

Medical education in sub-Saharan Africa: a literature review

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OBJECTIVES This review synthesises research published in the traditional and 'grey' literature to promote a broader understanding of the history and current status of medical education in sub-Saharan Africa (SSA).

METHODS We performed an extensive review and analysis of existing literature on medical education in SSA. Relevant literature was identified through searches of five traditional medical databases and three non-traditional or grey literature databases featuring many African journals not indexed by the traditional databases. We focused our inquiry upon three themes of importance to educators and policy-makers: innovation; capacity building, and workforce retention.

RESULTS Despite the tremendous heterogeneity of languages and institutions in the region, the available literature is published predominantly in English in journals based in South Africa, the UK and the USA. In addition, first authors usually come from those countries. Several topics are thoroughly described in this

literature: (i) human resources planning priorities; (ii) curricular innovations such as problem-based and community-based learning, and (iii) the 'brain drain' and internal drain. Other important topics are largely neglected, including: (i) solution implementation; (ii) programme outcomes, and (iii) the development of medical education as a specialised field of inquiry.

CONCLUSIONS Medical education in SSA has undergone dramatic changes over the last 50 years, which are recorded within both the traditionally indexed literature and the non-traditional, grey literature. Greater diversity in perspectives and experiences in medical education, as well as focused inquiry into neglected topics, is needed to advance medical education in the region. Lessons learned from this review may be relevant to other regions afflicted by doctor shortages and inequities in health care resulting from inadequate capacity in medical education; the findings from this study might be used to inform specific efforts to address these issues.

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 INTRODUCTION

Medical educators have a key role to play in reducing inequities in global health by addressing the underlying doctor shortages that have reached crisis levels in some regions. The region in which these health inequities¹ and doctor shortages are most stark is sub-Saharan Africa (SSA),^{2–4} for which our group recently conducted the Sub-Saharan African Medical Schools Study (SAMSS).⁵ Data for this study were generated through three primary strategies: a systematic review of the literature; extensive site visits, and a survey of all medical schools in the region. Findings from our site visits and regional survey, and policy recommendations, have been published recently elsewhere.⁶ This article focuses on the literature we reviewed and analysed for the SAMSS project.

Medical education in SSA underwent its first significant expansion when newly independent African states emerged from the rule of the colonial powers: only five medical schools existed across the region before 1960,⁷ but by 1980 this number had grown to 47.⁸ Unfortunately, civil unrest, corruption and famine in the ensuing years eroded these promising developments and the widespread lack of resources and political will led to the decline or closure of many medical schools in the 1980s and early 1990s. Macro-economics and structural adjustment programmes to decentralise government spending also effectively reduced the SSA health care workforce during this period, further exacerbating existing shortages.⁹

Just before the turn of the century, a revival of medical education began in SSA and a second era of expansion has continued to the present. The scientific literature on medical education in SSA has also expanded dramatically in the last two decades and the emergence of new African journals, African databases and an attendant 'grey literature' has greatly facilitated scholarship on medical education. To date, this body of literature has not been thoroughly characterised or summarised to facilitate efforts to improve the provision of medical education in the region.

The current literature review is situated conceptually within broader efforts to address the 'North–South gap',^{10–13} that has emerged in scientific publications worldwide, with particular emphasis on the field of medical education. Although SSA demonstrates this gap in extremis, lessons learned from our review can

be applied to other regions afflicted by doctor shortages and health care inequities caused by inadequate capacity in medical education. Findings from this study can also inform specific efforts to reduce this north–south gap through the integration of global health approaches into health professions education,¹⁴ the promotion of the social mission of medical schools worldwide,^{15–17} and the development of global standards for accreditation in medical education.^{18,19}

 METHODS

We performed online searches of five large, 'traditional' medical databases (MEDLINE, CINAHL [Cumulative Index to Nursing and Allied Health Literature], ERIC [Educational Resources Information Centre], Global Health, EMBASE) and three large non-traditional databases (African Indicis Medicus, African Journals Online, Biomed) that feature many African journals not indexed by the traditional databases (Table S1, online). These latter databases were recommended by African members of the SAMSS Advisory Committee at the inception of our study; other grey literature sources were added as they were discovered. We performed our first search in August 2008 and conducted periodic update searches to April 2010. We did not use any search limits such as date of publication or language (all publication dates and languages in each database were included). Our goal was to characterise the existing literature on medical education in SSA as broadly and extensively as possible for the SAMSS Advisory Committee, which consisted of experienced African educators, clinicians and policymakers.²⁰ We used the keyword terms 'medical education', 'medical schools' and 'medical students' for all searches and added 'Africa' as a limiting search term in the traditional databases. In MEDLINE only, we also used the MeSH (*Medical Subject Headings*) terms 'schools, teaching' and 'health manpower' based on MEDLINE's categorisation scheme for terms related to our original search terms. These searches returned a combined total of 3749 titles which were reviewed for face-value relevancy to the overall objectives of the SAMSS. Two authors (SRG and FM) created an initial analytic framework of nine categories for our Advisory Committee. Subsequently, based on extensive feedback from this group of experts, we reorganised these categories into three unifying themes that represent key domains of interest to the SAMSS: building capacity for increased doctor training; innovations in doctor

training, and the retention of doctors once they are trained. We excluded articles that we felt did not clearly relate to at least one of these themes. We also excluded articles that did not meet our expectations in terms of scholarship (e.g. unreferenced editorials or polemics). Abstracts for 642 of the citations that met our criteria were retained for further analysis. The sources cited in this review were chosen because they represent those with the highest-quality scholarship and clarity of message, the greatest utility in fulfilling our goal of assessing the current status of medical education in SSA, and the overall best fit for the purposes of creating a synthetic narrative describing the challenges, opportunities, successes and failures of medical education in the region. We retrieved full citation information and the full text of the article when available and noted characteristics of each publication, such as the first author's primary institutional affiliation, the name and nationality of the publishing journal, and the country or region described by the article. To supplement our searches of the peer-reviewed grey literature, we searched several dozen Internet sites (some examples are listed in Table S1) for committee reports, consensus statements and similar documents pertinent to our project. This produced an additional 46 reports and related documents. Finally, we note that the SAMSS project has created detailed reports of 10 sub-Saharan medical schools, which also focus on capacity, innovation and retention, and which supplement the grey literature reviewed here.²¹

RESULTS

In this paper, we present results focused on three areas of high relevance to researchers, educators and policymakers in the region:

- 1 building *capacity* for increased doctor training;
- 2 *innovations* in doctor training, and
- 3 the *retention* of doctors once they have been trained.

Additionally, we performed a *bibliometric* analysis to describe key attributes of this literature, such as the nationality of authors, journals and medical schools described. Our key findings (Fig. 1) emphasise the strengths and weaknesses of this literature.

Capacity

Capacity to train doctors is a complex issue which encompasses many contributing factors, including

- The literature on medical education in SSA is growing rapidly
- The grey literature is growing even more rapidly than the traditionally indexed literature
- Dominant journals in this literature tend to be published in English and many are based in the UK or the USA
- SSA is under-represented in the global literature on medical education, which contributes to the North–South gap in overall scientific publications and to the deficit in knowledge about how doctors are trained worldwide
- The literature on medical education in SSA disproportionately represents countries with older medical schools, such as South Africa, Nigeria and Uganda
- Sudan is greatly under-represented in the literature, despite recent medical school expansion in that country
- Many medical schools in SSA are not mentioned at all in the literature
- Medical education as a field of inquiry and practice specific to the SSA region is underdeveloped
- There is no medical journal dedicated exclusively to medical education or academic medicine in SSA

Major strengths include descriptions and assessments of:

- problem-based learning
- community-based education
- human resources for health capacity planning
- causes of 'brain drain'
- strategies for workforce retention

Major weaknesses include the lack of description and analysis of:

- technology
- financing for medical education
- the scaling up of human resources for health
- outcomes including postgraduate training and primary care

Figure 1 Key findings of this review of 152 articles on medical education in sub-Saharan Africa (SSA) published during 1965–2010

physical infrastructure and the degree of intention to create a more ideal workforce that includes non-doctor clinicians and other health professionals as well as generalist and specialist doctors.

