BMJ Open

Health research capacity development in Low and Middle Income Countries: reality or rhetoric? A systematic meta-narrative review of the qualitative literature

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2016-012332
Article Type:	Research
Date Submitted by the Author:	20-Apr-2016
Complete List of Authors:	Franzen, Samuel; Oxford Policy Management; University of Oxford, The Global Health Network, Centre for Tropical Medicine and Global Health Chandler, Clare; London School of Hygiene & Tropical Medicine, Global Health and Development Lang, Trudie; University of Oxford, The Global Health Network, Centre for Tropical Medicine and Global Health
Primary Subject Heading:	Global health
Secondary Subject Heading:	Evidence based practice, Qualitative research, Research methods
Keywords:	QUALITATIVE RESEARCH, TROPICAL MEDICINE, EDUCATION & TRAINING (see Medical Education & Training)

Title

Health research capacity development in Low and Middle Income Countries: reality or rhetoric? A systematic meta-narrative review of the qualitative literature

Authors

Dr Samuel R P Franzen[1,2], Dr Clare Chandler[3], Prof Trudie Lang[1]

Corresponding author's address

Samuel R P Franzen, Oxford Policy Management, The Clarendon Centre, 52 Cornmarket Street, Oxford, OX1 3HJ, United Kingdom; Email: sam.franzen@opml.co.uk; Telephone: +44 (0)1865 410 846

Affiliations

1 The Global Health Network, Centre for Tropical Medicine and Global Health, University of Oxford, Oxford, UK.

2 Oxford Policy Management, Oxford, UK.

3 Department of Global Health and Development, London School of Hygiene & Tropical Medicine, London W, UK.

Key words

Health Research, Capacity Development, Low and Middle Income Countries, Research Systems, Clinical Trials

Word count

5653

Abstract

Objectives: Locally-led health research in Low and Middle Income Countries (LMIC) is critical for overcoming global health challenges. Yet, despite over 25 years of international efforts, health research capacity in LMICs remains insufficient and development attempts continue to be fragmented. The aim of this systematic review is to identify and critically examine the main approaches and trends in health research capacity development and consolidate key thinking to identify a more coherent approach.

Methods: This review includes academic and grey literature published between Jan 2000 and July 2013. Using a predetermined search strategy, we systematically searched PubMed, hand-searched Google Scholar, and checked reference lists. This process yielded 1668 papers. 240 papers were selected based on a priori criteria. A modified version of meta-narrative synthesis was used to analyse the papers.

Results: Three key narratives were identified: the effect of power relations on capacity development; demand for stronger links between research, policy, and practice; and the importance of a systems approach. Capacity development was delivered through 4 main modalities: vertical research projects, centres of excellence, North-South partnerships, and networks; all were controversial and each had their strengths and weaknesses. A plurality of development strategies were employed to address specific barriers to health research. However, lack of empirical research and monitoring and evaluation meant that their effectiveness was unclear and learning was weak.

Conclusions: There has been steady progress in LMIC health research capacity but major barriers to research persist and more empirical evidence on development strategies is required. Despite an evolution in development thinking, international actors continue to use outdated development models that are recognised as ineffective. To realise newer development thinking, research capacity outcomes need to be equally valued as research

outputs. While some development actors are now adopting this dedicated capacity development approach, they are in the minority.

Strengths and limitations of this study

- This systematic review goes beyond previous attempts that lacked reflexivity, to provide a nuanced, in-depth, and enquiring critique of health research capacity development approaches.

- This review integrates diverse qualitative literature that largely lacked formal reporting procedures or empirical base, allowing the inclusion of voices that are traditionally excluded in other styles of systematic analyses.

- Some academic articles may have been missed because PubMed was the only formal database used, and there was limited inclusion of evaluation and programme-level data due to poor grey literature indexing in Google and Google Scholar.

- However, the meta-narrative method aims to develop overarching narratives through saturation of themes, rather than include every eligible article, so inclusion of additional papers would be unlikely change the findings of the study.

1 Introduction

Locally-led health research is critical for overcoming global health challenges in Low and Middle Income Countries (LMICs) [1]. This research is needed to "propose culturally apt and cost-effective individual and collective interventions, to investigate their implementation, and to explore the obstacles that prevent recommended strategies from being implemented" [2]. Such research is now the focus of key capacity development efforts, such as the regional educational centres supported by the Special Programme for Research and Training in Tropical Diseases (TDR) [3].

However, these arguments are not new; the importance of LMIC research capacity has been recognised for well over two decades. The 1990 Commission on Health Research for Development stated that strengthening research capacity in LMICs is "one of the most powerful, cost-effective, and sustainable means of advancing health and development" [4]. This marked the beginning of a "revolution" in health research [5] where there was a surge of investment and concerted effort to conduct health research aimed at solving health problems in LMICs [6].

Nevertheless, at the turn of the millennium LMICs accounted for 85% of the world's population but 92% of the global disease burden, and only 10% of global funding for health research was devoted to addressing these persistent health challenges [6]. Recognition of this "10/90" gap led to renewed calls for health research capacity development in LMICs and further investment [5].

Yet nearly 15 years later, many LMICs still lack sufficient health research capacity to build a local evidence-base with which to inform policy and improve population health. This was recently and profoundly described in The 2013 World Health Report which argued that "all nations should be producers and users of research as well as consumers", noting that this was not yet the case [1].

Therefore, despite years of international collaborations and investment, development of LMIC nation's capacity to address their own health problems appears enduringly problematic. Where there has been progress, such gains often do not appear sustainable without continued strong foreign support [7, 8], which is itself questionable in light of recent austerity and bilateral aid agency restructuring [1, 9, 10].

Although there is a large and diverse body of literature on health research capacity development, it remains confusing, controversial, and poorly defined, with various contradictory understandings [11] and conceptualisations [1]. Since capacity development is now something that most research actors are expected to participate in, or at least be knowledgeable on [5, 12], this is problematic. To increase the likelihood of future capacity development efforts being effective, there is a need to take stock of past experiences and learn from successes and failures. Such an exercise would not only provide a unifying picture to appraise previous capacity development efforts, but also encourage discussion and reflection that could lead to fresh thinking.

The aim of this systematic review is to identify and critically examine the main approaches, strategies, and trends in health research capacity development and consolidate key thinking in order to identify a more coherent approach. This review should prove useful to all stakeholders interested in learning how to undertake the complex business of capacity development, and will be of particular interest to actors working to develop locally-led and sustainable health research capacity in LMICs.

2 Methods

Our systematic review followed the 6 stages of the meta-narrative methodology developed by Greenhalgh *et al* [13]. The meta-narrative method is a "systematic, theory-driven interpretative technique, which [was] developed to help make sense of heterogeneous evidence about complex interventions applied in diverse contexts in a way that informs policy" [14]. It was therefore highly suited to the purposes of this study.

2.1 Inclusion criteria

This review considers the perspectives of all actors involved in health research capacity development (HRCD) that publish within academic and grey literature from the year 2000 onwards. We included any papers that broadly discussed HRCD or its more specific components. Papers that mentioned HRCD but did not discuss the issue further were not included. Non-English language publications were excluded due to lack of resources for translation. Papers published before the year 2000 were initially included, but after screening it became clear that paradigm shifts in global health at the turn of the millennium [5, 6] meant that much of their content was not relevant to current day. Furthermore, many papers published post 2000 effectively summarised historically important issues. Therefore, all papers published pre-2000 were excluded.

2.2 Search strategy and study selection

The search and study selection process is presented in Figure 1. We searched PubMed using the search terms presented in Box 1 for all papers published up to 20 June 2013. This search yielded 1668 potentially relevant papers. The titles and abstracts of these papers were then screened for eligibility, resulting in 1376 papers being excluded based on pre-screening, with an additional 75 papers excluded after it was decided that papers published before 1 January 2000 should not be included.

Fig 1: Search and study selection process

Box 1: Search terms used in PubMed search

((((((((((((((((capacity building[MeSH Terms]) OR ((("developing"[Title/Abstract]) OR "develop"[Title/Abstract]) OR "capacity"[Title/Abstract]))))) OR "strengthen"[Title/Abstract]) OR "strengthening"[Title/Abstract])) AND ((((developing country[MeSH Terms]) OR Africa) OR Asia) OR Latin America))) AND ((("trial"[Title]) OR "trials"[Title]) OR "research"[Title])))) NOT clinical trial[Publication Type]) NOT informed consent[MeSH Terms]) NOT waste management[MeSH Terms]) NOT air pollution[MeSH Terms]) NOT agriculture[MeSH Terms]) NOT ("Na6(H2O)8(ZnAsO4)6" [Supplementary Concept] OR "K3Zn4O(AsO4)3" [Supplementary Concept])

The PubMed search was complemented by a search of Google and Google Scholar using the terms “Health AND research AND capacity AND strengthening OR Building OR Development”. All literature added from Google were found in the first 10 pages (n=30). After the first 10 pages, no search results were relevant to the study. Literature collections of the authors and other experts were also hand searched and references snowballed (n=45). A total of 292 papers were read in full and considered for eligibility. Based on this screening, the final synthesis involved 240 papers. The full list of papers included in this review can be found in supplementary file S1.

Relevant papers published between June 20 2013 and December 14 2014 were scanned and read to determine if the synthesis findings were still valid post-search. Although there were some pertinent new articles, their content would not have changed the findings of this synthesis.

