology and innovation (STI) have focused on strengthening human resources for research.^{17,36-43} Capacity building efforts have similarly been directed at the health sector, where much work has been done to address the shortage of human resources for health (HRH) in LMICs.⁴⁴⁻⁴⁶ There have been similar calls to increase health research system capacity^{12,14,28,47} and strengthen the knowledge base required to address local health needs. However, there are limited calls to action, recommendations, or planning specifically for resources for those who must capacitate this system or help create this particular knowledge base.^{8,48}

Where is the capacity for health research?

The health research system interfaces with both the health and the research systems. However, other than disparate discussions on migration and curbing the brain drain,⁴⁹ the need to capacitate health research is often neglected. Furthermore, health research is typically dealt with by three different ministries – health, science and technology (S&T), and higher education – further exacerbating the fragmentation of health research capacity. While most academic health research falls under ministries of higher education, research conducted by medical research councils and other national bodies is mandated to ministries of health. The separation of research in the health sector from that conducted in the STI domain is becoming increasingly irrelevant and unproductive. Health research is more usefully conceptualised in systematic terms, allowing for more effective communication between stakeholders in all sectors and at each end of the research process.

Health research capacity is defined as the ability to identify problems, set priorities, build sustainable institutions, and identify solutions to key national health problems.⁵⁰ Capacity building efforts in HRHR are marked by their absence, and there is little understanding of how capacity is weak.²⁵ This is partly because

much health research conducted in LMICs is problem-specific ('vertical approach') and typically concerns only conditions for which international funding is available. While capacity building is often included as a component of many development programmes, it is seldom the primary objective.^{14,24,51-53} Nonetheless, there is increasing potential for evaluating the impact of such investments because of efforts towards measuring the effectiveness of sustainable capacity building.^{13,31,33,54} Such initiatives will hopefully encourage greater national and international investment in capacity building in LMICs.

Strengthening HRHR capacity: From individual training to system growth

Analysis and strengthening of research capacity must appreciate the different levels (individual, institutional and macro), functions and enabling variables within the system.^{25,28} Previous capacity building strategies have focused on individual skills development, knowledge transfer and training,^{15,23,47} but there is increasing recognition that capacity building must be approached in systemic terms.^{12,14,24,28,47} This necessitates capacitating the system with people who have skills including administration and management, priority setting, networking and leadership, translation into policy and action, dissemination, advocacy, and ethics. An enabling environment for research is important,^{12,16} along with the political will and leadership to mobilise a sustainable system.^{28,55}

We know of no framework that brings all these dimensions together to assist with decisions regarding the forms of capacity strengthening needed within the health research system. As a starting point, the Council on Health Research for Development (COHRED) has developed a simple model for mapping capacity at all levels of the system to identify areas in need of strengthening. Recognising the dynamic and complex nature of health research systems, it is possible for many capacity building actions to contribute to more than one box in the grid. The Research Capacity Strengthening (RCS) grid (Table I) is a 2x2 table in which the level of development of a nation's research system is related to the level at which capacity building or strengthening needs to be undertaken.

Where are the human resources for health research in Africa?

Although progress has been made, the disparity in research capacity among countries and between regions is wide, and unfavourably

Table I. Research capacity strengthening (RCS) grid

Type of intervention / Level of intervention	Individual	Institution	Research system	Socio- economic & political	International collaboration & linkage
'Capacity building'	Master level training	Grants management	Priority setting Strategy development	Increase demand for research	Good partnerships (e.g. alignment & harmonisation)
'Capacity strengthening'	Doctoral level training	Merit-based promotion system	Research ethics review capacity	Civil society engagement	Fair research contracting
'Performance enhancement' <i>*equity-focus</i>	Networking researchers, peer reviews	Research communication	Monitoring & evaluation of output & impact	Focus on health, equity & socio-economic development	Focus on research competitiveness

The actions listed in this grid are selected examples of capacity strengthening at each level. Many more actions can be undertaken in each cell; however, a full listing of all activities is beyond the scope of this article.