Physical infrastructure for medical training

Descriptive accounts of new medical schools flourished in the Independence Era of the 1960s and 1970s and trailed off during the decline of the 1980s and early 1990s.^{22,23} The articles we identified emphasise the importance of new schools in advancing the health and developmental aspirations of the newly independent nations of SSA. Although a new phase of investment in infrastructure has led to the opening of many new schools since the 1990s, only a few of these schools and their roles in building national health infrastructure are described in the literature, with some notable exceptions such as the new school in Malawi.²⁴ Several authors describe overall training infrastructure at the national level in Nigeria,^{25–27} Zimbabwe,²⁸ Malawi²⁹ and the

Sudan,³⁰ but this information is lacking for most other countries in SSA. Common challenges described include the inadequacy of overall funding to maintain or update facilities, as well as the insufficiency of staff resources for teaching and administration, especially in the face of rapidly expanding student bodies.

Workforce planning and scaling up

Global inequities in human resources for health (HRH) are worse than ever, particularly in Africa.^{31–33} Furthermore, HRH density has been shown to be an important predictor for health outcomes,^{32,33} particularly for HIV care.^{34,35} Based on this evidence, consensus has emerged on the top priorities in HRH-related endeavours. Firstly, there must be a dramatic scaling-up of the total number of health professionals in SSA.^{1,3,31,36,37} Increasing the capacity of medical schools to produce doctors is crucial,^{9,38} but a team approach that includes non-doctor clinicians has received greater attention in recent years.^{39,40} Broad consensus exists on increasing the numbers of non-doctor clinicians alongside those of doctors,^{2,33,37} but less information is available about ideal ratios or functions.³⁹ As the role of these providers becomes more defined, further research on their effective use in task shifting^{38,41} and descriptions of team-training models at health science schools will become increasingly important. Secondly, funding for HRH must increase from multiple sources, including government,^{37,42} non-government organisations (NGOs) and the donor community.^{38,43} Moreover, although raising capital to start educational programmes is difficult, sustaining adequate funding is often an even greater challenge, especially once the 10-year mark is reached.²⁴ Thirdly, increased collaboration between nations^{2,38,44} and strategic planning and management organisations is needed to coordinate expansion and utilisation patterns across different regions.^{2,33,36,37} Unfortunately, information on regulatory bodies that can oversee this expansion is available for only a dozen countries^{18,19} and basic information about the numbers and characteristics of medical schools across the region is also lacking.^{45,46}

Training generalists versus specialists

Expanding the capacity of medical schools to produce adequate numbers of both specialists and generalists is an issue of growing importance in the recent literature. Many SSA nations have officially endorsed the primary health care (PHC) approach to

health care, and some authors have also made the case for 'regional' or 'rural specialists' to advance a concept of PHC modelled after conditions in underserved areas.^{47,48} Moreover, students in many countries have mixed feelings about PHC versus specialisation and may sometimes favour the latter.^{49,50} Schools utilising the community-based education and service (COBES) model have reported high student and community satisfaction,^{51,52} but students may also express negative views of PHC if faculty commitment is perceived as weak and curricula are seen as unfocused and unmatched to realities in communities.⁵³ This literature on PHC training refers to undergraduate medical education, whereas articles on postgraduate training tend to focus on specialty fields; we did not encounter articles describing postgraduate training in general internal medicine or paediatrics. Consistent with the current surgical workforce crisis in SSA,⁵⁴ much of this literature describes specific training programmes in fields such as obstetrics and gynaecology,⁵⁵ paediatric surgery,⁵⁶ general surgery^{57–59} and emergency medicine.⁶⁰ Articles describing postgraduate education in non-surgical specialties are more limited and include material on neurology,⁶¹ anaesthesia^{62,63} and radiology.⁶⁴ Overall, there is a great deal of fragmentation on the topic of training specialists versus generalists, which makes this material difficult to connect with the literature on infrastructure, scaling up and workforce planning.

Innovation

Medical education in SSA has demonstrated remarkable innovation recently. Although some schools continue to use the 'traditional' mid-century Western model, the literature reveals decades of innovation in medical education in step with global trends.

Community-based education and service

Community-based education and service (COBES) has been an important component of some schools since the first era of expansion in the 1960s and 1970s.^{65–67} Although substantial variations exist among schools, examples of COBES activities include: the family attachment in which the student follows a patient and his or her family for 2–3 years;⁶⁸ visits to rural homes and health centres in which students engage in patient counselling and community needs assessment,⁶⁹ and small-group discussions of community and public health topics.⁷⁰ Major challenges described include: the tendency to underestimate the amount of time needed by students and faculty members to adapt community-

based education (CBE) approaches;⁷¹ unreliable public utilities; language barriers, and the maintenance of high educational standards with the community doctors who supervise learners.^{72,73} Despite these challenges, the advantages of CBE include lower attrition rates, a greater perceived ability to function in rural communities,⁷⁴ and high satisfaction expressed by students and community members alike.⁷⁵

Problem-based learning

Often incorporated with COBES, problem-based learning (PBL) strategies have been integrated into many SSA curricula in the last two decades.^{67,74,75} Many of the challenges described are familiar to educators using PBL anywhere, such as the need for faculty members to adapt their teaching skills to accommodate active learning and clinical reasoning,⁷⁶ but some challenges, such as high start-up costs,⁷⁷ lack of adequate learning materials⁶⁸ and lack of prior experiences in adult learning for students, are especially limiting for schools in SSA.^{77,78} These challenges notwithstanding, PBL can improve outcomes in SSA by generating greater sophistication in learning strategies,⁷⁹ increased understanding and application of the basic sciences,⁸⁰ lower overall attrition rates and higher rates of on-time graduation,⁷⁶ as well as improvements in skills such as those pertaining to collaboration and communication.⁸¹ Moreover, implementing PBL in SSA often involves a complex balancing act: although faculty staff need not be experts in the content matter of the classes they facilitate⁸² – which affords greater flexibility and encourages mentorship^{81,83} – the mastery of PBL facilitation techniques can be challenging to staff who are more familiar with traditional pedagogy. Finally, many schools struggle to provide the increased staff resources and facilities required for PBL curricula, particularly in the early phases of implementation and in the context of faculty shortages.⁸⁴

Assessment and evaluation

One difficult paradox facing medical educators in SSA is that scarce resources cannot be wasted on ineffective techniques, yet research to assess the effectiveness of a strategy is often difficult to support. Many studies illustrate lessons that have been learned by soliciting feedback and measuring outcomes after the implementation of innovations such as service-based learning or PBL.^{85,86} Another impetus for research on assessment methods is the global trend toward the increased evaluation of clinical

skills. To date, reports of observed structured clinical examinations in SSA are very rare and reported pass rates are rather low.^{87,88} Some schools have implemented early clinical skills training with high student and faculty approval,⁸⁹ or have described structured clinical summaries⁹⁰ or structured assessments of communication skills.⁹¹ Others have attempted to shape consensus on the procedures and skills that should be considered essential for new doctors⁹² and how best to select assessment tools for these skills.⁹³ Finally, several authors have described truly unique approaches, such as the use of student drawings to convey formal feedback⁹⁴ and the integration of difficult material into a game-based format.⁹⁵ Although these approaches may be unconventional, their initial results are promising.