2.3 Quality assessment

No papers were excluded based on assessment of quality because the majority of papers lacked an empirical or explicit study design, and all stakeholders’ views regardless of their perceived validity were considered important. Furthermore, capacity development

discussion is inherently political and most contributions are based on personal opinion informed by theoretical, ethical, or experiential standpoint. Accordingly much of it is biased. Rather than attempt to remove the bias, assumptions and motivations were explicitly studied to undercover authors' implicit logic, so that readers can make their own informed opinion.

Instead of using quality criteria, similarity of arguments within the literature was used as an indicator of current agreement on a topic or popularity of an idea. This allowed a comprehensive analysis of all the HRCD narratives, while still highlighting and giving emphasis to the most widely accepted opinions.

2.4 Data extraction and synthesis

To synthesise the literature, papers need to be framed within a "storyline" that recognises where the contribution came from [13]. *Greenhalgh et al.'s* method explicitly catalogues these storylines as "meta-narratives" [13]. Developing meta-narratives provides context to contributions whose underlying assumptions and interests would otherwise be opaque. Although less prescribed than a quantitative systematic review, this approach pragmatically allows a plurality of ideas, recognising there may be no single correct answer.

To ensure that source content was interpreted alongside its context, even when broken into themes and narratives, a tagging system was used instead of a traditional extraction form. All sources were organised in EndNote X7 (Thomson Reuters) and associated citations, metadata and PDF copies of the documents were attached. These data were then imported into Nvivo 9 qualitative analysis software (QSR International) where the sources were given tags using deductive codes for key characteristics.

Meta-narratives were then identified inductively by reading each paper and coding for meta-narratives where several authors in the literature discussed and presented topics

similarly. This is an interpretive approach similar to that used in thematic coding analysis, where reoccurring themes that are conceptually related are grouped into concepts. Once the meta-narratives had been finalised they were systematically applied to all relevant papers. No prior theory beyond the guidance presented by Greenhalgh *et al.* [13] was explicitly used to help identify and categorise the meta-narratives. Instead, iterative rounds of open data-driven inductive coding were used.

2.5 Position of the authors

This systematic review was undertaken, in part, to inform the design of a larger body of empirical research on health research capacity development in LMICs. The authors of this paper do not include individuals from LMICs, but this paper was reviewed and commented on by individuals from LMICs who collaborated on the aforementioned empirical research, and discussed with other relevant experts at meetings and conferences. While some context-specific differences in experiences were inevitably raised, all individuals considered the findings of this study to be relevant and consistent with their broad view of health research capacity development in LMICs. All authors have backgrounds in social science and global health.

3 Results

3.1 Definitions and actors

The concept of capacity development can be confusing because there are multiple and conflicting terminologies for development activities and actors. To assist the reader, typologies of key definitions and development actors were produced. Supplementary file S2 presents these definitions alongside reasons for adopting them, and supplementary file S3 categorises and provides background to development actors' activities.

3.2 Characteristics of included papers

Table 1 summarises the main characteristics of the papers included in the review. Based on first author characteristics, the greatest number of articles came from LMIC academic and healthcare institutions (31.3%), closely followed by HIC academic and healthcare institutions (29.6%). Contributions from funders were very low (0.8%), and industry and civil society were absent, potentially reflecting the sampling from academic databases. Europe was the greatest contributing region (32.9%) followed by Sub-Saharan Africa at 23.8%. Contributions from Latin America (2.5%), Middle East (1.7%) and North Africa (0.8%) were low. Although most articles were concerned with capacity development across all LMICs (42.1%), Sub-Saharan Africa dominated the regional specific discussions (34.6%). The main basis for viewpoints were opinion, debate or personal perspectives (34.2%); sharing experiences represented 21.7%, and empirical work 20.8%.

Table 1: Characteristics of papers included in this review

Category* of development actor (for first author)	%	Location of first author's institution	%	Region of interest	%	Main topic of development interest	%	Main disease of interest	%	Basis for viewpoint	%
LMIC Academic and Healthcare Institutions	31.3	Europe	32.9	All LMIC countries	42.1	Multiple broad issues discussed	24.6	Not disease specific or address multiple	72.5	Opinion, debate, perspective	34.2
HIC Academic and Healthcare Institutions	29.6	Sub Saharan Africa	23.8	Sub Saharan Africa	34.6	Individual level development	15.8	HIV	6.3	Experience report	21.7
Multi-laterals	10.4	North America	13.8	South Asia	10	Partnerships networking, consortia	15.8	Malaria	5.8	Empirical research	20.8
Consortia & Networks, NGOs and Public-Private Partnerships	8.8	South Asia	10	East Asia	6.7	Operational challenges & opportunities	11.3	Other	4.6	Literature review, summary or synthesis	7.9
Academic Journals	5.4	East Asia	9.2	All Asia	2.9	System approaches and macro level development	9.2	Mental Health and Addiction	2.5	Proceedings or conference report	7.5
LMIC Governmental	4.6	Australia	2.9	Latin America	1.7	Agenda and priority setting	6.3	Maternal Child Health and Paediatrics	2.5	Organisation document	4.6
LMIC Funders, Research Councils and Institutes of Health	4.6	Latin America	2.5	Pacific	0.8	Institution level development	5.4	Tuberculosis	2.1	News report	3.3
Bi-lateral aid agencies	2.1	Not specific	2.1	Middle East	0.8	Monitoring and evaluation	2.9	Non-communicable diseases	2.1		
HIC Research Councils and Institutes of Health	2.1	Middle East	1.7	Central Asia	0.4	Research and development	2.1	Dental or oral health	1.7		
Private Foundations or Charity Funders	0.8	North Africa	0.8			Ethics and regulations	1.7				
Industry	0	Pacific	0.4			Knowledge cycle	0.8				
Civil Society and Media	0										

* Some categories have been merged because they could not be discretely separate

3.3 Meta-narratives in health research capacity development

Three key narratives ran though the literature: the effect of power relations on capacity development; demand for stronger links between research, policy, and practice; and the importance of a systems approach to HRCD. Each narrative is described below with reference to the key papers that discussed these narratives in detail.

3.3.1 Effect of power relations on capacity development

The effect of power relations on capacity development was the most common narrative running through the literature (present in 29% of papers). The main concerns of this topic are that research agendas in LMICs are set more by international funders than by LMIC institutions, and research conducted in LMICs is predominantly led by HIC researchers with little involvement of LMIC individuals or institutions. This is argued to erode national sovereignty [15], prevent capacity development [16, 17], and create research priorities that more closely match funder agendas than countries' needs [18-20] leading to a situation of "he who pays the piper calls the tune" [20, 21]. Examples include "spotlight issues", which receive funding regardless of relative need [22], and "parachute" research where data is collected in LMICs but all other work is conducted in HIC institutions.

"North-South" collaborations between HIC and LMIC research institutions are considered to be better mechanisms for developing research capacity [8], but many authors still thought that they comparatively disadvantage the LMIC partner [9, 12, 15]. The perceived situation of "treating Africa as a repository of raw materials for expatriate-driven research" [9] led to the development of guidelines for research collaboration. To reflect the change in approach, there was a rhetorical shift to using the term "partnership" to describe collaborations that were equitable [17]. These partnerships should be built on mutual trust and shared decision making, national ownership, early planning for translation of research findings and development of national research capacity [17]. Importantly, it is

now expected that all partnerships should have capacity development at their forefront [12]. However, despite discussion for well over a decade, a good proportion of the international community still feels that partnerships are not yet equal [12, 23, 24], and they cannot be until the power divide is addressed [15] because LMICs are unable to negotiate for a fairer deal [15, 25, 26].

In an effort to adjust the power balance there have been conscious efforts towards recognising local research capacity in LMICs [12, 20]. This change is again reflected in rhetoric through the evolution of the term “capacity development” which gradually places stronger emphasis on extant capacity; changing from “capacity building” to “capacity strengthening” [20] to “capacity utilisation” [27], “unleashing” and “releasing” [20]. Many authors now propose that research and capacity development in LMICs should be locally owned and led [17, 20, 28, 29]. This is because LMIC researchers have the best understanding of evidence gaps [17] and can present research to policy makers with an understanding of the political and cultural context which increases the chance of evidence uptake [30, 31]. Locally-led studies are also thought to be better aligned with national agendas [32] and address more applied implementation topics than foreign-led research [17].

Most stakeholders now agree that research and capacity development should, at a minimum, include the local research community in the design and conduct of research studies [33]. Development actors are also advised to be more sensitive to the power dynamics they create and ensure they strengthen, not weaken, the role of national governments by responding specifically to their priorities [20, 29, 34] and including the “recipients” in any agenda setting [35]. However, others argue that this situation will inevitably continue so long as foreign countries are the majority financers of research in LMICs [36]; only through greater national investment and commitment will LMICs have a stronger voice to make relations more equitable [7, 9, 37]. Nevertheless, the vast majority

of development efforts reportedly still focus on international collaborative research meaning local investigator-led studies are largely ignored [38]. This is evidenced by only 3 papers in this review being focussed on supporting locally-led clinical trials, compared to 33 papers aimed at developing international clinical trials.

3.3.2 Demand for stronger links between research, policy and practice

Arguments for stronger links between research, policy and practice were present in 16% of sources. These emerged due to concerns that much research was failing to be translated into policy [25, 39], and was too narrowly conceived and disease-specific to have impact [40].

