Article

The needs of biomedical science training in Africa: Perspectives from the experience of young scientists

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Introduction

Biomedical research is a powerful tool for solving health challenges in developing regions. The present study is aimed at describing the needs of biomedical science training in Africa from the experience of young African scientists at home and in the diaspora. A total of 107 young scientists were recruited through existing international networks and interviewed via a web-based program, on the current status of biomedical research in their different institutions, as well as the major obstacles faced and their aspirations. This survey revealed that although considerable efforts have been made in strengthening research capacity in Africa, much remains to be done. Biomedical research in Africa is seriously hindered by obstacles such as lack of infrastructure, expertise, energy supply, institutional support and financial support from governments. We encourage applied research and public-private partnership to foster implementation of research findings into goods and services for public benefit.

Background

With the disproportionately large share of the global burden of communicable and non-communicable disease in sub-Saharan Africa, one would expect that the solutions to these problems be home-grown. Unaccountably, the capacity for this is grossly lacking. An overwhelming majority of African countries fall well below the average on standard indices of science and technology capacity.[1] The infrastructural and legislative environment in many African countries is not conducive to research.[2] Moreover, over the years, Africa has witnessed a steady loss of university staff, which has led to low scientific research output, weak preparation of the next generation of African biomedical scientists, and doubt about the capacity of African universities to produce globally competitive graduates.[3,4]

Biomedical research is a powerful tool for solving health challenges. Therefore various initiatives are underway to strengthen biomedical research capacity in Africa.[1,2,5,6] These activities are largely based on input from senior scientists in Africa and abroad. In order to give voice to young African and African diaspora scientists on these issues *Build AfReCa!* (Build African Research Capacity), a global network of young scientists, was recently started. *Build AfReCa!* represents Africa's rising pool of scientific talent. The present survey is the first effort at defining the needs of biomedical research training in Africa and of Africans. This study describes the needs of biomedical science training in Africa from the experience of young scientists. The findings address policy makers, service providers, governments, academic institutions, and students to assess and strengthen capacity building in Africa.

Methods

The survey was based on voluntary, anonymous participation and involved 107 young scientists and postgraduate students from English- and French-speaking Africa, studying or working in Africa or outside continent. Participants were recruited through existing international networks like *Build AfReCa!*, African Network for Drug and Diagnosis Innovation (ANDI), African Regional Groups of the Student Council of the International Society for Computational Biology (RGSC-ISCB) and Central Africa Nutrition Graduate Students Network (AGSNet-Central Africa).

The questionnaire was designed in English and French, based on participants' identification, institution and research area, obstacles encountered with the research work, needs, career plan and preferences. The questionnaire was filled by the participants online, via the Monkey Survey web-based program (www.surveymonkey.com).

Data collected with each version of the questionnaire were summarised using the Monkey Survey tool and exported into Excel 2007 format. Answers from the French version were translated into English and the two datasets were merged before analysis. Results were expressed as frequency distributions for each question, and correlation between variables assessed by cross-tabulation (Pearson's Chi-square test $p<0.05$). The statistical analysis was conducted with SPSS version 17.0 and Epi Info version 3.5.0.0. The charts and tables were designed on Microsoft Office Excel 2007.

Results

Study participants, site and affiliation

Overall, 107 people participated in the study; 37.4% were female and 62.6% male and 77.5% were below the age of 40 years.

All the four regions of sub-Saharan Africa took part in the survey in addition to those in the diaspora. The highest number of respondents were from West Africa (46.7%) followed by Central Africa (21.5%) then East Africa (15.9%). While 81.3% of the participants were residing in their country of origin, 18.7% were currently working or studying outside their home country.

While 48.35% of the participants were affiliated to a university, and 21.98% to a university/teaching hospital, 13.19% worked in a government/national and 16.48% in a non-governmental research institute. Table I summarises the distribution of research participants by position and region of residence. Participants' position depends strongly on the type of the institution (x^2= 91.68, p=0.0004).

Skills and research output

The study participants had publications in both local and international journals in a wide range of topics. Respondents who have published in peer-reviewed journals were 30.21% while 26.04% have written a grant application wholly or in part.

Respondents had presented their work at international conferences (34.97%), national conferences (17.48%), departmental/institution seminars (27.97%) or at laboratory/journal club meetings (29.37%). In general, a significantly high proportion of students who had presented at seminars and conferences were those receiving financial support from their host institutions (x^2= 51.122, p=0.0108).