Technology

Information technology has revolutionised medical education in many countries and promises to bring greater access to high-quality educational products to schools in SSA.^{78,96} Web-based course tools (webCTs) have facilitated increased communication between faculty staff and students, as well as greater access to learning resources.⁹⁷ Other institutions have developed online 'spiral curricula' in which students build and reinforce competency in new subject areas by revisiting prior course materials online.⁹⁸ Unfortunately, this technology presents start-up and maintenance costs that are prohibitive for many SSA schools. Accordingly, some educators have employed more affordable technologies such as the video-projected structured clinical examination⁹⁹ and video-conferencing for teaching and clinical consultation.¹⁰⁰ Other considerable problems include high student : computer ratios, slow Internet connections, and the so-called 'digital divide' or gap in computer literacy between students in resource-poor countries and those in industrialised northern nations.¹⁰¹ However, it is difficult to make generalisations; several authors have uncovered discouraging deficiencies in basic computer skills,^{102,103} whereas others have shown that students are able to adapt quickly to Internet-based innovations regardless of their degree of prior experience.^{97,104}

Retention

Although the emigration of doctors to nations with more developed health care systems – the 'brain drain' – remains the greatest threat to retention, SSA also faces serious internal sources of doctor attrition and difficulties in recruiting and retaining talented individuals within academic medicine.

Medical emigration

At least one in eight doctors trained in SSA is lost to more developed nations^{105,106} and future shortages are predicted to be even greater than those seen at present.¹⁰⁷ As many as six of 47 SSA countries have lost over 60% of their doctor workforce to migration¹⁰⁸ and estimates of lost investment range from US\$0.18 million to US\$0.50 million for each departing doctor.¹⁰⁹ The underlying causes of the brain drain have been described as a combination of 'push' factors, such as civil instability and personal health risks in SSA, and 'pull' factors, such as the higher income, job satisfaction and career development available outside SSA.^{110,111} These factors also act on students, among whom reported rates of intention to emigrate reach as high as 86% in some countries,^{9,110} and support an attendant 'culture of migration' in which emigration is normalised and viewed as the ultimate marker of career success.^{112,113} In terms of sheer numbers, medical migration is mostly an Anglophone phenomenon: four principal recipient nations (the USA, the UK, Canada, Australia) draw the greatest numbers of migrant doctors from three SSA countries (South Africa, Nigeria, Ghana), but the effects of losing even a few doctors can be devastating to smaller countries.^{105,113} Several authors have cited the moral obligation of industrialised countries to halt the 'robbing' and 'looting' of human resources from poor countries.^{114,115} Certainly, the right of individual doctors to seek better lives for themselves and their families cannot be regulated,¹¹² but international codes or trade agreements could limit predatory recruitment efforts by governments and for-profit agencies.¹¹⁶ Specific options for the major recipient countries (the USA,³⁸ the UK,¹¹⁷ Canada¹¹⁸ and Australia¹¹⁹) have been proposed, as have policy options for African countries.⁴² Finally, although the tracking of graduates from individual schools is often difficult,¹²⁰ the general dictum that graduates of schools that emphasise Western standards of practice show high rates of emigration is supported by student attitudes,^{121–123} as well as by some empirical evidence.^{124,125}

Internal drain and retention in rural areas

The greatest internal burden facing doctors in SSA is the HIV/AIDS crisis, which strains the existing workforce in two ways: it increases the need for care as prevalence rates increase, and it decreases the available manpower as health care workers are themselves infected.^{9,38,110,111} Indeed, HIV in SSA has been described as 'the straw that broke the camel's

back' in the HRH crisis and infection rates in health care workers may be even higher than in the general population.³² Some medical school cohort analyses have reported that more of their graduates are deceased than are living overseas¹²⁶ and trainees have reported feelings of hopelessness leading to burnout in settings in which demand for care is high but eager providers are paralysed by a lack of basic supplies, utilities and medications.^{127,128} In response to this crisis, international collaborations have led to the instigation of a Pediatric AIDS Corps¹²⁹ and proposals to create an HIV Peace Corps for Health¹³⁰ and similar multi-national efforts by doctors from developed nations.^{2,131} Undergraduate training and postgraduate courses on HIV care have also been proposed to help build the skills base of doctors dealing with populations that are heavily burdened by HIV/AIDS.^{132,133} Although recruiting students from rural and underserved areas may help, ultimately greater direct financial and social support for doctors practising in these areas may be necessary if they are to be retained.^{38,110,134,135} Other than improved salaries, doctors cite improved living conditions, including better-quality schools for their children, and better career development as important to retaining them in rural settings.^{136,137} Compulsory service programmes have been reported in 16 SSA countries, with encouraging but incomplete results,¹³⁸ and the provision of 'conditional scholarships' for health professionals to treat HIV/AIDS populations may also represent a cost-effective way to address crisis-level shortages.¹³⁹

Building academic medicine

Managing support staff for medical education in SSA is challenging,^{140,141} but the difficulties of recruiting and retaining academic staff who are able to build the teaching and research missions of schools represent a critically limiting step in efforts to innovate and improve academic medicine in SSA.¹⁴² Efforts to develop the teaching skills of faculty staff are rarely described and, when they are, such material typically refers to developments in the context of training for roles as PBL facilitators.^{84,143} Descriptions of rewards specifically for teaching are rarer still. One study documents rewards for teaching in seven of eight South African medical schools; however, standards for the selection and significance of the rewards varied greatly.¹⁴⁴ Efforts to build research infrastructure as a means of increasing the recruitment and retention of academic faculty staff are more frequently described in the literature and often involve international collaboration.¹⁴⁵ Several Western universities have partnered with schools in

SSA to increase training specifically for HIV research and care^{146,147} or to support a focus on teaching and research in surgery,¹⁴⁸ but opportunities to develop skills in medical education as a specialty are infrequently described.^{145,149} Moreover, some authors caution that collaborators must be careful to avoid ‘post-colonial syndrome’ in which the research interests and goals of the Western partner take precedence over those of the African partner.¹⁵⁰ Accordingly, guidelines for the ethical ‘twinning’ of foreign partners with African institutions have been advocated by several organisations.^{145,151} Despite these efforts, medical education as a specialty or research focus for faculty staff is still not frequently described in the literature. We were able to identify only one journal dedicated to the broader study of health professions education in SSA: the *African Journal of Health Professions Education*, established in 2009.

Bibliometrics

The peer-reviewed literature presented here is predominantly written in the English language and printed in journals published in English-speaking countries (Fig. 2).

In terms of the countries described in these articles, South Africa is disproportionately represented, claiming 39% of the total literature but only 6% of all SSA medical schools. The second most frequently described country, Nigeria, has a more proportionate share of the literature (18%) and has 23% of SSA schools. Uganda, the third most frequently described country, accounts for 5% of the literature and is

home to 3% of SSA schools. At the other end of the spectrum, the Sudan is grossly under-represented by a 2% share of the literature, although it accommodates 23% of SSA schools (Fig. 3).

First authors affiliated with American or British institutions account for a large proportion of the literature and, when combined with first authors from South African institutions, account for over 50% of published material (Fig. 4). Although our search findings included articles describing countries in which French, Arabic, Portuguese or Amharic are spoken, the majority of these articles were also published in English.

DISCUSSION

Through this review, we have identified several important strengths and weaknesses in this literature, which should guide further scholarship on medical education in SSA and other regions suffering from inadequate doctor supply. In combination, Figures 2–4 demonstrate a homogeneity in the literature on medical education in SSA that does not reflect the tremendous diversity of nationalities, institutions, languages, problems and solutions that exist on the ground. In order to facilitate a clear understanding of the state of medical education in this and other developing regions, more data must be published from countries and institutions that are not well-represented in the current literature.