Accordingly, applied fields now deemed to be highly relevant to decision makers and those that promote sustainable adoption and implementation of evidence based medicine have been called for [30, 41, 42]. These include health policy and systems research [43], health services research [44], implementation research, and operations research [45-47]. These arguments formed the backbone of the WHO strategy on “research for health” which “gives priority to research and innovation that has the greatest potential to improve global health security, accelerate health-related development, redress health inequities and help to attain the Millennium Development Goals” [48] .

Despite these discussions, much research is still regarded as uncoordinated and concentrating on a few high profile diseases [49] such as the “big 3”: HIV/AIDS, Malaria and Tuberculosis. Furthermore, the majority of research is critiqued as largely technology development focused, even though many argue that the impact of this research is low [44] and more lives could be saved by improving service delivery of existing interventions [25, 43, 50].

3.3.3 The importance of a systems approach to capacity development

The importance of taking a systems approach to HRCD was discussed in 24% of sources. Conceived in the 1990s and popularized after the Ministerial Summit on Health Research in Mexico in 2004 [25], systems approaches to HRCD emerged in response to perceived failings of capacity development targeted at only one level. Particular weaknesses cited included: lack of provision for trained individuals to use their skills [6] leading to "brain drain" of LMIC researchers to HICs [51, 52]; exclusively focusing on high performing individuals [53] rather than strengthening local institutions to develop researchers [54]; absence of national bodies to coordinate priorities, develop policy, and translate evidence into action [55]; and the fragmentation of capacity development activities [56, 57].

Proponents of systems approaches argue that for capacity development to be effective and sustainable [8, 58], new approaches to addressing all three levels of the national research system are needed; macro, institutional and individual [58] (for definitions of these levels, please see supplementary file 2). Macro-level capacity development should include: priority setting, planning and coordinating research, governance and regulation, and knowledge translation and dissemination [48, 57, 59]. Individual development should include a broader range of stakeholders than just research producers (e.g. policy makers, administrators, medical personnel and ethics board members) and teach a wider variety of skills and disciplines, particularly "soft skills" such as organisation, management and leadership [55]. Institutional development should focus on the ability to generate, retain and utilise individual capacity through improving curricula, training support, mentorship, and research resources [60-62].

Although presented as a complex task with long time frames [63], taking a systems approach is said to result in more dynamic capacity development that produces endogenous change, greater local ownership, and removal of perennial system barriers

[20] which helps countries to effectively target their own health needs [19]. This is in stark contrast to previous approaches that established parallel structures to deliberately bypass local systems because they were deemed to be chronically ineffective [24]. However, despite the accepted importance of research systems development, little is known about how health research systems can be formed [19], there are few successful examples of research system strengthening, and little guidance is available [64].

3.4 A summary of modern health research capacity development modalities

After attempts at aligning human, material and technical capacities failed in the 1980s, research models that directed funds and technology through HIC institutions became the preferred HRCD mechanism [5]. These mechanisms are now the most common approach to HRCD. The justification for requiring LMICs to collaborate with HICs is that knowledge transfer and HIC expertise are required to achieve capacity development [65, 66]. However, others argue that such development models propagate inequities in research and development [17, 36]. Discussions on development modalities are therefore contentious. The following sections summarise the justifications, benefits, drawbacks and controversies of the main development modalities.

3.4.1 Vertical research projects

One of the earliest and most persistent research models arising from the HIC fund channelling mechanism was vertical research projects [5]. This involves a HIC research collaborator working in a LMIC to conduct applied, normally short-term research projects with narrow objectives [54]. The theoretical advantage of a vertical strategy is that it maintains focus on a specific scientific mission [67]. This allows the necessary capacity to be developed more rapidly and can quickly produce research outputs [5] even where major expansion of R&D is required [35]. These approaches now account for the biggest

share of health research funding [58]. Examples include product development partnerships such as The Global Alliance for TB Drug Development, and many commercial or non-commercial clinical trials [68].

HRCD is often included in these programmes, but development of capacity is usually not the primary objective [59]. Rather it is designed to develop capacities that will benefit the successful completion of the project [60] and result in high quality research outputs [54]. Vertical projects often have strong expatriate leadership and are frequently managed by external institutions [54], which is argued to result in parallel structures that bypass local research institutions [69]. Where individual-level development is provided, it is typically short term and project specific [70].

Critics of vertical projects argue that local researchers often only have support roles [16], samples may be shipped abroad for analysis [23] and there can be little investment in local institutions because they are bypassed [15, 69]. Therefore when these short-term projects finish, research sites and individuals are rarely left with the skills or resources to run their own studies [41, 68]. Another criticism is that vertical approaches force the research community to work separately on overlapping issues [71] leading to fragmentation of national research systems [55].

Proponents of vertical interventions are however mindful that there is a trade-off between the speed and quality of research, and capacity development [72]. They argue that in the case of health emergencies, investment should be made in excellent research, not excellent capacity development.

3.4.2 Centres of excellence

A common modality for developing long-term capacity to conduct advanced research in LMICs is “centres of excellence”. These have taken various forms, but the approach generally concentrates investment within a few institutions that show potential to excel and

become high quality self-sustaining sites. These models are reportedly useful because they increase the likelihood of high quality research and renewed investment in an otherwise challenging environment [52, 55, 73].

Early forms of this concept were criticised as being “annexed” research sites, effectively led and managed by expatriate staff [74]. Others argue that they create parallel research structures outside of the national system that further depletes the local resource pool by diverting investment and human resources towards these better funded sites [17, 24, 44]. More recent forms of “centres of excellence”, such as those championed by the European and Developing Countries Clinical Trials Partnership, strive for greater Southern leadership and better integration with local research systems [75].

3.4.3 North-South partnership

Another common development model is North-South partnerships. They are distinct forms of collaboration between HIC and LMIC researchers because unlike “centres of excellence”, they are usually project specific rather than institution building, and they put more emphasis on sustainable research, shared leadership and mutual benefit than vertical research projects. However, depending on the nature of the partnership, these demarcations can become blurred.

Since the millennium, North-South partnerships and have been heavily promoted by organisations such as The Global Forum for Health Research [6] and The European and Developing Countries Clinical Trial Partnership (EDCTP) [75]. Such partnerships are said to be responsible for increasing resource flows to LMICs [31] and have been advocated for: increasing scientific productivity [76], training of graduates, staff exchange and knowledge sharing, exposure to cutting edge technology [52], strengthening local education programmes and moderate levels of institutional strengthening [6, 77, 78]. This is argued to result in more sustainable development [54], greater cost-efficiency and a

broader research scope than exclusively expatriate-led or locally-led research could achieve alone [17, 20].

Despite their popularity, a greater proportion of the literature is dedicated to discussing problems with North-South partnerships than their benefits. Many authors still feel that despite much guidance for entering into partnerships [12, 17, 53, 80, 81], too few benefits are accrued by the Southern partner [9, 12, 23, 24, 79] because they are forced to collaborate with HIC institutions to meet funding requirements [82]. Accordingly, LMIC partners are reported to sometimes receive little financial benefit, go unrecognised in publications, and release intellectual property rights [9, 12]. Proposed amendments to this model have involved adapting partnerships to be driven by LMIC demand [60], led by the Southern partner [20] or supporting more South-South partnerships [28][83].

3.4.4 Networks and consortia

Networks and consortia development models emerged in the mid-1990s. By the mid-2000s they were used to tackle whole programmes of research [60] and are now very popular with funders [60]. Actors adopting network models are highly diverse and can sometimes be hard to separate from partnership models or vertical programmes. However, they all involve linking multiple research departments, groups or institutions.

Networks are considered advantageous because they encourage less-hierarchical leadership and competitive and individualistic attitudes. They are therefore reportedly useful for working cooperatively on shared problems at regional or global levels [84, 85]. Because networks facilitate information exchange and pooling of resources to achieve a critical mass [86], they are seen as particularly important where groups may be isolated [87] or when one group alone would have insufficient capacity to address an issue [88]. Networks are also thought to: help focus on common research priorities [60, 89]; increase knowledge exchange and speed diffusion of innovations [57, 64]; and help forge long term

relationships [5, 87], and sustainability [37, 86, 90, 91]. However, some authors point out that most networks focus on highly thematic research projects [60] and only develop capacity of individual research groups, not research systems [87].

3.5 Specific development strategies

The reviewed literature contained a multitude of development strategies targeted at all levels of the health research system; macro, institutional and individual. These are presented in Table 3 and grouped according to the barrier they address. The popularity of the development strategies are indicated as a percentage of the reviewed sources that proposed them as a solution to a health research barrier.