Table II. Selected examples of HRHR capacity building initiatives in Africa

Human Resources for Health Research in Africa (HRHR Africa). The consultative process and Africa regional expert meeting on HRHR, Nairobi, 2006, was probably the first holistic look at human resources needs in the health research for development context. (http://www.idrc.ca/en/ev-102239-201-1-DO_TOPIC.html <http://www.cohred.org/HR-HR>)

The Initiative to Strengthen Health Research Capacity in Africa (ISHReCA) was started by some African health researchers to create a network 'to promote the creation of self-sustaining pools of excellence capable of... high-quality health research in Africa... and translating research products into policy and practice through... capacity building at individual, institutional and system levels' (<http://ishreca.tropika.net>)

Wellcome Trust – the UK-based global charity – has invested in individual capacity building through PhD programmes for many years. It has supported two major research capacity building initiatives in Africa and institutions in the UK to support research at African universities. www.wellcome.ac.uk <http://www.wellcome.ac.uk/News/Media-office/Press-releases/2008/WTD039430.htm> <http://www.wellcome.ac.uk/News/Media-office/Press-releases/2009/WTX055742.htm>

The National Institutes of Health and the Wellcome Trust – Human Hereditary for Health in Africa (H3Africa) initiative aims to facilitate a contemporary research approach to studying genomics and environmental determinants of common diseases with the goal of improving the health of African populations. The H3Africa initiative aims to contribute to developing the necessary expertise among African scientists, and to establish networks of African investigators. <http://h3africa.org>

The **World Health Organization** has four programmes on research and research capacity building and supports capacity building for ethics review of health research.

- **Tropical Disease Research (WHO/TDR)** focuses on individual doctoral programmes and research on tropical diseases. It includes a 'country capacity building focus' <http://apps.who.int/tdr>
- An 'initiative' of WHO/TDR is **African Network for Drugs and Diagnostics Innovation (ANDI)** which aims to 'create a sustainable platform for R&D innovation in Africa to address Africa's own health needs' <http://www.andi-africa.org/>
- **Evidence-Informed Policy Network (EVIPNet)** promotes the systematic use of health research evidence in policy making. Country teams operate in Burkina Faso, Cameroon, Central African Republic, Ethiopia, Mali, Mozambique, Tanzania, Uganda and Zambia.
- **Enhancing Support for Strengthening the Effectiveness of National Capacity Efforts (ESSENCE)** is hosted by WHO/TDR in Geneva. Funded by Sida, it is a collaboration between funding agencies to provide co-ordination to address research capacity needs. <http://apps.who.int/tdr/svc/partnerships/initiatives/essence>

INDEPTH network – an international organisation for the demographic evaluation of populations and their health in developing countries – is the largest, most long-lasting and productive research network in health in Africa with 26 INDEPTH sites in 12 African countries: Burkina Faso, Ethiopia, the Gambia, Ghana, Guinea Bissau, Kenya, Malawi, Mozambique, Senegal, South Africa, Tanzania and Uganda www.indepth-network.org

National Institutes of Health: NIH/FIC – and other institutes – probably provide the largest part of externally funded research in Africa – directly or through USA-based research institutions (for example, National Institute of Allergy and Infectious Diseases (NIAID)-funded **Malaria Research and Training Center** in Mali). NIH have also given long-term support to institutional capacity building in research ethics in Africa. Now in its 10th year, it has co-ordinated other NIH institutes to provide grants to over 10 African institutions that have trained many more professionals in ethics review of health research. <http://www.fic.nih.gov/index.htm>

The **African Malaria Network Trust (AMANET)** aims to 'promote capacity strengthening and networking of malaria research and development in Africa'. Based in Tanzania, it offers training courses across Africa. <http://www.amanet-trust.org>

The **Consortium for Advanced Research Training in Africa (CARTA)** aims to have a positive impact on public and population health by focusing on research training and capacity building and establishing multidisciplinary research hubs at African universities. <http://www.apfrc.org/insidepage/?articleid=417>