Although innovations in medical education, such as PBL and CBE, are richly described in this literature

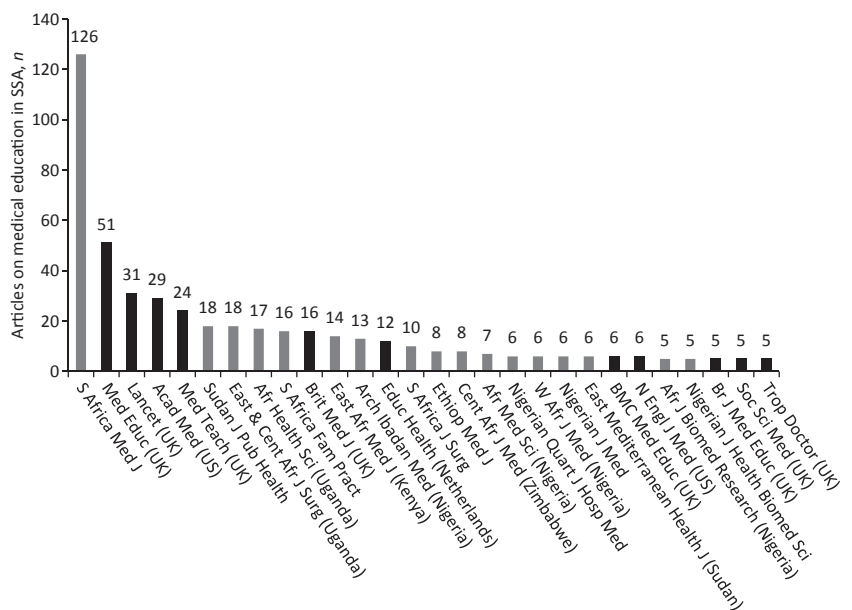


Figure 2 Journals which have published at least five articles on medical education in sub-Saharan Africa (SSA) (n = 479 articles published during 1965–2010). Black bars represent non-African journals. The country of origin of the journal is listed in parentheses if it is not part of the journal title. Articles from these 28 journals represent 75% of the 642 articles identified for this review

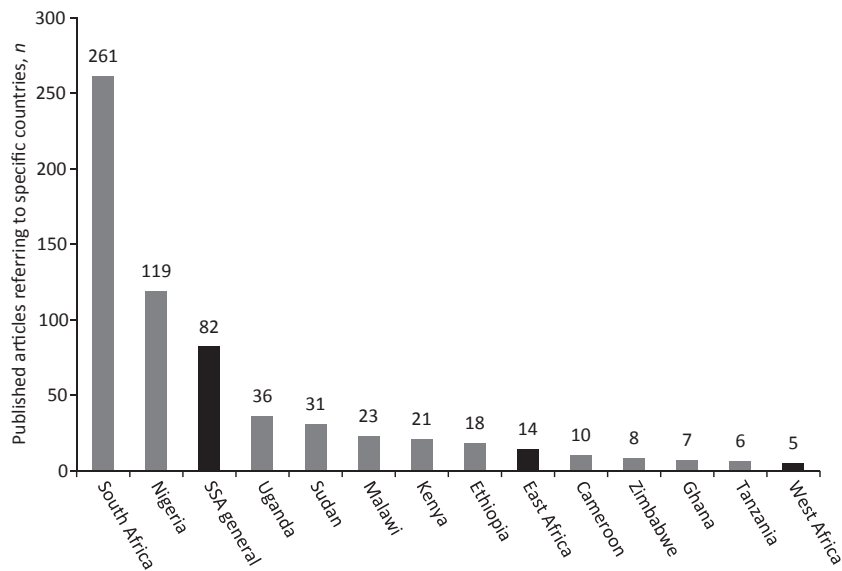


Figure 3 Countries described in articles on medical education in sub-Saharan Africa (SSA) published during 1965–2010. Total $n = 667$ because some articles refer to more than one country. Countries described in fewer than five articles include: Mozambique ($n = 4$ articles); Zambia ($n = 3$); Congo, Madagascar, Mauritania, Senegal ($n = 2$ each), and Lesotho, Mauritius, Namibia, Rwanda, Sierra Leone ($n = 1$ each). Central Africa, Southern Africa and Francophone Africa are also described in two articles each

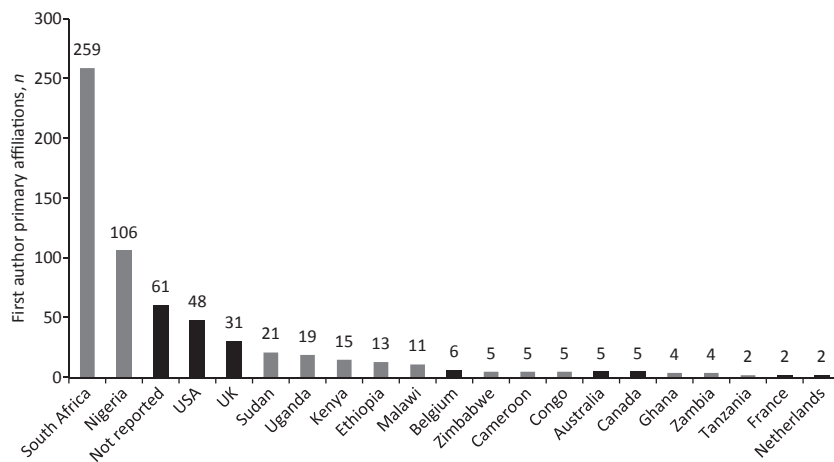


Figure 4 Primary institutional affiliations of first authors by country ($n = 642$ articles published during 1965–2010). Not reported = information unavailable in abstract, full article unavailable online. Black bars represent non-African countries. Egypt, Iran, Israel, Italy, Madagascar, Mauritania, Portugal, Philippines, Poland, Senegal, Switzerland, Saudi Arabia, and Trinidad and Tobago were cited as the country of the primary affiliation of the first author in one article each

and nuanced consideration is given to the difficulties encountered and adaptations made in resource-limited settings, further data on outcomes are required on issues such as whether graduates of these programmes go on to provide care where it is most needed. Current descriptions of innovations in assessment and the use of technology serve to establish a core body of foundational studies, but additional work is needed to describe the challenges and solutions to implementation in SSA and other developing regions.

The literature that is concerned principally with capacity includes thorough descriptions of priorities for workforce planning and management, but more accounts of implementation attempts and associated successes, failures and challenges are required. Other key areas for exploration include macro-

and micro-financing to establish how funding at the country level can be improved, and the innovations fashioned by individual schools to deal with needs for physical plant, personnel and other critical items of infrastructure. Toward this end, much more information is needed about newer medical schools on the continent. We also need substantially more information on postgraduate training in specialties such as paediatrics and internal medicine and their subspecialties. Finally, greater attention to the role of research in capacity building is needed as research activity has been essential to the success of older schools in SSA, such as those at Makerere University in Kampala, the University of Cape Town and the University of Ibadan. Further development of research capacity is likely to play an important role in the growth and sustainability of new schools in SSA, as well as in other developing regions.

Similarly, the phenomena of the brain drain and internal drain are very well described, as are many possible policy-based solutions, but very little connection is made between these issues and medical education. Again, the question of outcomes is of paramount concern: is there anything that medical schools can do to encourage the retention of their graduates within the country? Given the known correlation between HRH and health indices, do health outcomes actually improve when doctors and other health care workers are retained in greater numbers? Finally, much more information is needed overall about building academic medicine in SSA and other developing regions: what are emerging strategies for faculty development? How is research capacity being developed? How is excellence in activities such as curricular reform, teaching and mentoring recognised?