Table 3: Summary of capacity development strategies designed to address specific barriers to health research

Barrier to research	Strategies designed to address barriers to research	Popularity (% of sources)
Fragmented research systems	• Undertake a situational analysis & build on existing assets [28, 29, 57, 92] • Collaboratively develop research agendas with LMIC stakeholders [55, 70, 75] • Create a research coordinating body or scientific councils [29, 64, 93]	Recently gaining popularity (12%)
Insufficient research funding	• Establish a research finance system using innovative revenue generation [52, 94, 95] • Provide long-term funding & flexible grants [8, 63, 96] • Advocate for funding through shared causes & engaging with the media [68, 97]	Very popular (21%)
Limited use of research evidence	• Build capacities of policy makers to demand & scrutinise research [25, 84, 98] • Develop evidence repositories & use Research-to-Action-Groups as knowledge brokers to package findings appropriately [39, 99] • Create knowledge translation platforms to support evidence dissemination & dialogue between research producers and users [30, 39, 64, 100]	Consistent popularity (11%)
Limited governance & regulatory capacity	• Work research into a legislative framework [64, 101, 102] • Clarify guidelines, map review capacity, & streamline procedures [74, 103] • Strengthen regulatory & ethical review capacity [42, 64]	Growing popularity (21%)
Insufficient networking	• Develop and share a database of researchers and their expertise [31] • Utilise or develop professional networks, especially web-based communities [42, 104] • Organise conferences & working groups on locally important topics [2, 105]	Very popular (26%)
Inefficient admin & research management	• Train management & research support staff [29, 106] • Set up a research support office to help with grant management, reporting & contracts, & develop information and finance systems [20, 28, 72] • Develop transparent & accountable policies & procedures [69, 107]	Unpopular but increasing (8%)

Inadequate material capacity	• Upgrade libraries & journal availability and invest in laboratories [28, 91, 108] • Improve Information Technology, particularly internet [6, 78] • Ensure stable power & water supplies [108]	Widely recognised (20%)
Insufficient human capacity with research knowledge & skills	• Develop LMIC university research training capacity using "train the trainer" programmes, LMIC-HIC "sandwich" courses, or visiting research fellowships [20, 70, 92, 96, 109-111] • Make research principles & skills key components of undergraduate & continuing professional medical education [37, 70, 112] • Develop a variety of research roles: nurses, data managers, statisticians, laboratory personnel, managers, data collectors [9, 63, 70, 109, 113-115] • Increase distance learning via e-technologies or e-learning resources [26, 41, 70, 116, 117] • Training in major skills gaps: data collection, data management, data analysis & statistics, GCP, laboratory skills, computer literacy & ethics [46, 51, 54, 109, 118] • Training in core capabilities: protocol development, writing for grant applications & publication, grant management & budgeting, & policy dialogue [29, 45, 55, 63, 119]	Extremely popular (41%). Training in core capabilities less popular (15%)
Insufficient practical research experience	• Supplement didactic training with research "learning by doing" opportunities [40, 47, 55] • Involve more LMIC institutional staff in research projects [54] • Exchange visits to advanced research sites to update skills [120] • Pilot or small grants for early stage researchers to gain experience [53, 121]	Fairly accepted (11%)
Too few research leaders	• Develop leadership, project and human resource management skills [8, 72] • Opportunities for junior staff to take responsibility within a supportive environment [20] • In collaborative projects, local staff must be involved in the entire research process [122]	Gaining popularity (13%)
Too few mentors & role models	• Support mentors with long term funded positions & recognition [73, 78] • Where mentoring is not available locally, institutional partnerships/exchanges or peer mentorship can be used [9, 11, 55]	Popular (15%)
Lack of research culture	• Promote academic departmental leaders based on research experience [112] • Set up a departmental committee to promote research [123] • Journal clubs & seminars to develop interest in research & critical thinking [70, 120]	Not popular (6%)
Low motivation to conduct research	• Protected research time & longer term contracts [54, 76] • Re-entry grants or guaranteed jobs to encourage "brain drain" diaspora to return home [109, 110] • Higher salaries or funded research time to off-set private-practice incentives [76, 124]	Popular (18%)

3.6 Reported success and effectiveness of development efforts

Broadly, authors consider capacity to conduct health research in Africa to have increased considerably since the millennium [12] with potential to leverage further gains from current efforts [59]. This is best exemplified by increases in the number of clinical trials conducted in LMICs [103, 125] with reports of enhanced trial capacity [68],

particularly laboratories [126] and quality standards [38, 117, 127], and greater LMIC inclusion [106, 128]. Such institutional strengthening is also thought to have helped reduce brain drain in specific cases [109]. Although some countries still lag behind in regulatory and ethical review capacity, several publications indicate that LMICs have made good progress [108, 129].

The increase in research capacity is thought to have been driven by recognition of the importance of health research over the last 20 years [5], a revised strategic focus [30], and the expansion of networks and partnerships for addressing research needs [60, 67, 91]. However, it is not possible to attribute success to these development approaches due to lack of monitoring and evaluation data; in Africa, positive outcomes in the quality and quantity of published research have been recorded [60, 109, 130], but their connection to development inputs and outputs is not established [131]. Operational research and sharing of on-the-ground experiences is thought to be a useful learning resource, but with the exception of a few examples [42, 132], little published material on operations is thought to exist [133]. This is argued to make it hard to learn from previous efforts and experience [60] and determine why and how successes were achieved [28].

The paucity of monitoring and evaluation data is a recognised problem [60][58][5], with authors attributing it to long time-lags to achieve objectives [11], outcomes such as organisational culture being difficult to measure [11], lack of commonly agreed and conceptually robust indicators [59, 60, 102], and most evaluation data not being published [131]. To remedy this situation, guidance on planning and implementing monitoring and evaluation for health research has been developed [29], and one research group provides online resources to help record and share operational guidance [41].

It was also clear from the literature that significant capacity gaps remain in many LMICs. Following the example of clinical trials, authors point out that early phase studies are still lacking [134] and there are too few quality research sites to meet demand [103].

Despite increases in some capacities, translation of findings into policy is considered an enduringly difficult outcome [60, 135] and LMIC leadership and authorship in studies is still thought to be too low [43]. Reportedly insufficient political buy-in for strengthening investment in health research has also raised concerns over the sustainability of capacity development achievements [7, 8]. Some authors argue that longer term projects and planning for sustainability of research staff and services is needed [103], but little literature explores this [63].

4 Discussion

4.1 An evolution in health research capacity development thinking

This literature synthesis has objectively presented the main HRCD modalities and strategies, and shows that some development actors continue to operate research models that are contrary to widely accepted views of best practice. Nevertheless, the literature reveals that there has been steady progress in health research capacity in LMICs. Development actors have continuously reassessed their approaches and have become much more reflexive of their actions. National stakeholders have taken on a stronger voice and greater ownership, and are generally in a more self-sufficient position.

Overall, development actors now agree that there is no panacea or one-size-fits-all model to HRCD. Instead a plurality of solutions exists, the choice of which should be determined by the specific capacities constraints and research goals of LMIC institutions. However, despite progress, major barriers to health research persist, there is little evidence to support decision-making, and the sustainability of HRCD achievements is questionable.

4.2 Health research capacity development, reality or just rhetoric?

The evolution in HRCD thinking appears promising, but the literature demonstrates that good HRCD practices are not always enacted. While the requirement for short term projects is recognised [5], the vertical model has been the dominant model for almost 20 years [58]. This would indicate that vertical approaches have be used in situations that would be better served by longer term systems strengthening strategies [5]. However, there are far fewer programmes dedicated to implementing systems approaches to capacity development. Other examples include: focusing on a few high profile diseases, donor-led research agendas, compulsory requirements for collaboration with HICs, setting

up parallel structures, and fragmentary competitive research. To make the HRCD rhetoric a reality, there is a need to understand why research models that do not enhance or potentially inhibit locally-led research remain the *modus operandi*, even though there is clear agreement that they are bad practice.

The literature findings clearly and frequently show that the persistence of flawed development strategies is driven by approaching capacity development within the context of a dedicated research model. This creates a trade-off between doing good research and doing good capacity development. Projects prioritising good research place research outputs as the primary goal and assume capacity will be developed through limited LMIC involvement in research activities. This means that specific development strategies designed to improve capacity are not used. This "implicit" capacity development is known to be largely ineffective [63, 72], yet is it regularly used. As a result, local research systems may fail to develop or deteriorate [22], and development efforts are likely to become multiplicative and fragmented [60, 92], despite overlapping interests and generic requirements [104]

The other main alternative is "explicit" capacity development. This refers to research projects that place more priority on capacity development and use specific strategies designed to address capacity gaps. There is wide recognition that this is a superior approach and is more likely to improve capacity sustainably [11, 63]. However, because the research component is usually more valued by the research community, capacity development receives less attention and often focusses on developing project-specific capacities, not addressing systemic deficiencies. Accordingly, the capacity development component often becomes "bolted-on" and *ad hoc* [11, 28]; thus making it "implicit" in disguise.

Instead, the review findings suggest that conducting research to improve health in LMICs, and developing health research capacity in LMICs, must be considered two,

sometimes diverging objectives. Recognising this leads to a third way; “dedicated” capacity development. This implies that developing local capacity is as equally valued as the research outputs and should be considered as carefully as the research designs. Due to the additional resources this requires, previous efforts have been limited to individual capacity development or centres of excellence [91]. However, some capacity development actors are now attempting to do this at a more systemic level. Examples include: The Special Programme for Research and Training in Tropical Disease’s (TDR) operational research programmes [3], WHO’s Strategic Initiative for Developing Capacity in Ethical Review [136], ESSENCE on Health Research [137], and The Global Health Network [138].

4.3 Implications for policy and practice

This systematic literature review provides an important synthesis of HRCD that should prove useful for policy makers and practitioners alike. It identifies the strengths, limitations and, controversies of the main development approaches and summarises strategies that can be used to overcome specific research system barriers.