Northern academic institutions. Some northern academic institutions have long-term relationships with African institutions that contribute to research capacity building. The partnership between the **London School of Hygiene and Tropical Medicine** with South Africa and Thailand showed improvements in research skills of researchers and institutions. <http://www.health-policy-systems.com/content/6/1/8> The **Bandim Health Project** in Guinea Bissau has operated since 1978 between the **University of Copenhagen**, Denmark, and Guinea Bissau. It has mostly focused on research and individual training. <http://www.bandim.org>

Table II. Selected examples of HRHR capacity building initiatives in Africa – continued

The **European and Developing Countries Clinical Trial Partnership (EDCTP)** aims to accelerate the development of new or improved drugs, vaccines and microbicides against HIV/AIDS, malaria and tuberculosis – through capacity building for clinical trials. <http://www.edctp.org>. It has funded work in most of sub-Saharan Africa.

The **International Association of National Public Health Institutes (IANPHI)** is one of the few global initiatives concentrating on institutional strengthening in public health. Its African members are Angola, Cote d'Ivoire, Ghana, Guinea Bissau, Kenya, Morocco, Mozambique, Nigeria, South Africa, Tanzania, Togo and Uganda. It aims to develop stronger and more co-ordinated public health systems, by developing national public health institutes. www.ianphi.org

Collaborative networks in the social sciences include the **Network of Excellence for Qualitative Research in the Social Sciences**, which helps to strengthen the research capacity of higher education institutions in sub-Saharan Africa, mainly through training of individuals. It is a project of the Institute for Development Studies (IDS), UK, with collaborative centres in Ghana, South Africa and Tanzania. <http://www.ids.ac.uk/go/idsproject/network-of-excellence-for-qualitative-research-in-the-social-sciences> and <http://www.qrmafrica.org>

New Partnership for Africa's Development (NEPAD)–COHRED initiative: Strengthening Pharmaceutical Innovation Capacity in Africa is the only initiative that targets the governance level, which combines technical and political components. It aims to enable countries to establish 'conducive environments' in which pharmaceutical innovation can flourish. http://www.cohred.org/African_Innovation

Equinet, the Regional Network on Equity in Health in Southern Africa, comprises professionals, civil society members, policy makers, state officials and others within the region who are interested in promoting shared values of equity and social justice in health. <http://www.equinet africa.org>

The **Zambian Forum for Health Research (ZAMFOHR)** works to create an environment where health research evidence forms the basis for policy and practice. Its goals are to harmonise and harvest health research in Zambia and relating to Zambian issues, assist knowledge translation processes, particularly as a broker bringing together the producers and users of knowledge, and to be a resource centre for the research community. www.zamfohr.org

CIAM, the Public Health Research and Development Centre, in the Gambia, bridges the gap between the health needs of people in West Africa, national health policies and relevant research. <http://www.ciam.gm>

weighted against LMICs.⁵⁶⁻⁵⁸ As elsewhere, health research is seen as separate from STI in most African countries,^{59,60} and the ways in which the poorest African countries can develop their fragile health systems and their own capacity to do health research is rarely discussed.^{9,61,62} Despite this, much health research is happening in Africa, and the building of research capacity over the last three decades has left the continent increasingly capable and self-assured in the context of research and innovation for health.²⁻¹⁰ Nonetheless, even in countries, like South Africa, that are leaders in STI on the continent,^{63,64} deficits remain in human resources for *health* research.⁴⁸

While attempts have been made to map international initiatives aimed at strengthening research capacities in Africa generally,²⁴ knowledge about capacity building support for *health* research and research uptake in Africa is fragmented or non-existent.^{15,24,62} Overall the African effort is unco-ordinated, small-scale, and largely driven from outside Africa. Nevertheless, the lack of information on current strategies is not a reflection of what is happening, as many activities are under way to strengthen HRHR capacity in Africa (Table II).