Research area and needs

Research areas of the respondents range from epidemiology and drug discovery to immunological and molecular biology. Most respondents conduct research on infectious diseases, especially those that are prevalent in sub-Saharan Africa. Only 6.7% (confidence limits 2.2%, 14.9%) of the researchers were involved in clinical trials. Research techniques and methods in use presently or in the future were a major cause of concern as expertise and unavailability of equipment is a shortcoming to a number of exciting projects. Needs range from the lack of basic facilities such as a laboratory space to sophisticated equipment (Fig. 1).

Lack of training was also a major need raised by the respondents and field of training required varied from one institution to another. When all the desired fields of training were put together, the need varied from basic good laboratory practice (GLP) and good clinical practice (GCP) to biostatistics and biotechnology.

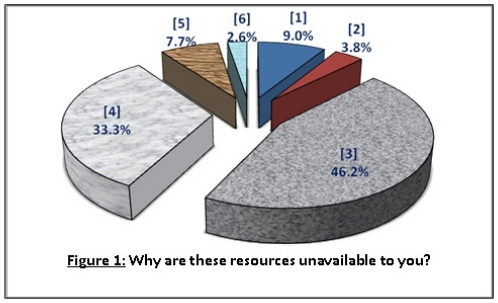

Figure 1: Why are these resources unavailable to you?

[1]: The companies that sell the equipment and materials do not ship to my country (Conf. Limits: 3.4%, 22.2%)
[2]: The necessary materials are shipped cold or frozen from abroad, and would perish (Conf. Limits: 0.5%, 12.3.9%)
[3]: My lab does not have the funds to purchase the necessary equipment and materials (Conf. Limits: 40.2%, 69.3%)
[4]: My institution does not have the funds to build the necessary facilities (Conf. Limits: 7.8%, 29.7%)
[5]: No one in my lab knows how to perform the methods I need to use (Conf. Limits: 2.0%, 12.2%)
[6]: Other (Conf. Limits: 0.5%, 14.0%)

Most of the respondents preferred training to be in the form of internships at expert research laboratories while some preferred workshops and seminars in their laboratories/institutions by visiting scientists (33.06%).

A major drawback to research as indicated by most of the respondents is frequent faculty/institution strikes. The research or academic study of up to 46.43% of the respondents had been perturbed by strikes ranging from 3 months to more than 4 years. Delay in research as a result of strike was significant (p<0.05).

Work plan after research training varied widely. Work stations chosen include public-private research institutions, NGOs, and faculty at a university. A good number of the respondents preferred to work in Africa (54.65%; confidence limits 23.3%, 48.0%), followed by North America (19.77%) then Europe (16.28%).

Research funding and brain drain issues

Only 16.92% of researchers based in their home country receive 100% financial support from their host institution, 63.08% who are also based in their home country receive no financial support at all. There was a significant difference in proportion between researchers who received financial support and those who did not receive (x^2=55.190, p=0.003). The consistency of the support also varies widely from one region to another (Cramer's V=0.375; p=0.018). The diaspora comes first with 66.67% of the researchers receiving more than 50% of support from their host institution, followed by East Africa (50%), southern Africa (25%) and West Africa (12.5%), while only 15% of students from Central Africa receive 10% of financial support from their institution.

Consequently, they are bound to either sponsor their research or seek funding elsewhere. Access to scientific papers was a nightmare to some of the respondents. Only 20.48% of the respondents had full access to scientific publications. Limiting factors include lack of Internet access or connection problems, frequent power failure, and/or lack of money to cover the costs.

Of the respondents, 36.9% were out of their country of origin in pursuit of education. There was a preference for overseas studies because of better training by experts abroad, access to well-equipped laboratories, the quest for knowledge of a particular technique, and/or acquisition of scholarship and good assistantship. Better working conditions coupled to job security or good pay package served as a driving force for some choosing foreign countries for studies.

Limited research facilities in their country of origin (35.71%), limited research funding (28.57%), unemployment despite the expertise (12.86%) and the opportunity to transfer skills to scientists in resource-limited countries (21.43%) were reasons why some researchers prefer to work abroad.

Discussion

From this survey some positive points were highlighted regarding capacity building for biomedical research in Africa. A good number of African students have published in renowned journals and/or have had formal presentation of their works at national and international seminars/conferences. This observation may reflect growing interest in biomedical science on the continent and the emergence of north-south and south-south networks across Africa. Some of these include the Multilateral Initiative

Table I. Distribution of participants by region of origin and position at the research institution

Position at institution	Participant's region of residence					Total
	Central Africa	Diaspora	East Africa	Southern Africa	West Africa	
Senior/principal investigator	1	1	0	2	3	7
Postdoctoral Fellow	0	4	0	0	2	6
PhD student	15	7	1	1	7	31
Master's degree student	3	2	3	5	2	15
MD student	0	0	0	0	2	2
Research assistant	3	1	2	1	3	10
Laboratory technician	0	0	0	0	3	3
Bachelor degree student	0	0	0	0	3	3
Other	0	0	1	1	7	9
Total	20	15	7	10	32	86