Dedicated capacity development appears to offer the best approach for achieving the WHO’s vision of all nations becoming producers and users of research [1]. However, a key barrier to designing development strategies based on this thinking is the lack of empirical evidence. Without operational and implementation research and quality evaluation data, it is not possible to know the relative effectiveness of different development strategies and difficult to predict if they will be appropriate for a given context. The current experience sharing data is a good start, but more systematic empirical research is required. This should be done with the same rigorous attention to methodological design, analysis, and reporting standards as any other research endeavour.

4.4 Study strengths and limitations

Previous reviews of capacity development have lacked sufficient reflexivity and questioning of assumptions implicit in many strategies [40]. This systematic review produced a nuanced and enquiring critique of HRCD approaches in LMICs and has identified dedicated capacity development as a promising strategy for future HRCD efforts. It also integrated diverse qualitative literature that largely lacked formal reporting procedures or empirical base, allowing the inclusion of voices that are traditionally excluded in other styles of systematic analyses.

Some academic articles may have been missed because PubMed was the only formal database used. However, the meta-narrative method aims to develop overarching narratives through saturation of themes, rather than include every eligible article, so using additional databases would add little to the study. More problematic was the limited availability and inclusion of programme evaluations and evidence supporting operational learning. While expert opinion and the popularity of development strategies was presented, it was apparent that this is not a reliable indicator of good development practice. Searching Google and Google Scholar, hand searching literature collections, and snowballing references did identify the most seminal papers, but some useful organisational documents will have been missed due to poor grey literature indexing. Furthermore, most articles had a general focus or related only to sub-Saharan Africa, meaning that context and research specific differences could not be examined in detail.

4.5 Conclusion

Despite gains in health research capacity and progress in development thinking, further work is needed to develop sustainable health research systems in LMICs. One promising option is dedicated capacity development in which capacity outcomes are as equally valued as research outputs. However, more empirical research is needed to identify the

most effective strategies. If these issues are successfully addressed, health research in all nations could become a reality, rather than just rhetoric.

Funding Statement

This work was supported by a grant from The Bill and Melinda Gates Foundation to Prof Trudie Lang (grant reference: OPP1053843), and in part by a Nuffield Department of Medicine Doctoral Prize Studentship to Dr Samuel Franzen (http://www.ndm.ox.ac.uk/ndm-prize-studentships). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Contributors

SF, CC, and TL conceived and designed the study. SF collected and analysed the data and drafted the manuscript with intellectual input and assistance from CC and TL. All authors approved the final version of the manuscript.

Acknowledgments

The authors would like to thank Professor Sisira Siribaddana and Dr Julius Atashili for their technical advice and intellectual input.

Competing interests

The authors declare that they have no competing interests.

Data sharing statement

No additional data are available.

References

1. Dye C, Boerma T, Evans D, Harries AD, Lienhardt C, McManus J, et al. The World Health Report 2013: Research for universal health coverage. In: Organisation WH, editor. Geneva: World Health Organisation; 2013.

2. Thornicroft G, Cooper S, Bortel TV, Kakuma R, Lund C. Capacity building in global mental health research. Harv Rev Psychiatry. 2012;20(1):13-24. Epub 2012/02/18. doi: 10.3109/10673229.2012.649117. PubMed PMID: 22335179; PubMed Central PMCID: PMC3335140.

3. TDR Special Programme for Research and Training in Tropical Diseases. Seven universities selected to host international postgraduate training scheme. Geneva: World Health Organisation; 2015.

4. The Commission on Health Research for Development. Health Research: Essential Link to Equity in Development. In: Development TCoHRf, editor. New York: Oxford University Press; 1990.

5. Davey S. The 10/90 Report on Health Research 2003-2004. In: Global Forum for Health Research, editor. Geneva, Switzerland: Global Forum for Health Research; 2004.

6. Global Forum for Health Research. The 10/90 report on health research 2000. In: Research GFfH, editor. Geneva: Global Forum for Health Research; 2000.

7. Gulland A. Plan to stimulate research in developing countries is put on hold. BMJ. 2012;344:e3771. Epub 2012/05/30. PubMed PMID: 22641833.

8. Annerstedt J, Liyanage S. Challenges when Shaping Capabilities for Research: Swedish Support to Bilateral Research Cooperation with Sri Lanka and Vietnam, 1976–2006, and a Look Ahead. In: Cooperation DfR, editor. Stockholm: SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY; 2008.

9. Laabes EP, Desai R, Zawedde SM, Glew RH. How much longer will Africa have to depend on western nations for support of its capacity-building efforts for biomedical

research? Trop Med Int Health. 2011;16(3):258-62. Epub 2011/03/05. doi: 10.1111/j.1365-3156.2010.02709.x. PubMed PMID: 21371216.

10. Davies R. Dismantling AusAID: taking a leaf out of the Canadian book? DevPolicyBlog: Development Policy Centre; 2013.

11. Bates I, Akoto AY, Ansong D, Karikari P, Bedu-Addo G, Critchley J, et al. Evaluating health research capacity building: an evidence-based tool. PLoS Med. 2006;3(8):e299. Epub 2006/09/01. doi: 10.1371/journal.pmed.0030299. PubMed PMID: 16942394; PubMed Central PMCID: PMC1502158.

12. Marais D, Toohey J, Edwards D, IJsselmuiden C. Where there is no lawyer: Guidance for fairer contract negotiation in collaborative research partnerships. In: Development CiHRf, editor. Geneva & Pietermaritzburg: Council in Health Research for Development; 2013.

13. Greenhalgh T, Robert G, Macfarlane F, Bate P, Kyriakidou O, Peacock R. Storylines of research in diffusion of innovation: a meta-narrative approach to systematic review. Soc Sci Med. 2005;61(2):417-30. doi: http://dx.doi.org/10.1016/j.socscimed.2004.12.001.

14. Greenhalgh T, Wong G, Westhorp G, Pawson R. Protocol - realist and meta-narrative evidence synthesis: Evolving Standards (RAMESES). BMC Medical Research Methodology. 2011;11(1):115. doi: info:pmid/21843376.

15. White MT. A right to benefit from international research: a new approach to capacity building in less-developed countries. Account Res. 2007;14(2):73-92. Epub 2007/09/12. doi: 10.1080/08989620701290341. PubMed PMID: 17844784.

16. Mony PK, Kurpad A, Vaz M. Capacity building in collaborative research is essential. BMJ. 2005;331(7520):843-4. Epub 2005/10/08. doi: 10.1136/bmj.331.7520.843-b. PubMed PMID: 16210297; PubMed Central PMCID: PMC1246129.

17. Costello A, Zumla A. Moving to research partnerships in developing countries. BMJ. 2000;321(7264):827-9. Epub 2000/09/29. PubMed PMID: 11009530; PubMed Central PMCID: PMC1118627.

18. Sitthi-Amorn C, Somrongthong R. Strengthening health research capacity in developing countries: a critical element for achieving health equity. BMJ. 2000;321(7264):813-7. Epub 2000/09/29. PubMed PMID: 11009525; PubMed Central PMCID: PMC1118622.

19. Kok MO, Rodrigues A, Silva AP, de Haan S. The emergence and current performance of a health research system: lessons from Guinea Bissau. Health Res Policy Syst. 2012;10:5. Epub 2012/02/11. doi: 10.1186/1478-4505-10-5. PubMed PMID: 22321566; PubMed Central PMCID: PMC3295730.

20. Green A, Bennett S, editors. Sound Choices: Enhancing Capacity for Evidence-Informed Health Policy. Geneva: World Health Organisation; 2007.

21. Jentsch B, Pilley C. Research relationships between the South and the North: Cinderella and the ugly sisters? Soc Sci Med. 2003;57(10):1957-67. Epub 2003/09/23. PubMed PMID: 14499518.

22. Coloma J, Harris E. From construction workers to architects: developing scientific research capacity in low-income countries. PLoS Biol. 2009;7(7):e1000156. Epub 2009/07/22. doi: 10.1371/journal.pbio.1000156. PubMed PMID: 19621063; PubMed Central PMCID: PMC2704958.

23. Gonzalez-Block MA, Vargas-Riano EM, Sonela N, Idrovo AJ, Ouwe-Missi-Oukem-Boyer O, Monot JJ. Research capacity for institutional collaboration in implementation research on diseases of poverty. Trop Med Int Health. 2011;16(10):1285-90. Epub 2011/07/19. doi: 10.1111/j.1365-3156.2011.02834.x. PubMed PMID: 21762393.