The listing here focuses on those programmes supporting the capacities of African countries and institutions to manage health research. However, it shows that many efforts are geared towards individual capacity building, with indirect benefit to institutions. For example, one donor or bilateral agency may fund several institutions in their own country, all of which will have individual projects in African countries.⁵² Local research institutions, scientific academies and universities rarely receive any direct support. Separation by

language regions persists, and attention to co-ordinating mechanisms is rare.

Currently there is no way to accurately map all these externally driven initiatives. Therefore it is close to impossible to list the individual research projects that focus on specific diseases or conditions, or that are interested in health systems evaluation and performance. However, it is increasingly possible to map African institutions for health research through COHRED's Health Research Web (HRWeb) and, in future, through NEPAD's African Science, Technology and Innovation Indicator (ASTII) project.

Conclusions

HRHR is a key component of national research capacity and national health systems. Until recently, LMICs have largely been spectators in research for health that is essentially about their own countries. But considerable progress has been made in Africa in research for health in the past three decades, and the spectator phase is giving way to active participation in research that is for and about the health and development needs of African countries.

Despite this, HRHR is not being explicitly addressed by global efforts to improve the number and expertise of human resources for health in LMICs. Because HRHR straddles different domains (health, S&T, and higher education), it falls between the gaps. Major potential is lost by not systematically addressing HRHR and not viewing it in collaboration with the STI domain. Tapping into such potential can contribute significantly to health and health systems development.

Why is it acceptable that health care and human resources for health should be built up within African countries themselves, but that *health research* can be provided for and driven from outside Africa? Health systems strengthening, currently high on the agendas of international and national partners, cannot happen without adequate HRHR. Africa needs many more HRHRs to improve its own health systems and address its own health needs.

Recommendations

- **Africa needs data** – on research, on research for health, and on human resources for both.
- Based on these data, Africa must develop a **co-ordinated strategy** to build HRHR capacity.
- The commitment by African ministries of health to spend **2% of health budgets on health research** following the Bamako Declaration must be reiterated. Data on how well African governments are faring on this measure are sparse because research for health is often funded out of budgets in ministries other than the Ministry of Health. The *World Health Report 2012* will further highlight the need for co-ordinated efforts in this regard.
- **Responsible vertical programming (RVP)** should become the norm. This means restructuring disease-focused research programmes in ways that support national capacity for health research and health research management. HRHR must be seen as integral to development, and not only as a short-term, crisis-solving tool.
- **Harmonisation and partnership.** There must be greater communication and collaboration among international funders to support for capacity building efforts in health research.^{24,54,66} Dedicated funding is needed for explicit capacity building initiatives for HRHR, while health research programmes should have built-in capacity building components, with a focus on developing HRHR.
- **Diversification of capacity building.** Capacity building efforts must focus on knowledge transfer and generation and also on human resources for policy development and advocacy, research management, governance and stewardship.
- **Monitoring and evaluation** is an area requiring urgent attention. While several RCS initiatives have been undertaken, systematic learning from them has been weak.^{13,24} Establishing indicators to measure the effectiveness of HRHR capacity building would strengthen the case for investing in such efforts.