Finally, it is important to note the recent rise of this body of grey literature on medical education in SSA, which is published in peer-reviewed African journals but is not indexed in traditional databases such as PubMed. This grey literature may be published independently in print or online by organisations, committees or other groups, such as the World Health Organization (WHO) or the Global Health Workforce Alliance (Fig. 1). Although the traditional literature base is growing rapidly, this grey literature may be expanding even faster, but it is unclear whether this will help to narrow the north–south gap in knowledge about how doctors are trained worldwide or whether it will merely increase the information in a fragmented way.

CONCLUSIONS

Medical education in SSA has undergone dramatic changes over the last 50 years and the literature describing these transformations has also grown significantly in size and sophistication. This expansion in the literature has occurred within the body of peer-reviewed journals cited in the traditionally indexed databases, but has also embraced an alternative body of new databases and online resources, designated the ‘grey literature’. Despite this recent expansion, narrowing the North–South gap^{13,17} in terms of both information on doctor training and cumulative scientific publications will require focused and sustained effort. Indeed, we identified relatively few publications overall from a limited number of countries, which indicates a great deal of uncertainty about what is happening in medical education in

most of SSA. Much more research on medical education in the region is needed and ensuring that it is carried out should be a high priority for scholars, funders and political leaders.

Within the broader context of global health and medical education, this study demonstrates both encouraging developments and troubling limitations in the current literature on SSA, which may be generalisable to other developing regions that face doctor workforce crises and health inequities. Certainly, the rapid expansion of the literature on medical education in SSA is a positive sign of vibrant growth in the field in this region and further study is warranted to determine if similar growth is occurring in other developing regions. Fortunately, organisations such as the WHO and others continue to advocate for these studies in an effort to promote ‘transformative education’ in Africa and similarly challenged regions.^{14,152}

Collectively, this increased activity may help to narrow the North–South gap in scientific publications. However, the rate of growth in the literature in SSA is not homogeneous across the region but is dominated by a group of countries and institutions. This may further limit efforts to improve medical education capacity in the most critical regions in SSA and in similarly resource-limited environments elsewhere in the developing world. In conclusion, while this review summarises current successes in and challenges for improving medical education in SSA, it also suggests several issues of key importance for further study with the aim of building up the existing literature on medical education in SSA and other regions facing critical doctor shortages.

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REFERENCES

- World Health Organization. The Health of the People. 2008. http://whqlibdoc.who.int/afro/2006/9290231033_rev_eng.pdf. [Accessed 25 May 2011.]
- High Level Forum on the Health MDGs. Addressing Africa's Health Workforce Crisis: an avenue for action. 2004. <http://www.hlfhealthmdgs.org/Documents/AfricasWorkforce-Final.pdf>. [Accessed 25 May 2011.]
- Gukas ID. Global paradigm shift in medical education: issues of concern for Africa. *Med Teach* 2007;**29** (9):887–92.
- Omer MI. Can medical education rise to the challenge of the African crisis? *Ann Trop Paediatr* 2005;**25** (4):227–41.
- Sub-Saharan African Medical Schools Study. Sub-Saharan African Medical Schools Study. <http://samss.org>. [Accessed 25 May 2011.]
- Mullen F, Frehywot S, Omaswa F *et al*. Medical schools in sub-Saharan Africa. *Lancet* 2011;**377** (9771): 1113–21.
- O'Brien HR. The dawn of medical education in tropical Africa. *J Med Educ* 1958;**33** (8):553–64.
- World Health Organization. WHO Avicenna World Directory of Medical Schools. 2007. http://avicenna.ku.dk/database/WHO_directory/. [Accessed 25 May 2011.]
- Liese B, Dussault G. The State of the Health Workforce in sub-Saharan Africa: evidence of crisis and analysis of contributing factors. 2004. <http://info.worldbank.org/etools/docs/library/206769/The%20State%20of%20Health%20Workforce%20in%20SubSaharan%20Africa.pdf>. [Accessed 25 May 2011.]
- Horton R. North and south: bridging the information gap. *Lancet* 2000;**355**:2231–6.
- Hoffman KJ, Kanyengo CW, Rapp BA, Kotzin S. Mapping the health research landscape in sub-Saharan Africa: a study of trends in biomedical publications. *J Med Libr Assoc* 2009;**97**:41–4.
- Sumathipala A, Siribaddana S, Patel V. Underrepresentation of developing countries in the research literature: ethical issues arising from a survey of five leading medical journals. *BMC Med Ethics* 2004;**5**:E5.
- Keiser J, Utzinger J, Tanner M, Singer BH. Representation of authors and editors from countries with different human development indexes in the leading literature on tropical medicine: survey of current evidence. *BMJ* 2004;**328**:1229–32.
- Frenk J, Chen L, Bhutta ZA. Health professionals for a new century: transforming education to strengthen health systems in an interdependent world. *Lancet* 2010;**376**:1923–58.
- van Niekerk JP. Missions of a medical school: an African perspective. *Acad Med* 1999;**8** (Suppl):38–44.
- Sewankambo N. Academic medicine and global health responsibilities. *BMJ* 2004;**329** (7469):752–3.
- Boelen C. Social accountability and accreditation: a new frontier for educational institutions. *Pedagogie Medicale* 2008;**9** (4):235–44.
- van Zanten MN, Norcini JJ, Boulet JR, Simon F. Overview of accreditation of undergraduate medical education programmes worldwide. *Med Educ* 2008;**42**:930–7.
- Burdick W. Challenges and issues in health professions education in Africa. *Med Teach* 2007;**29** (9):882–6.
- Sub-Saharan African Medical Schools Study. SAMSS Communiqué. 2008. http://samss.org/samss.upload/wysiwyg/SAMSS_Communique_En.pdf. [Accessed 25 May 2011.]
- Sub-Saharan African Medical Schools Study. Site visit reports. 2010. <http://samss.org/display.aspx?reports>. [Accessed 25 May 2011.]
- Fleming CM. Medical education in East Africa: a link with the University of Glasgow. *Br Med J* 1965;**1** (5439):918–9.
- Woodruff AW. A new medical school in Central Africa. *Lancet* 1982;**2** (8297):545–6.
- Broadhead RL, Muula AS. Creating a medical school for Malawi: problems and achievements. *BMJ* 2002;**325** (7360):384–7.
- Ameh EA, Adejuyigbe O, Nmadu PT. Paediatric surgery in Nigeria. *J Pediatr Surg* 2006;**41** (3):542–6.
- Akiode O. Residency training in Nigeria. *Arch Ibadan Med* 2005;**6** (1):43–6.
- Ibrahim M. Medical education in Nigeria. *Med Teach* 2007;**29** (9):901–5.
- Mufunda J, Chatora R, Ndambakuwa Y, Samkange C, Sigola L, Vengesa P. Challenges in training the ideal