24. Crane J. Scrambling for Africa? Universities and global health. The Lancet. 2011;377(9775):1388-90.

664 25. World Health Organisation. Ministerial Summit on Health Research (2004: Mexico
665 City, Mexico). In: Report from the Ministerial Summit on Health Research: identify
666 challenges ia, correct inequities., editor. Geneva: World Health Organisation; 2005.
667 26. Lansang M., Dennis R. The need to develop research capacity. Global Forum
668 Update on Research for Health Volume 4. 4. London: Pro-Brook Publishing Ltd; 2007. p.
669 123-7.
670 27. Silove D, Rees S, Tam N, Liddell B, Zwi A. Staff management and capacity building
671 under conditions of insecurity: lessons from developing mental health service and research
672 programs in post-conflict Timor-Leste. Australas Psychiatry. 2011;19 Suppl 1:S90-4. Epub
673 2011/09/09. doi: 10.3109/10398562.2011.583076. PubMed PMID: 21878030.
674 28. DFID. Capacity Building in Research. In: Development DfI, editor. 2010.
675 29. ESSENCE on Health Research. Planning Monitoring and Evaluation; Framework
676 for Capacity Strengthening in Health Research. In: ESSENCE Good Practice Document
677 Series, editor. Geneva: Copytrend; 2011.
678 30. Aksoy S. Solutions to neglected tropical diseases require vibrant local scientific
679 communities. PLoS Negl Trop Dis. 2010;4(3):e662. Epub 2010/04/03. doi:
680 10.1371/journal.pntd.0000662. PubMed PMID: 20361026; PubMed Central PMCID:
681 PMC2846929.
682 31. Chandiwana S, Ornbjerg N. Review of North-South and South-South cooperation
683 and conditions necessary to sustain research capability in developing countries. J Health
684 Popul Nutr. 2003;21(3):288-97. Epub 2004/01/14. PubMed PMID: 14717574.
685 32. Devasenapathy N, Singh K, Prabhakaran D. Conduct of clinical trials in developing
686 countries: a perspective. Curr Opin Cardiol. 2009;24(4):295-300. doi: Doi
687 10.1097/Hco.0b013e32832af21b. PubMed PMID: ISI:000267279500004.
688 33. Ali R, Finlayson A, Network ICR. Building capacity for clinical research in
689 developing countries: the INDOX cancer research network experience. Global Health

690 Action. 2012;5:1-6. doi: DOI 10.3402/gha.v5i0.17288. PubMed PMID:
691 ISI:000304003100001.
692 34. Editorial. The Bamako call to action: research for health. Lancet.
693 2008;372(9653):1855-. PubMed PMID: WOS:000261388700001.
694 35. Lexchin J. One step forward, one step sideways? Expanding research capacity for
695 neglected diseases. BMC Int Health Hum Rights. 2010;10:20. Epub 2010/07/16. doi: 1472-
696 698X-10-20 [pii]
697 10.1186/1472-698X-10-20. PubMed PMID: 20630063; PubMed Central PMCID:
698 PMC2922093.
699 36. Khanna R, Hota P, Lahariya C. Health research strengthening and operational
700 research needs for improving child survival in India. Indian J Pediatr. 2010;77(3):291-9.
701 Epub 2010/05/01. doi: 10.1007/s12098-010-0037-x. PubMed PMID: 20431966.
702 37. Mgone CS. Strengthening of the clinical research capacity for malaria: a shared
703 responsibility. Malar J. 2010;9 Suppl 3:S5. Epub 2010/12/22. doi: 10.1186/1475-2875-9-
704 s3-s5. PubMed PMID: 21144085; PubMed Central PMCID: PMC3002146.
705 38. Shafiq N, Pandhi P, Malhotra S. Investigator-initiated pragmatic trials in developing
706 countries--much needed but much ignored. Br J Clin Pharmacol. 2009;67(1):141-2. Epub
707 2008/11/14. doi: BCP3291 [pii]10.1111/j.1365-2125.2008.03291.x. PubMed PMID:
708 19006544; PubMed Central PMCID: PMC2668099.
709 39. Kasonde JM, Campbell S. Creating a Knowledge Translation Platform: nine lessons
710 from the Zambia Forum for Health Research. Health Res Policy Syst. 2012;10:31. Epub
711 2012/10/05. doi: 10.1186/1478-4505-10-31. PubMed PMID: 23034056; PubMed Central
712 PMCID: PMC3491024.
713 40. vasquez E, Hirsch J, Giang L, Parker R. Rethinking health research capacity
714 strengthening. Global Public Health. 2013.

41. Lang TA, White NJ, Hien TT, Farrar JJ, Day NPJ, Fitzpatrick R, et al. Clinical Research in Resource-Limited Settings: Enhancing Research Capacity and Working Together to Make Trials Less Complicated. PLoS Negl Trop Dis. 2010;4(6):e619.

42. Mbuagbaw L, Thabane L, Ongolo-Zogo P, Lang T. The challenges and opportunities of conducting a clinical trial in a low resource setting: the case of the Cameroon mobile phone SMS (CAMPS) trial, an investigator initiated trial. Trials. 2011;12:145. Epub 2011/06/11. doi: 1745-6215-12-145 PubMed PMID: 21658262; PubMed Central PMCID: PMC3138444.

43. Adam T, Ahmad S, Bigdeli M, Ghaffar A, Rottingen JA. Trends in health policy and systems research over the past decade: still too little capacity in low-income countries. PLoS One. 2011;6(11):e27263. Epub 2011/12/02. doi: 10.1371/journal.pone.0027263. PubMed PMID: 22132094; PubMed Central PMCID: PMC3222652.

44. Mgone C, Volmink J, Coles D, Makanga M, Jaffar S, Sewankambo N. Linking research and development to strengthen health systems in Africa. Trop Med Int Health. 2010;15(12):1404-6. Epub 2010/10/20. doi: 10.1111/j.1365-3156.2010.02661.x. PubMed PMID: 20955373.

45. Courtright P, Faal HB. How can we strengthen ophthalmic research in Africa? Can J Ophthalmol. 2006;41(4):424-5. Epub 2006/08/03. doi: 10.1016/s0008-4182(06)80003-7. PubMed PMID: 16883358.

46. Garcia PJ, Cotrina A, Gotuzzo E, Gonzalez E, Buffardi AL. Research training needs in Peruvian national TB/HIV programs. BMC Med Educ. 2010;10(1). doi: 10.1186/1472-6920-10-63.

47. Harries AD, Rusen ID, Reid T, Detjen AK, Berger SD, Bissell K, et al. The Union and Medecins Sans Frontieres approach to operational research. Int J Tuberc Lung Dis. 2011;15(2):144-54, i. Epub 2011/01/12. PubMed PMID: 21219672.

48. World Health Organisation. The WHO strategy on research for health. Geneva: World Health Organisation; 2012.

49. Garrett L. The Challenge of Global Health. (cover story). Foreign Affairs. 2007;86(1):14-38.

50. Whitworth J, Sewankambo NK, Snewin VA. Improving implementation: building research capacity in maternal, neonatal, and child health in Africa. PLoS Med. 2010;7(7):e1000299. Epub 2010/07/14. doi: 10.1371/journal.pmed.1000299. PubMed PMID: 20625547; PubMed Central PMCID: PMC2897765.

51. Goto A, Nguyen TN, Nguyen TM, Hughes J. Building postgraduate capacity in medical and public health research in Vietnam: an in-service training model. Public Health. 2005;119(3):174-83. Epub 2005/01/22. doi: 10.1016/j.puhe.2004.05.005. PubMed PMID: 15661126.

52. Lansang MA, Dennis R. Building capacity in health research in the developing world. Bull World Health Organ. 2004;82(10):764-70. Epub 2005/01/13. PubMed PMID: 15643798; PubMed Central PMCID: PMC2623028.

53. Nchinda TC. Research capacity strengthening in the South. Soc Sci Med. 2002;54(11):1699-711. Epub 2002/07/13. PubMed PMID: 12113452.

54. Magwaza S, Mathambo V, Magongo B, Mvo E, Makhanya N. Health research Capacity Building in South Africa: Current knowledge and practices. Durban: Health Systems Trust; 2003.

55. Nuyens Y. No Development Without Research. Geneva: Global Forum for Health Research; 2005.

56. Pang T, Sadana R, Hanney S, Bhutta Z, Hyder A, Simon J. Knowledge for better health — a conceptual framework and foundation for health research systems. Bulletin of the World Health Organization. 2003;81(11):815-20.

765 57. World Health Organisation. National Health Research Systems. Report of an
766 international workshop, Cha-am, Thailand, 12–15 March 2001. Geneva: World Health
767 Organisation; 2002.
768 58. Bennett S, Adam T, Zarowsky C, Tangcharoensathien V, Ranson K, Evans T, et al.
769 From Mexico to Mali: progress in health policy and systems research. Lancet.
770 2008;372(9649):1571-8. Epub 2008/11/06. doi: 10.1016/s0140-6736(08)61658-x. PubMed
771 PMID: 18984191.
772 59. Ijsselmuiden C, Marais DL, Becerra-Posada F, Ghannem H. Africa's neglected area
773 of human resources for health research - the way forward. S Afr Med J. 2012;102(4):228-
774 33. Epub 2012/04/03. PubMed PMID: 22464504.
775 60. Jones N, Bailey M, Lyytikainen M. Research capacity strengthening in Africa:
776 Trends, gaps and opportunities. In: Institute OD, editor. London: Overseas Development
777 Institute; 2007.
778 61. Kariuki T, Phillips R, Njenga S, Olesen OF, Klatser PR, Porro R, et al. Research
779 and capacity building for control of neglected tropical diseases: the need for a different
780 approach. PLoS Negl Trop Dis. 2011;5(5):e1020. Epub 2011/06/10. doi:
781 10.1371/journal.pntd.0001020. PubMed PMID: 21655352; PubMed Central PMCID:
782 PMC3104960.
783 62. Minja H, Nsanzabana C, Maure C, Hoffmann A, Rumisha S, Ogundahunsi O, et al.
784 Impact of health research capacity strengthening in low- and middle-income countries: the
785 case of WHO/TDR programmes. PLoS Negl Trop Dis. 2011;5(10):e1351. Epub
786 2011/10/25. doi: 10.1371/journal.pntd.0001351. PubMed PMID: 22022630; PubMed
787 Central PMCID: PMC3191138.
788 63. Vogel I. Research Capacity Strengthening: Learning from Experience. In: (UKCDS)
789 UCoDS, editor.: UK Collaborative on Development Sciences (UKCDS); 2011.