References

1. IJsselmuide C. Human resources for health research. *Medicus Mundi Switzerland (MMS) Bulletin* 2007;104:22-27.
2. Ezeh AC, Chimaraokwe OI, Kabiru CW, et al. Building capacity for public and population health research in Africa: The Consortium for Advanced Research Training in Africa (CARTA) model. *Global Health Action* 2010; 3, doi: 10.3402/gha.v3i0.5693.
3. Kebede D, Zielinski G, Mbondji PE, et al. Improving the availability of health information, research evidence, and knowledge to strengthen health systems. *The African Health Monitor* 2010;12:53-64.
4. Lazarus JW, Wallace SA, Liljestrand J. Improving African health research capacity. *Scand J Public Health* 2010;38:670-671.
5. Mgone C, Volmink J, Coles D, Makanga M, Jaffar S, Sewankambo N. Linking research and development to strengthen health systems in Africa (Editorial). *Trop Med Int Health* 2010;15:1404-1406.
6. Ncayiyana D. Africa can solve its own health problems (Editorial). *BMJ* 2002;324:688-689.
7. Nwaka S, Ilunga TB, Da Silva JS, et al. Developing ANDI: A novel approach to health product R&D in Africa. *PLoS Medicine* 2010;7, e1000293. doi:10.1371/journal.pmed.1000293
8. Parker I, Atimmo T, May J, Titanji V, et al. Health and human well-being in sub-Saharan Africa. ICSU Regional Office for Africa Science Plan. Pretoria: International Council for Science, 2009.
9. Whitworth JA, Kokwaro G, Kinyanjui S, et al. Strengthening capacity for health research in Africa. *Lancet* 2008;372:1590-1593.
10. Williams JR, Schatz EJ, Clark BD, et al. Improving public health training and research capacity in Africa: a replicable model for linking training to health and socio-demographic surveillance data. *Global Health Action* 2010;3, doi: 10.3402/gha.v3i0.5287.
11. Mullan F, Frehywot S, Omaswa F, et al. Medical schools in sub-Saharan Africa. *Lancet* 2011;377:1113-1121.
12. Pang T, Sadana R, Hanney S, Bhutta ZA, Hyder AA, Simon J. Knowledge for better health – a conceptual framework and foundation for health research systems. *Bull World Health Organ* 2003;81:815-820.
13. Bates I, Taetmeyer M, Bertel Squire S, et al. Indicators of sustainable capacity building for health research: analysis of four African case studies. *Health Research Policy and Systems* 2011; 9:14 doi:10.1186/1478-4505-9-14.