- doctor for Africa: lessons learned from Zimbabwe. *Med Teach* 2007;**29** (9):878–81.
- 29 Muula AS. Every country or state needs two medical schools. *Croat Med J* 2006;**47** (4):669–72.
- 30 Fahal AH. Medical education in the Sudan: its strengths and weaknesses. *Med Teach* 2007;**29** (9):910–4.
- 31 Human Resources for Health. Overcoming the Crisis: The Joint Learning Initiative. 2004. <http://www.hrhresourcecenter.org/node/31>. [Accessed 25 May 2011.]
- 32 Africa Working Group of the Joint Learning Initiative on Human Resources for Health and Development. The Health Workforce in Africa: Challenges and Prospects. 2006. http://www.hrhresourcecenter.org/hosted_docs/AWG_Report_2006.pdf. [Accessed 25 May 2011.]
- 33 Global Health Workforce Alliance, Human Resources for Health in Africa. Experiences, Challenges, and Realities – The Douala Declaration. 2007. http://www.who.int/workforcealliance/knowledge/resources/doualameeting_report/en/index.html. [Accessed 25 May 2011.]
- 34 Kober K, van Damme W. Scaling up access to antiretroviral treatment in southern Africa: who will do the job? *Lancet* 2004;**364** (9428):103–7.
- 35 Regional AIDS Training Network. Promoting excellence in training. UNAIDS Best Practices Collection. 2001. <http://unaids.today.org/>. [Accessed 25 May 2011.]
- 36 Global Health Workforce Alliance. The Kampala Declaration and Agenda for Global Action. 2008. http://www.who.int/workforcealliance/knowledge/resources/kampala_declaration/en/index.html. [Accessed 25 May 2011.]
- 37 Africa Union of Ministers of Health. Africa Health Strategy 2007–2015: Strengthening Health Systems for Equity and Development in Africa. 2007. http://www.africa-union.org/root/UA/Conferences/2007/avril/SA/9-13%20avr/doc/en/SA/AFRICA_HEALTH_STRATEGY.pdf. [Accessed 25 May 2011.]
- 38 Physicians for Human Rights. The Right to Health and Health Workforce Planning: A Guide for Government Officials, NGOs, Health Workers and Development Partners. 2008. <http://physiciansforhumanrights.org/library/documents/reports/health-workforce-planning-guide-2.pdf>. [Accessed 25 May 2011.]
- 39 Dovlo D. Using mid-level cadres as substitutes for internationally mobile health professionals in Africa. A desk review. *Hum Resour Health* 2004;**2** (1):7.
- 40 Mullan F, Frehywot S. Non-physician clinicians in 47 sub-Saharan African countries. *Lancet* 2007;**370** (9605):2158–63.
- 41 World Health Organization. Task shifting: rational redistribution of tasks among health workforce teams : global recommendations and guidelines. 2008. <http://www.who.int/healthsystems/TTR-TaskShifting.pdf>. [Accessed 25 May 2011.]
- 42 New Partnership for Africa's Development. Human Resource Development Initiative. 2003. <http://www.nepad.org/humancapitaldevelopment/health/about>. [Accessed 25 May 2011.]
- 43 Parry E, Parry V. Training for health care in developing countries: the work of the Tropical Health and Education Trust. *Med Educ* 1998;**32** (6):630–5.
- 44 World Health Organization/PEPFAR Scaling up nursing and medical education. 2009. http://www.who.int/hrh/resources/scaling-up_planning_report.pdf. [Accessed 25 May 2011.]
- 45 Boulet J, Bede C, McKinley D, Norcini J. An overview of the world's medical schools. *Med Teach* 2007;**29** (1):20–6.
- 46 Boelen C, Boyer M. A view of the world's medical schools: defining new roles. Geneva: World Health Organization 2001. <http://www.iaomc.org/WHOREptMedSchools.pdf>. [Accessed 25 May 2011.]
- 47 Brock JF. The training of the physician: adaptation of medical education to regional needs. *N Engl J Med* 1964;**271**:989–93.
- 48 de Villiers MR, van Velden DP. Curriculum development for the rural specialist. *S Afr Med J* 1996;**86** (12):1528.
- 49 Draper CE, Louw G. Medical students' attitudes towards the primary health care approach – what are they and how do they change? *S Afr Fam Pract* 2007;**49** (2):17.
- 50 Akinyinka OO, Ohaeri JU, Asuzu MC. Beliefs and attitudes of clinical year students concerning medical specialties: an Ibadan medical school study. *Afr J Med Med Sci* 1992;**21** (2):89–99.
- 51 Hamilton JD, Ogunbode O. Medical education in the community: a Nigerian experience. *Lancet* 1991;**338** (8759):99–102.
- 52 Omotara BA, Yahya SJ, Shehu U, Bello HS, Bassi AP. Communities' awareness, perception and participation in the community-based medical education of the University of Maiduguri. *Educ Health (Abingdon)* 2006;**19** (2):147–54.
- 53 Otti PN. Medical education and primary health care in tropical Africa: evidence for change. *East Afr Med J* 1989;**66** (4):300–6.
- 54 Ozgediz D. Africa's neglected surgical workforce crisis. *Lancet* 2008;**371**:627–8.
- 55 Martey JO, Hudson CN. Training specialists in the developing world: ten years on, a success story for West Africa. *Br J Obstet Gynaecol* 1999;**106** (2):91–4.
- 56 Mhando S, Lyamuya S, Lakhoo K. Challenges in developing paediatric surgery in sub-Saharan Africa. *Pediatr Surg Int* 2006;**22**:425–7.
- 57 Dent DM. Surgical training in 21st-century Africa – a South African perspective. *S Afr J Surg* 1998;**36** (2):44.
- 58 Galukande M, Luboga S, Kijambu S. Improving recruitment of surgical trainees and training of surgeons in Uganda. *East Afr Med J* 2006;**11** (1):17–24.
- 59 Awojobi OA. Surgical training in Nigeria: a reappraisal. *Acad Med* 2005;**6** (1):59–62.