NB: A total of 86 answers were recorded for the question on the participant's position at their research institution.

on Malaria (MIM) with headquarters in Cameroon, the African Malaria Network Trust (Tanzania), the newly created African Network for Drug and Diagnostics Innovation (ANDI), Build African Research Capacity *(Build AfReCa!)*, African AIDS Vaccine Programme (AAVP), etc. Such organisations, if well designed and focused, are likely to foster biomedical research and its implementation.[7]

Research and publication are crucial in medical education, and scientific publications represent a major element in the transfer of knowledge from clinicians and academics to potential users including decision markers.[8] However, considering the population and available resources, Africa is still far from the rest of the world, and there is serious concern about disparities across the continent. Africa produces about 27 000 papers per year, which is about the same volume for the Netherlands. Between 1999 and 2008, Egypt produced nearly 30 000 papers, which is about three times that for Tunisia, its regional neighbour. In west-central Africa, Nigeria's total publications for the same period was over 10 000, compared with roughly 6 500 for Kenya, the leading research economy in East Africa. South Africa's dominance, as might be expected, is even more pronounced: nearly 47 000 papers during 1999 - 2008, compared with the southern region's next most prolific nation, Tanzania, which fielded just over 3 000.[9]

Nwaka *et al.* identified about 2700 institutions in 47 of the 53 African countries as lead institutions based on their position as corresponding institutions for articles cited in peer-reviewed journals. These findings clearly indicate the existence of significant health research and development capacity in Africa, but the lack of intercontinental collaboration, coupled with low levels of investment, are the major factors hindering the continental research agenda and contributing to a lack of local ownership of research undertaken on the continent and suboptimal utilisation of available research capacity to address African health problems.[10]

The existing networks need to coordinate their complementary actions in order to be more effective and avoid wastage of resources in unnecessary replication of actions. According to the Parliamentary Office of Science and Technology,[11] 'the global approach to international development has shifted over the last few decades from developed countries telling developing countries how to address their own problems, to developing countries identifying their problems and working with developed countries to achieve the assistance they need'. Efficacious mechanisms are therefore crucial for African countries to identify their needs and design appropriate solutions to solve them. At this point, the importance of public–private partnership (PPP) cannot be over-emphasised. The approach by ANDI to create centres of excellence across the continent is laudable and warmly welcomed since this will surely reduce some of the technological and socio-economic disparities encountered from one region to another. African governments should be more present to provide institutional and financial support and create an environment conducive to research and development, instead of relying on the lone support from developed countries. Pan-African organisations like ANDI, AMANET, *Build AfReCa!* and others should be particularly encouraged and effectively supported by African governments.

From this survey it was also observed that biomedical research in Africa or by Africans mostly consists of basic/fundamental research. The proportion of researchers involved in clinical trials is remarkably low. Ironically, no economy in the world has prospered without a strong research policy and only few outreaches had been recorded from core-basic research. This implies that, to be able to make good use of its immense natural resources, Africa should go beyond the exploratory fundamental research and implement findings to solve its numerous daily problems. For example, discovering new antimalarial leads could really alleviate the malaria burden only if these active ingredients are actually converted into medicines available on the shelves. Therefore applied research and a fair collaboration with private sector and international bodies are strongly encouraged.

Students interviewed prefer web-based courses, short training programmes focusing on specific subjects and internships in laboratories with expertise as teaching methods. Internships in laboratories with expertise are likely to boost technology transfer to developing countries although this is really effective only when coupled to infrastructure development and a powerful implementation policy. Virtual conferencing and web-based courses may prove to be an effective low-cost strategy for conveying education to African scientists who otherwise would be deprived of the opportunity. Unlike conventional programmes, they permit the involvement of a greater number of participants who would otherwise be unable to participate in events of this breadth owing to *(i)* limited travel fellowships, if any; *(ii)* lack of time to travel to distant conference locations; and *(iii)* insufficient accommodation and subsistence funds.[12] Therefore communication technologies should be given priority by public and private investments. However, it is urgent for African governments to revise their energy strategies and invest more in renewable energy, in order to facilitate communication and solve the recurrent

energy supply problem that constitutes a major handicap for research in many African countries.