64. Chanda-Kapata P, Campbell S, Zarowsky C. Developing a national health research system: participatory approaches to legislative, institutional and networking dimensions in Zambia. Health Res Policy Syst. 2012;10:17. Epub 2012/06/08. doi: 10.1186/1478-4505-10-17. PubMed PMID: 22672331; PubMed Central PMCID: PMC3463500.

65. Cooke J. A framework to evaluate research capacity building in health care. BMC Family Practice. 2005;6(1):1-11. doi: 10.1186/1471-2296-6-44.

66. Iaccarino M. Mastering science in the South. To develop much-needed research capacity, developing countries cannot rely on the industrialized world, but have to find their own specific solutions. EMBO Rep. 2004;5(5):437-41. Epub 2004/06/09. doi: 10.1038/sj.embor.7400159. PubMed PMID: 15184971; PubMed Central PMCID: PMC1299062.

67. Higgs ES. The Southeast Asian Influenza Clinical Research Network: development and challenges for a new multilateral research endeavor. Antiviral Res. 2008;78(1):64.

68. Ogutu BR, Baiden R, Diallo D, Smith PG, Binka FN. Sustainable development of a GCP-compliant clinical trials platform in Africa: the malaria clinical trials alliance perspective. Malar J. 2010;9:103. Epub 2010/04/22. doi: 10.1186/1475-2875-9-103. PubMed PMID: 20406478; PubMed Central PMCID: PMC2873521.

69. Sawyerr. African Universities and the Challenge of Research Capacity Development. JHEA/RESA Vol 2, No 1, 2004, pp 211–240. 2004.

70. Gezmu M, DeGruttola V, Dixon D, Essex M, Halloran E, Hogan J, et al. Strengthening biostatistics resources in sub-Saharan Africa: research collaborations through U.S. partnerships. Stat Med. 2011;30(7):695-708. Epub 2011/03/12. doi: 10.1002/sim.4144. PubMed PMID: 21394746.

71. Lang T. Advancing global health research through digital technology and sharing data. Science. 2011;331(6018):714-7. Epub 2011/02/12. doi: 10.1126/science.1199349. PubMed PMID: 21311011.

816 72. Marjanovic S, Hanlin R, Diepeveen S, Chataway J. RESEARCH CAPACITY-
817 BUILDING IN AFRICA: NETWORKS, INSTITUTIONS AND LOCAL OWNERSHIP. Journal
818 of International Development. 2012:n/a-n/a. doi: 10.1002/jid.2870.
819 73. Whitworth JA, Kokwaro G, Kinyanjui S, Snewin VA, Tanner M, Walport M, et al.
820 Strengthening capacity for health research in Africa. Lancet. 2008;372(9649):1590-3. Epub
821 2008/11/06. doi: S0140-6736(08)61660-8 [pii]
822 10.1016/S0140-6736(08)61660-8. PubMed PMID: 18984193; PubMed Central PMCID:
823 PMC2607030.
824 74. Andronikou S, Mngomezulu V. Paediatric radiology seen from Africa. Part II:
825 recognising research advantages in a developing country. Pediatr Radiol. 2011;41(7):826-
826 31. Epub 2011/05/10. doi: 10.1007/s00247-011-2080-9. PubMed PMID: 21553039.
827 75. Matee MI, Manyando C, Ndumbe PM, Corrah T, Jaoko WG, Kitua AY, et al.
828 European and Developing Countries Clinical Trials Partnership (EDCTP): the path towards
829 a true partnership. BMC Public Health. 2009;9:249. Epub 2009/07/22. doi: 1471-2458-9-
830 249 [pii]
831 10.1186/1471-2458-9-249. PubMed PMID: 19619283; PubMed Central PMCID:
832 PMC2719636.
833 76. Dakik HA, Kaidbey H, Sabra R. Research productivity of the medical faculty at the
834 American University of Beirut. Postgrad Med J. 2006;82(969):462-4. Epub 2006/07/11. doi:
835 10.1136/pgmj.2005.042713. PubMed PMID: 16822923; PubMed Central PMCID:
836 PMC2563770.
837 77. Mayhew SH, Doherty J, Pitayarangsarit S. Developing health systems research
838 capacities through north-south partnership: an evaluation of collaboration with South Africa
839 and Thailand. Health Res Policy Syst. 2008;6:8. Epub 2008/08/05. doi: 10.1186/1478-
840 4505-6-8. PubMed PMID: 18673541; PubMed Central PMCID: PMC2559830.

78. Andruchow JE, Soskolne CL, Racioppi F, Bertollini R. Capacity building for epidemiologic research: a case study in the newly independent state of Azerbaijan. Ann Epidemiol. 2005;15(3):228-31. Epub 2005/02/23. doi: 10.1016/j.annepidem.2004.06.004. PubMed PMID: 15723769.

79. Jones AC, Geneau R. Assessing research activity on priority interventions for non-communicable disease prevention in low- and middle-income countries: a bibliometric analysis. Glob Health Action. 2012;5:1-13. Epub 2012/09/05. PubMed PMID: 22944364; PubMed Central PMCID: PMC3427597.

80. de-Graft Aikins A, Arhinful DK, Pitchforth E, Ogedegbe G, Allotey P, Agyemang C. Establishing and sustaining research partnerships in Africa: a case study of the UK-Africa Academic Partnership on Chronic Disease. Global Health. 2012;8:29. Epub 2012/08/18. doi: 10.1186/1744-8603-8-29. PubMed PMID: 22897937; PubMed Central PMCID: PMC3475042.

81. Gadsby EW. Research capacity strengthening: donor approaches to improving and assessing its impact in low- and middle-income countries. Int J Health Plann Manage. 2011;26(1):89-106. Epub 2010/04/28. doi: 10.1002/hpm.1031. PubMed PMID: 20422620.

82. Muula AS. What drives health research in a developing country? Croat Med J. 2007;48(2):261-7. Epub 2007/04/17. PubMed PMID: 17436392; PubMed Central PMCID: PMC2080513.

83. Siriwardhana C, Sumathipala A, Siribaddana S, Samaraweera S, Abeysinghe N, Prince M, et al. Reducing the scarcity in mental health research from low and middle income countries: a success story from Sri Lanka. Int Rev Psychiatry. 2011;23(1):77-83. Epub 2011/02/23. doi: 10.3109/09540261.2010.545991. PubMed PMID: 21338302.

84. Sadana R, D'Souza C, Hyder AA, Chowdhury AM. Importance of health research in South Asia. BMJ. 2004;328(7443):826-30. doi: 10.1136/bmj.328.7443.826. PubMed PMID: 15070643; PubMed Central PMCID: PMC383385.

867 85. Choi HY, Ko JW. Facilitating large-scale clinical trials: in Asia. Urol Oncol.
868 2010;28(6):691-2. Epub 2010/11/11. doi: 10.1016/j.urolonc.2009.12.016. PubMed PMID:
869 21062654.
870 86. Editorial. Strengthening research capacity in Africa. Lancet. 2009;374(9683):1.
871 Epub 2009/07/07. doi: 10.1016/s0140-6736(09)61213-7. PubMed PMID: 19577676.
872 87. Bennett S, Agyepong IA, Sheikh K, Hanson K, Ssengooba F, Gilson L. Building the
873 Field of Health Policy and Systems Research: An Agenda for Action. PLoS Med.
874 2011;8(8). doi: ARTN e1001081
875 DOI 10.1371/journal.pmed.1001081. PubMed PMID: ISI:000294477300015.
876 88. Lee PP, Lau YL. Improving care, education, and research: the Asian primary
877 immunodeficiency network. Ann N Y Acad Sci. 2011;1238:33-41. Epub 2011/12/02. doi:
878 10.1111/j.1749-6632.2011.06225.x. PubMed PMID: 22129051.
879 89. Excler JL, Pitisuttithum P, Rerks-Ngarm S, Shao Y, Zhang L, Tamashiro H, et al.
880 Expanding research capacity and accelerating AIDS vaccine development in Asia.
881 Southeast Asian J Trop Med Public Health. 2008;39(4):766-84. PubMed PMID: 19058617.
882 90. Kilama WL, Chilengi R, Wanga CL. Towards an African-driven malaria vaccine
883 development program: history and activities of the African Malaria Network Trust
884 (AMANET). Am J Trop Med Hyg. 2007;77(6 Suppl):282-8. Epub 2008/01/31. doi:
885 77/6_Suppl/282 [pii]. PubMed PMID: 18165504.
886 91. Miiro GM, Oukem-Boyer OO, Sarr O, Rahmani M, Ntoumi F, Dheda K, et al.
887 EDCTP regional networks of excellence: initial merits for planned clinical trials in Africa.
888 BMC Public Health. 2013;13:258. Epub 2013/03/23. doi: 10.1186/1471-2458-13-258.
889 PubMed PMID: 23517572; PubMed Central PMCID: PMCPmc3623728.
890 92. Editorial. Bringing health research forward. Tanzan J Health Res. 2009;11(4):iii-iv.
891 Epub 2010/08/26. PubMed PMID: 20734693.