- 60 Binam F, Malongte P, Beyiha G, Ze Minkande J, Takongmo S, Bengono G. Emergency medicine training: the future of emergency care in Africa. *Med Trop* 2002;**62** (3):275–7.
- 61 Aarli JA, Diop AG, Lochmuller H. Neurology in sub-Saharan Africa: a challenge for the World Federation of Neurology. *Neurology* 2007;**69** (17):1715–8.
- 62 Walker IA. Con: paediatric anaesthesia training in developing countries is best achieved by out of country scholarships. *Paediatr Anaesth* 2009;**19** (1):45–9.
- 63 Gathuya ZN. Pro: paediatric anaesthesia training in developing countries is best achieved by selective out of country scholarships. *Paediatr Anaesth* 2009;**19** (1):42–4.
- 64 Rabinowitz DA, Pretorius ES. Postgraduate radiology training in sub-Saharan Africa: a review of current educational resources. *Acad Radiol* 2005;**12** (2):224–31.
- 65 Bennett JF, Saxton GA, Lutwama JSW, Namboze JM. The role of a rural health centre in the teaching programme of a medical school in East Africa. *J Med Educ* 1965;**50**:690–9.
- 66 Bollag U, Schmidt H, Fryers T, Lawani J. Medical education in action: community-based experience and service in Nigeria. *Med Educ* 1982;**16** (5):282–9.
- 67 Monekosso GL. The teaching of medicine at the University Centre for Health Sciences Yaounde, Cameroon: its concordance with the Edinburgh Declaration on medical education. *Med Educ* 1993;**27** (4):304–20.
- 68 Schreier A, Dub B. Attitudes of medical students to a family attachment scheme. *S Afr Med J* 1977;**51** (15):501–3.
- 69 Brieger WR. Developing service-based teaching in health education for medical students. *Health Educ Monogr* 1978;**6** (4):345–58.
- 70 Whittaker DE, Hoffman M. Students' attitudes to small-group work in community health. *Med Educ* 1987;**21** (4):350–2.
- 71 Iputo JE, Nganwa-Bagumah AB. The innovative medical curriculum of the University of Transkei Medical School. Part II. Community-based learning. *S Afr Med J* 1996;**86** (6):651–2.
- 72 Matchaya M, Muula AS. Perceptions toward private medical practitioners' attachments for undergraduate medical students in Malawi. *Malawi Med J* 2009;**21** (1):6–11.
- 73 Ogunbode O. Features and controversies in community-based education. *Arch Ibadan Med* 2005;**6** (1):24–8.
- 74 Kwizera EN, Igumbor EU, Mazwai LE. Twenty years of medical education in rural South Africa – experiences of the University of Transkei Medical School and lessons for the future. *S Afr Med J* 2005;**95** (12):920–2.
- 75 Jinadu MK, Ojofeitimi EO, Oribabor P. Evaluation of an innovative approach to community-based medical undergraduate education in Nigeria. *Educ Health (Abingdon)* 2002;**15** (2):139–48.
- 76 Iputo JE, Kwizera E. Problem-based learning improves the academic performance of medical students in South Africa. *Med Educ* 2005;**39** (4):388–93.
- 77 Gukas ID. Problem-based learning in undergraduate medical education: can we really implement it in the West African subregion? *West Afr J Med* 2007;**26** (2):87–92.
- 78 Adeogun M. Paradigm shifts in medical education: implications for medical/health librarians in sub-Saharan Africa. *University of Dar es Salaam Library Journal* 2007;**9** (2):72–85.
- 79 Iputo JE. Impact of the problem-based learning curriculum on the learning styles and strategies of medical students at the University of Transkei. *S Afr Med J* 1999;**89** (5):550–4.
- 80 Boon JM, Meiring JH, Richards PA, Jacobs CJ. Evaluation of clinical relevance of problem-oriented teaching in undergraduate anatomy at the University of Pretoria. *Surg Radiol Anat* 2001;**23** (1):57–60.
- 81 McLean M. Clinical role models are important in the early years of a problem-based learning curriculum. *Med Teach* 2006;**28** (1):64–9.
- 82 Kwizera EN, Dambisya YM, Aguirre JH. Does tutor subject-matter expertise influence student achievement in the problem-based learning curriculum at UNITRA Medical School? *S Afr Med J* 2001;**91** (6):514–6.
- 83 McLean M. What can we learn from facilitator and student perceptions of facilitation skills and roles in the first year of a problem-based learning curriculum? *BMC Med Educ* 2003;**3**:1–10.
- 84 Kiguli-Malwadde EK, Kijjambu S, Kiguli S *et al*. Problem-based learning, curriculum development and change process at Faculty of Medicine, Makerere University, Uganda. *Afr Health Sci* 2006;**6** (2):127–30.
- 85 Cameron D, Blitz J, Durrheim D. Teaching young docs old tricks – was Aristotle right? An assessment of the skills training needs and transformation of interns and community service doctors working at a district hospital. *S Afr Med J* 2002;**92** (4):276–8.
- 86 Connolly C, Seneque M. Evaluating problem-based learning in a multilingual student population. *Med Educ* 1999;**33** (10):738–44.
- 87 Oviasu E. Clinical skills evaluation in a resource-constrained environment. *Med Educ* 2008;**42** (5):524–5.
- 88 Burch VC, Nash RC, Zabow T, Gibbs T, Aubin L, Jacobs B, Hift RJ. A structured assessment of newly qualified medical graduates. *Med Educ* 2005;**39** (7):723–31.
- 89 Kiguli S, Kijjambu S, Mwanika A. Clinical skills training in a resource-constrained medical school. *Med Educ* 2006;**40** (5):473.
- 90 Anochie IC, Nkanginieme KE, Eke N, Gbogo I. Development and validation of standardised clinical summary format. *Niger J Med* 2008;**17** (3):300–3.
- 91 de Villiers M, Van Heusden M. A comparison of clinical communication skills between two groups of final year medical students with different levels of communication skills training. *S Afr Fam Pract* 2007;**49** (7):1–5.
- 92 Mash B, Couper I, Hugo J. Building consensus on clinical procedural skills for South African family

- medicine training using the Delphi technique. *S Afr Fam Pract* 2006;**48** (10):14.
- 93 Walubo A, Burch V, Parmar P, Raidoo D, Cassimjee M, Onia R, Ofei F. A model for selecting assessment methods for evaluating medical students in African medical schools. *Acad Med* 2003;**78** (9):899–906.
- 94 McLean M, Henson Q, Hiles L. The possible contribution of student drawings to evaluation in a new problem-based learning medical programme: a pilot study. *Med Educ* 2003;**37** (10):895–906.
- 95 Beyliefeld AA, Struwig MC. A gaming approach to learning medical microbiology: students' experiences of flow. *Med Teach* 2007;**29** (9):933–40.
- 96 World Federation for Medical Education. Guidelines for Using Computers in Medical Education. *Med Educ* 1998;**32**:205–8.
- 97 McLean M, Murrell K. WebCT: integrating computer-mediated communication and resource delivery into a new problem-based curriculum. *J Audiov Media Med* 2002;**25** (1):8–15.
- 98 Masters K, Gibbs T. The spiral curriculum: implications for online learning. *BMC Med Educ* 2007;**7**:52.
- 99 El Shallaly GH, Ali EA. Use of video-projected structured clinical examination (ViPSCE) instead of the traditional oral (viva) examination in the assessment of final year medical students. *Educ Health (Abingdon)* 2004;**17** (1):17–26.
- 100 Hadley GP, Mars M. Postgraduate medical education in paediatric surgery: videoconferencing – a possible solution for Africa? *Ped Surg Int* 2008;**24** (2):223–6.
- 101 Williams CD, Pitchfork EL, O'Callaghan C. Computers, the Internet and medical education in Africa. *Med Educ* 2010;**44**:485–8.
- 102 Samuel M, Coombes JC, Miranda JJ, Melvin R, Young EJ, Azarmina P. Assessing computer skills in Tanzanian medical students: an elective experience. *BMC Public Health* 2004;**4**:37.
- 103 Ameh N, Kene TS, Ameh ES. Computer knowledge amongst clinical year medical students in a resource-poor setting. *Afr Health Sci* 2008;**8** (1):40–3.
- 104 Olantuji-Bello II, Ibegwam A, Odugbemi TO. A review of the use of computer and Internet services in a Lagos tertiary institution. *Niger J Health Biomed Sci* 2002;**1** (1):13–21.
- 105 Mullan F. The metrics of the physician brain drain. *N Engl J Med* 2005;**353**:1810–8.
- 106 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;**2**:17.
- 107 Scheffler RM, Liu JX, Kinfu Y, Dal Poz MR. Forecasting the global shortage of physicians: an economic- and needs-based approach. *Bull World Health Organ* 2008;**86** (7):516–23.
- 108 Clemens MA, Pettersen G. New data on African health professionals abroad. *Hum Resour Health* 2007;**6**:1.
- 109 Kirigia JM, Gbary AR, Muthuri LK, Nyoni J, Seddoh A. The cost of health professionals' brain drain in Kenya. *BMC Health Serv Res* 2006;**6** (89); <http://www.biomedcentral.com/1472-6963/6/89> [Accessed 25 May 2011.]
- 110 Awases M, Gbary A, Nyoni J, Chatora R. Migration of health professionals in six countries: a synthesis report. 2004. <http://www.hrhresourcecenter.org/node/61>. [Accessed 25 May 2011.]
- 111 Dovlo D. Wastage in the health workforce: some perspectives from African countries. *Hum Resour Health* 2005;**3**:6.
- 112 Astor A, Tasleem A, Matallana VM, Olowu FA, Tallo V, Lie RK. Physician migration: views from professionals in Colombia, Nigeria, India, Pakistan and the Philippines. *Soc Sci Med* 2005;**61** (12):2492–500.
- 113 Hagopian A, Ofosu A, Fatusi A, Biritwum R, Essel A, Hart LG, Watts C. The flight of physicians from West Africa: views of African physicians and implications for policy. *Soc Sci Med* 2005;**61** (8):1750–60.
- 114 Mills EJ, Schabas WA, Volmink J, Walker R, Ford N, Katabira E, Anema A, Joffres M, Cahn P, Montaner J. Should active recruitment of health workers from sub-Saharan Africa be viewed as a crime? *Lancet* 2008;**371** (9613):685–8.
- 115 Coombes R. Developed world is robbing African countries of health staff. *BMJ* 2005;**330**:923.
- 116 World Health Organization. Global Code of Practice on the International Recruitment of Health Personnel. 2010. <http://www.who.int/hrh/migration/code/practice/en/index.html>. [Accessed 25 May 2011.]
- 117 Eastwood JB, Conroy RE, Naicker S, West PA, Tutt RC, Plange-Rhule J. Loss of health professionals from sub-Saharan Africa: the pivotal role of the UK. *Lancet* 2005;**365** (9474):1893–900.
- 118 Labonte R, Packer C, Klassen N *et al.* The brain drain of health professionals from sub-Saharan Africa to Canada. 2006. <http://www.hrhresourcecenter.org/node/1468>. [Accessed 25 May 2011.]
- 119 Scott ML, Whelan A, Dewdney J, Zwi AB. 'Brain drain' or ethical recruitment? *Med J Aust* 2004;**180** (4):174–6.
- 120 Longombe A, Burch V, Luboga S, Mkony C, Olapade-Olaopa E, Otieno-Nyunya B *et al.* Research on medical migration from sub-Saharan medical schools: usefulness of a feasibility process to define barriers to data collection and develop a practical study. *Educ Health (Abingdon)* 2007;**20** (1):27.
- 121 Bekele A, Mekonnen A, Osman M. Medical students' perspective towards their future medical practice. *J Ethiop Med Pract* 2001;**3** (2):85–91.
- 122 Bourne D, Gunst C, Snyders S. Medical students' attitudes to emigration. *S Afr Med J* 1993;**83** (11):861–2.
- 123 Dambisya Y. Career intentions of UNITRA medical students and their perceptions about the future. *Educ Health (Abingdon)* 2003;**16** (3):286–97.
- 124 Ihekweazu C, Anya I, Anosike E. Nigerian medical graduates: where are they now? *Lancet* 2005;**365** (9474):1847–8.
- 125 Price M, Weiner R. Where have all the doctors gone? Career choices of Wits medical graduates. *S Afr Med J* 2005;**95** (6):414–9.