14. Nuynens Y. No Development without Research: A Challenge for Capacity Strengthening. Geneva: Global Forum for Health Research, 2005.
15. Green A, Bennett S, eds. *Sound Choices: Enhancing Capacity for Evidence-Informed Health Policy*. Geneva: WHO, 2007.
16. Gyapong JO, Ofori-Adeji D. Capacity Building for Relevant Health Research in Developing Countries. Netherlands: Netherlands Organisation for International Cooperation in Higher Education, 2006.
17. Kearney ML. Higher education, research and innovation: charting the course of the changing dynamics of the knowledge society. In: Meek VL, Teichler U, Kearney ML, eds. *Higher Education, Research and Innovation: Changing Dynamics*. Report on the UNESCO Forum on Higher Education, Research and Knowledge, 2001-2009. Germany: International Centre for Higher Education Research Kassel (INCHER-Kassel), 2009:8-24.
18. Commission on Health Research for Development. *Health Research: Essential Link to Equity in Development*. New York: Oxford University Press, 1990.
19. Global Forum for Health Research. *Monitoring Financial Flows for Health Research*. Geneva: GFHR, 2004. <http://www.globalforumhealth.org/Media-Publications/Publications/Monitoring-Financial-Flows-for-Health-Research-2004> (accessed 4 March 2011).
20. World Health Organization. *Macroeconomics and Health: Investing in Health for Economic Development*. Report of the Commission on Macroeconomics and Health. Geneva: WHO, 2001.
21. World Health Organization. *Public Health, Innovation and Intellectual Property Rights*. Report of the Commission on Intellectual Property, Innovation and Public Health. Geneva: WHO, 2006.
22. World Health Organization. *Closing the Gap in a Generation: Health Equity through Action on the Social Determinants of Health*. Final Report of the Commission on the Social Determinants of Health. Geneva: WHO, 2008.
23. Organisation for Economic Co-operation and Development. *The Challenge of Capacity Development: Working Towards Good Practice*. Paris: OECD, 2006.
24. Jones N, Bailey M, Lyytikäinen M. *Research Capacity Strengthening in Africa: Trends, Gaps and Opportunities*. A scoping study commissioned by DFID on behalf of IFORD. London: ODI, 2007.
25. Ghaffar A, IJsselmuide C, Zicker F. *Changing Mindsets: Research Capacity Strengthening in Low- and Middle-Income Countries*. Geneva: COHRED, Global Forum for Health Research and UNICEF/UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR), 2008.
26. Farley SE. *Support to Science, Technology, and Knowledge for Development: A Snapshot of the Global Landscape (Summary Report)*. Paper prepared for the Africa-Canada-UK Exploration: Building Science and Technology Capacity with African Partners. London: World Bank, Rockefeller Foundation & IDRC, 2005.
27. Magwaza S, Mathambo V, Magongo B, Kortzenbut E, Mvo N, Makhanya N. *Health Research Capacity Building in South Africa: Current Knowledge and Practices*. Cape Town: Health Systems Trust, 2003.
28. Lansang MA, Dennis R. Building capacity in health research in the developing world. *Bull World Health Organ* 2004;82:764-770.
29. Frank C, Nason E. Health research: measuring the social, health and economic benefits. *Can Med Assoc J* 2009;180:528-534.
30. Laroche M, Merette M. On the concept and dimensions of human capital in a knowledge-based economy context. *Canadian Public Policy* 1999;25:87-100.
31. Bates I, Yaw A, Akoto O, et al. Evaluating health research capacity building: an evidence-based tool. *PLoS Medicine* 2006;3:1224-1229.
32. Cooke J. A framework to evaluate research capacity building in health care. *BMC Family Practice* 2005;6:44 doi:10.1186/1471-2296-6-44.
33. Gadsby EW. Research capacity strengthening: donor approaches to improving and assessing its impact in low- and middle-income countries. *The International Journal of Health Planning and Management* 2011;26:89-106. doi: 10.1002/hpm.1031.
34. Buxton M, Hanney S, Jones T. Estimating the economic value to societies of the impact of health research: a critical review. *Bull World Health Organ* 2004;82:733-739.
35. Inter-Academy Council (IAC). *Inventing a better future: IAC report*. Netherlands: IAC, 2003.
36. Academy of Science of South Africa (ASSAf). *The PhD study: an evidence-based study on how to meet the demands for high-level skills in an emerging economy*. Pretoria: ASSAf, 2010.
37. Organisation for Economic Co-operation and Development. *OECD reviews of innovation policy South Africa. Science & Information Technology* 2007;14:1-258.
38. Oketch MO. Determinants of human capital formation and economic growth of African countries. *Economics of Education Review* 2006;25:554-564.
39. Velho L. Building a critical mass of researchers in the least developed countries: new challenges. In Box L, Engelhard R, eds. *Science and Technology Policy for Development: Dialogues at the Interface*. London: Anthem Press, 2006.
40. Chandiwana S, Ornberg N. Review of north-south and south-south cooperation and conditions necessary to sustain research capability in developing countries. *Journal of Health & Population Research* 2003;21:288-297.
41. Kotecha P, Walwyn D, Pinto C. Deepening Research Capacity and Collaboration across Universities in SADC: A Southern African Universities Regional Research and Development Fund. Southern African Regional Universities Association (SARU), 2011.
42. Mwaba P, Bates M, Green C, Kapata N, Zumla A. Research capacity strengthening in African countries. *Lancet* 2010;375:1874.
43. Volmink J, Dare L. Addressing inequalities in research capacity in Africa (Editorial). *BMJ* 2005;331:705-706.
44. Joint Learning Initiative (JLI). *The Health Workforce in Africa. Challenges and Prospects*. A report of the Africa Working Group of the Joint Learning Initiative on Human Resources for Health and Development. Geneva: WHO, 2006.
45. World Health Organization. *The World Health Report 2006: Working Together for Health*. Geneva: WHO, 2006.
46. World Health Organization. *Everybody's Business: Strengthening Health Systems to Improve Health Outcomes: WHO's Framework for Action*. Geneva: WHO, 2007.
47. Potter C, Brough R. *Systemic Capacity Building: A Hierarchy of Needs*. *Health Policy & Planning* 2004;19:336-345. doi: 10.1093/heapol/czh038.
48. Academy of Science of South Africa. *Revitalising Clinical Research in South Africa: A Study on Clinical Research and Related Training in South Africa*. Pretoria: ASSAf, 2009. <http://www.assaf.co.za/wp-content/uploads/2009/09/ASSAf-Clinical-Report-2009.pdf> (accessed March 2011).
49. Saravia NG, Miranda JF. Plumbing the brain drain. *Bull World Health Organ* 2004;82:608-615.
50. Global Forum for Health Research. *The 10/90 Report on Health Research 2000*. Geneva: Global Forum for Health Research, 2000.
51. Olsson B, Mkandawire T. Compelling rationale for a UNESCO forum on knowledge systems. In: Meek VL, Teichler U, Kearney ML, eds. *Higher Education, Research and Innovation: Changing Dynamics*. Report on the UNESCO Forum on Higher Education, Research and Knowledge, 2001-2009. Germany: International Centre for Higher Education Research Kassel (INCHER-Kassel), 2009: 25-40.
52. Lele U, Ridker R, Upadhyay J. Health system capacities in developing countries and global health initiatives on communicable diseases. Background paper prepared for the International Task Force on Global Public Goods. Stockholm: Secretariat of the International Task Force on Global Public Goods, 2005.
53. COHRED. *Are International Health Research Programmes Doing Enough to Develop Research Systems and Skills in Low and Middle Income Countries? Responsible Vertical Programming: How Global Health Research can Deliver Essential Research, Achieve Impact and Build National Systems*. Geneva: COHRED, 2007.