Human resources for scientific research are unacceptably lacking in Africa. In 2004 it was estimated that in Africa (except South Africa), there were only 70 researchers of any field per million population, compared with 2 640/million in North America and 4 380/million in Japan.[8] The situation is aggravated by the phenomenon of brain drain in Africa. This present study showed that about 40% of African students reside out of their country of origin. Better working conditions coupled with job security or good pay packages represent the major driving forces for choosing foreign countries. For example, according to the World Health Report (2006) only 3.3% of nurses and midwives trained in Kenya remain in their country for a career.[4] This is clear evidence that developed countries continue to deprive developing countries of millions of dollars wealth of investments embodied in their human resources for health.[13] If locally trained African experts migrate to developed countries because of better offers, it is obvious that those trained out of Africa will hardly return home. Therefore fighting brain drain requires dedicated strategies[13] both at national and international levels: *(i)* research should be responsive to the country's needs and priorities; *(ii)* sandwich programmes should have priority over full training programmes; *(iii)* training should be accompanied or followed by equipment support to facilitate in-home implementation of acquired knowledge; *(iv)* political strategies like visa restrictions could be applied in specific cases; *(v)* decision makers in developing countries should equally be trained towards development focused research strategy; and *(vi)* private sectors should be strongly encouraged as main actors in research implementation.

Conclusion

From this first attempt to identify the needs of biomedical science training in Africa from the perspective of young scientists, it clearly appears that although considerable efforts have been made towards strengthening research capacity in the African continent, much remains to be done. Biomedical research in Africa is seriously inhibited by preventable obstacles which include the lack of infrastructure, expertise and energy supply and institutional and financial support from governments. There is need for applied research in the form of clinical trials to really foster the implementation of research outcomes.

There are enormous potentials embodied in African researchers. The continent would definitely experience exponential growth in health status and health innovation if African researchers are based in and focus their work on Africa and her many health problems. Therefore strategies to support African researchers in Africa to better identify and combat Africa's health issues are greatly encouraged.

Competing interests

The authors declare that they have no competing interests.

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Authors' contribution

DZ designed the survey, translated the questionnaire, participated in the recruitment of research participants, statistical analysis of data collected and the write-up. SA contributed in editing of the questionnaire, recruitment of research participants and write-up. CTN participated in the conception of the project, design of the survey, recruitment of research participants and the write-up. MS participated in the write-up. ZIT contributed in the questionnaire design and recruitment of research participants. OOA, CO and DMK participated in the recruitment of research participants. All the authors have read the final manuscript and approved the submission.

References

1. Wagner C, Brahmakulam I, Jackson B, Wong A, Yoda T. Science and technology collaboration: building capacity in developing countries? MR-1357.0-WB. Santa Monica, CA: RAND, 2008.
2. Whitworth JA, Kokwaro G, Kinyanjui S, Snewin VA, Tanner M, Walport M and Sewankambo N. Strengthening capacity for health research in Africa. Lancet 2008;372 (9649):1590-1593.
3. Anonymous. Brain Drain in Africa - Joint Statement by the Network of African Science Academies 2009. http://www.nationalacademies.org/includes/NASAC-braindrain09.pdf.
4. Kirigia JM, Gbary AR, Muthuri LK, Nyoni J, Seddoh A. The cost of health professionals' brain drain in Kenya. BMC Health Services Research 2006;6:89 doi:10.1186/1472-6963-6-89.
5. Matee MI, Manyando C, Ndumbe PM, Corrah T, Jaoko WG, Kitua AY. European and Developing Countries Clinical Trials Partnership (EDCTP): the path towards a true partnership. BMC Public Health Letter 2009;9:249.
6. TDR. Building capacity for research - TDR Seventeenth Programme Report. 2005.
7. Ntoumi F, Djimdé AA, Mbacham W, Egwang T. The importance and future of malaria research in Africa. Am J Trop Med Hyg 2004;71:4-6.
8. Frantz M. Identifying strategies to improve research publication output in health and rehabilitation sciences: a review of the literature. African Journal of Health Professions Education 2011;3(1):7-10.
9. Adams J, King C, Hook D. Global Research Report - Africa. Thomson Reuters. Leeds, UK. 2010. available at: http://thomsonreuters.com/content/corporate/docs/globalresearchreport-africa.pdf
10. 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(6): e1000293.
11. Parliamnetary Office of Science and Technology. Scientific capacity in developing countries. Postnote 2004;216:1-4.
12. Gichora NN, Fatumo SA, Ngara MV, et al. Ten simple rules for organizing a virtual conference - anywhere. PLoS Computational Biology 2010;6(2):e1000650. doi:10.1371/journal. 2010. pcbi.1000650
13. Kupfer L, Hofman K, Jarawan R, Mcdermott J, Bridbord K. Strategies to discourage brain drain. Bull World Health Org 2010;82(8):616-619.