- 126 Igumbor EU, Kwizera EN. The positive impact of rural medical schools on rural intern choices. *Rural Remote Health* 2005;**5** (2):417.
- 127 Raviola G, Machoki M, Mwaikambo E, Good MJ. HIV, disease plague, demoralisation and 'burnout': resident experience of the medical profession in Nairobi, Kenya. *Cult Med Psychiatry* 2002;**26** (1):55–86.
- 128 de Castella T. Health workers struggle to provide care in Zimbabwe. Brain drain adds to woes of a cash-strapped health-care system. *Lancet* 2003;**362** (9377):46–7.
- 129 Kline MW, Ferris MG, Jones DC, Calles NR, Mizwa MB, Schwarzwald HL *et al*. The Pediatric AIDS Corps: responding to the African HIV/AIDS health professional resource crisis. *Pediatrics* 2009;**123** (1):134–6.
- 130 Mullan F. Responding to the global HIV/AIDS crisis: a Peace Corps for health. *JAMA* 2007;**297** (7):744–6.
- 131 Physicians for Human Rights. An action plan to prevent brain drain: building equitable health systems in Africa. 2004. <http://physiciansforhumanrights.org/library/report-2004-July.html>. [Accessed 25 May 2011.]
- 132 Renggli V, Ryck ID, Jacob S, Yeneneh H, Sirgu S, Sebuyira LM *et al*. HIV education for health care professionals in high prevalence countries: time to integrate a pre-service approach into training. *Lancet* 2008;**372** (9635):341–3.
- 133 Weaver MR, Nakitto C, Schneider G, Kanya MR, Kambugu A, Lukwago R *et al*. Measuring the outcomes of a comprehensive HIV care course: pilot test at the Infectious Diseases Institute, Kampala, Uganda. *J AIDS* 2006;**43** (3):293–303.
- 134 Dovlo D. The brain drain and retention of health professionals in Africa. Regional Training Conference on Improving Tertiary Education in Sub-Saharan Africa: Things that Work! 2003. <http://www.hrhresourcecenter.org/node/445>. [Accessed 25 May 2011.]
- 135 de Vries E, Reid S. Do South African medical students of rural origin return to rural practice? *S Afr Med J* 2003;**93**:789–93.
- 136 Kotzee TJ, Couper ID. What interventions do South African qualified doctors think will retain them in rural hospitals of the Limpopo province of South Africa? *Rural Remote Health* 2006;**6** (3):581.
- 137 Serneels P, Lindelow M, Montalvo JG, Barr A. For public service or money: understanding geographical imbalances in the health workforce. *Health Policy Plan* 2007;**22** (3):128–38.
- 138 Frehywot S, Mullan F, Payne PW, Ross H. Compulsory service programmes for recruiting health workers in remote and rural areas: do they work? *Bull World Health Organ* 2010;**80**:364–70.
- 139 Barnighausen T, Bloom DE. 'Conditional scholarships' for HIV/AIDS health workers: educating and retaining the workforce to provide antiretroviral treatment in sub-Saharan Africa. *Soc Sci Med* 2009;**68**:544–51.
- 140 van Zyl GJ, Nel M. The PRIME model: a management solution in academic medicine. *S Afr Fam Pract* 2008;**50** (1):71.
- 141 Ofoegbu EN, Ozumba BC. Establishment of an office of medical education: Nigeria. *Med Educ* 2007;**41** (5):507.
- 142 Monekosso GL. Strategies for developing innovative programmes in international medical education. A viewpoint from Africa. *Acad Med* 1989;**5** (Suppl):27–31.
- 143 Olmesdahl PJ, Manning DM. Impact of training on PBL facilitators. *Med Educ* 1999;**33** (10):753–5.
- 144 Olmesdahl PJ. Rewards for teaching excellence: practice in South African medical schools. *Med Educ* 1997;**31** (1):27–32.
- 145 Burdick WP, Morahan PS, Norcini JJ. Slowing the brain drain: FAIMER education programmes. *Med Teach* 2006;**28** (7):631–4.
- 146 Sande M, Ronald A. The academic alliance for AIDS care and prevention in Africa. *Acad Med* 2008;**83** (2):180–4.
- 147 Einterz R. Responding to the HIV pandemic: the power of an academic medical partnership. *Acad Med* 2008;**82** (8):812–8.
- 148 Ozgediz D, Wang J, Jayaraman S, Ayzengart A, Jamshidi R, Lipnick M *et al*. Surgical training and global health: initial results of a 5-year partnership with a surgical training programme in a low-income country. *Arch Surg* 2008;**143** (9):860–5.
- 149 Afolabi BB, Olapade-Olaopa E. International training in medical education. *Afr J Med Med Sci* 2006;**35**:59–67.
- 150 Glew RH. Promoting collaborations between biomedical scholars in the US and sub-Saharan Africa. *Exp Biol Med (Maywood)* 2008;**233** (3):277–85.
- 151 American International Health Alliance Twinning Center. HIV/AIDS Twinning Center Program Overview: American International Health Alliance–Twinning Center, 2009: <http://www.twinningagainstaids.org> [Accessed 25 May 2011.]
- 152 World Health Organization/PEPFAR. Collaboration for transformative scale-up of medical and nursing education. 2010. http://www.who.int/hrh/resources/guidelines_group/en/index.html. [Accessed 25 May 2011.]

SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article. Available online at: <http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2923.2011.04039.x/supinfo>

Table S1. Grey literature sources.

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