54. ESSENCE. Planning, monitoring & evaluation framework for capacity strengthening in health research: ESSENCE good practice document series. Geneva: Copytrend, 2011.
55. Omaswa F, Boufford JL. Supporting Ministerial Health Leadership: A Strategy for Health Systems Strengthening. New York: ACHEST & NYAM, with support from the Rockefeller Foundation, 2010.
56. Mgone CS. Strengthening of the clinical research capacity for malaria: a shared responsibility. *Malaria Journal* 2010;9:S5.
57. Nchinda TC. Research capacity strengthening in the South. *Soc Sci Med* 2002;5:1699-1711.
58. Sanyal BC, Varghese NV. Research Capacity of the Higher Education Sector in Developing Countries. Paris: International Institute for Educational Planning, UNESCO, 2006.
59. Juma C, Serageldin I. Freedom to Innovate: Biotechnology in Africa's Development. Report of the High-Level Panel on Modern Biotechnology, African Union (AU) and New Partnership for Africa's Development (NEPAD). Johannesburg: DS Print Media, 2007.
60. Kalua F, Awotedu A, Kamwanja L, Saka J, eds. NEPAD/African Union: Science, Technology and Innovation for Public Health in Africa. Johannesburg: DS Print Media, 2009.
61. COHRED. A health research perspective on the African Regional Health report: Research for health briefing 5. Geneva: COHRED: 2007
62. COHRED. Human resources for health research (HRHR). Background paper prepared by COHRED for the African Platform on Human Resources for Health, August 2010. Geneva: COHRED, 2010. <http://www.aphrh.org/category/resource-category/aphrh-technical-papers> (accessed February 2011).
63. Diab R, Gevers W, eds. The State of Science in South Africa. Pretoria: Academy of Science of South Africa, 2009.
64. UNESCO. UNESCO Science Report 2010: The Current Status of Science around the World. Paris: UNESCO, 2010.
65. Nurse K, Wight D. Development assistance and research capacity strengthening: The commissioning of health social science research in East Africa, 2006. http://www.policyinnovations.org/ideas/policy_library/data/01381/_res/id=sa_File1/Nurse_RCS_EastAfrica.pdf (accessed March 2011).
66. COHRED. Synthesis Report on Alignment and Harmonization in Health Research: AHA study. Geneva: COHRED, 2008.

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