93. Kamunyori S, Al-Bader S, Sewankambo N, Singer PA, Daar AS. Science-based health innovation in Uganda: creative strategies for applying research to development. BMC Int Health Hum Rights. 2010;10 Suppl 1:S5. Epub 2010/12/15. doi: 1472-698X-10-S1-S5 [pii]
10.1186/1472-698X-10-S1-S5. PubMed PMID: 21144076; PubMed Central PMCID: PMC3001613.

94. Barreto ML. Health research in developing countries. BMJ. 2009;339:b4846. Epub 2009/11/26. doi: 10.1136/bmj.b4846. PubMed PMID: 19933304.

95. Zachariah R, Reid T, Srinath S, Chakaya J, Legins K, Karunakara U, et al. Building leadership capacity and future leaders in operational research in low-income countries: why and how? Int J Tuberc Lung Dis. 2011;15(11):1426-35, i. Epub 2011/10/20. doi: 10.5588/ijtld.11.0316. PubMed PMID: 22008755.

96. Lang TA, Kokwaro GO. Malaria drug and vaccine trials in Africa: obstacles and opportunities. Trans R Soc Trop Med Hyg. 2008;102(1):7-10. Epub 2007/10/05. doi: S0035-9203(07)00279-9 [pii]
10.1016/j.trstmh.2007.08.008. PubMed PMID: 17915267.

97. Ntoumi F. Networking and capacity building for health research in Central Africa. Wien Klin Wochenschr. 2010;122 Suppl 1:23-6. Epub 2010/04/14. doi: 10.1007/s00508-010-1331-3. PubMed PMID: 20376720.

98. Sitthi-Amorn C, Pongpanich S, Somrongthong R, Likitkirirat T, Likitkirirat P. The Asian Voice in building equity in health for development - from the Asian Forum for Health Research, Manila, February 2000. Health Policy Plan. 2002;17(2):213-7. Epub 2002/05/10. PubMed PMID: 12000783.

99. World Health Organisation. Scaling up research and learning for health systems: now is the time. In: Report of a High Level Task Force paeatGMFoRfH, Bamako, Mali, editor. Geneva: World Health Organisation; 2009.

100. Van Royen K, Lachat C, Holdsworth M, Smit K, Kinabo J, Roberfroid D, et al. How can the operating environment for nutrition research be improved in sub-saharan Africa? The views of african researchers. PLoS One. 2013;8(6):e66355. Epub 2013/06/19. doi: 10.1371/journal.pone.0066355. PubMed PMID: 23776663; PubMed Central PMCID: PMC3680459.

101. Kirigia JM, Wambebe C. Status of national health research systems in ten countries of the WHO African Region. BMC Health Serv Res. 2006;6:135. Epub 2006/10/21. doi: 10.1186/1472-6963-6-135. PubMed PMID: 17052326; PubMed Central PMCID: PMC1622748.

102. McKee M, Stuckler D, Basu S. Where there is no health research: what can be done to fill the global gaps in health research? PLoS Med. 2012;9(4):e1001209. Epub 2012/05/01. doi: 10.1371/journal.pmed.1001209. PubMed PMID: 22545025; PubMed Central PMCID: PMC3335864.

103. Mwangoka G, Ogutu B, Msambichaka B, Mzee T, Salim N, Kafuruki S, et al. Experience and challenges from clinical trials with malaria vaccines in Africa. Malar J. 2013;12:86. Epub 2013/03/19. doi: 10.1186/1475-2875-12-86. PubMed PMID: 23496910; PubMed Central PMCID: PMCPmc3599886.

104. Lang T. Advancing Global Health Research Through Digital Technology and Data Sharing. Science. 2011;In Press.

105. Thamarangsi T. Addiction research centres and the nurturing of creativity: Center for Alcohol Studies (CAS), Thailand. Addiction. 2013;108(7):1201-6. Epub 2012/03/27. doi: 10.1111/j.1360-0443.2012.03795.x. PubMed PMID: 22443475.

106. Ali R, Finlayson A, Indox Cancer Research N. Building capacity for clinical research in developing countries: the INDOX Cancer Research Network experience. Glob Health Action. 2012;5. Epub 2012/05/09. doi: 10.3402/gha.v5i0.17288. PubMed PMID: 22566788; PubMed Central PMCID: PMC3343878.

107. White F. Capacity-building for health research in developing countries: a manager's approach. Rev Panam Salud Publica. 2002;12(3):165-72. Epub 2002/10/25. PubMed PMID: 12396634.

108. Excler JL, Pitisuttithum P, Rerks-Ngarm S, Shao Y, Zhang L, Tamashiro H, et al. Expanding research capacity and accelerating AIDS vaccine development in Asia. Southeast Asian J Trop Med Public Health. 2008;39(4):766-84. Epub 2008/12/09. PubMed PMID: 19058617.

109. Kellerman R, Klipstein-Grobusch K, Weiner R, Wayling S, Fonn S. Investing in African research training institutions creates sustainable capacity for Africa: the case of the University of the Witwatersrand School of Public Health masters programme in epidemiology and biostatistics. Health Res Policy Syst. 2012;10(1):11. Epub 2012/04/06. doi: 10.1186/1478-4505-10-11. PubMed PMID: 22475629; PubMed Central PMCID: PMC3378446.

110. Greenwood B, Bhasin A, Targett G. The Gates Malaria Partnership: a consortium approach to malaria research and capacity development. Trop Med Int Health. 2012;17(5):558-63. Epub 2012/03/17. doi: 10.1111/j.1365-3156.2012.02970.x. PubMed PMID: 22420422.

111. Kabiru CW, Izugbara CO, Wambugu SW, Ezeh AC. Capacity development for health research in Africa: experiences managing the African Doctoral Dissertation Research Fellowship Program. Health Res Policy Syst. 2010;8:21. Epub 2010/07/01. doi: 10.1186/1478-4505-8-21. PubMed PMID: 20587016; PubMed Central PMCID: PMC2907373.

112. Baum BJ, Scott J, Bickel M, Gombos G, Greenspan JS, Guo W, et al. Global challenges in research and strategic planning. Eur J Dent Educ. 2002;6 Suppl 3:179-84. Epub 2002/10/23. PubMed PMID: 12390276.

113. Halabi-Nassif H, Hatem M. [Evidence-based practice and the development of a nursing research culture]. Perspect Infirm. 2008;5(7):36-42. Epub 2009/03/10. PubMed PMID: 19266791.

114. Edwards N, Webber J, Mill J, Kahwa E, Roelofs S. Building capacity for nurse-led research. Int Nurs Rev. 2009;56(1):88-94. Epub 2009/02/26. doi: 10.1111/j.1466-7657.2008.00683.x. PubMed PMID: 19239521.

115. Gaym A. Health research in Ethiopia--past, present and suggestions on the way forward. Ethiop Med J. 2008;46(3):287-308. Epub 2009/03/11. PubMed PMID: 19271395.

116. Dodani S, Songer T, Ahmed Z, Laporte RE. Building research capacity in developing countries: cost-effectiveness of an epidemiology course taught by traditional and video-teleconferencing methods in Pakistan. Telemed J E Health. 2012;18(8):621-8. Epub 2012/10/16. doi: 10.1089/tmj.2011.0262. PubMed PMID: 23061643.

117. Gotch F, Gilmour J. Science, medicine and research in the developing world: a perspective. Nat Immunol. 2007;8(12):1273-6. Epub 2007/10/24. doi: 10.1038/ni1531. PubMed PMID: 17952077.

118. Manabe YC, Katabira E, Brough RL, Coutinho AG, Sewankambo N, Merry C. Developing independent investigators for clinical research relevant for Africa. Health Res Policy Syst. 2011;9:44. Epub 2011/12/31. doi: 10.1186/1478-4505-9-44. PubMed PMID: 22206247; PubMed Central PMCID: PMC3283488.

119. Siegfried NL, Hughes G. Herbal medicine, randomised controlled trials and global core competencies. S Afr Med J. 2012;102(12):912-3. Epub 2013/03/19. PubMed PMID: 23498035.

120. Abu-Zidan FM, Rizk DE. Research in developing countries: problems and solutions. Int Urogynecol J Pelvic Floor Dysfunct. 2005;16(3):174-5. Epub 2005/02/09. doi: 10.1007/s00192-004-1278-x. PubMed PMID: 15700105.

121. Tierney WM, Nyandiko WN, Siika AM, Wools-Kaloustian K, Sidle JE, Kiplagat J, et al. "These are Good Problems to Have...": Establishing a Collaborative Research Partnership in East Africa. J Gen Intern Med. 2013. Epub 2013/06/26. doi: 10.1007/s11606-013-2459-4. PubMed PMID: 23797916.

122. Muldoon KA, Birungi J, Berry NS, Ngolobe MH, Mwesigwa R, Shannon K, et al. Supporting southern-led research: implications for North-South research partnerships. Can J Public Health. 2012;103(2):128-31. Epub 2012/04/26. PubMed PMID: 22530536.

123. Akhtar W, Arain MA, Ali A, Sajjad Z. Interventions for improving research productivity in clinical radiology. J Coll Physicians Surg Pak. 2012;22(7):478-9. Epub 2012/07/04. doi: 07.2012/jcpsp.478479. PubMed PMID: 22747876.

124. Mullan F, Frehywot S, Omaswa F, Buch E, Chen C, Greysen SR, et al. Medical schools in sub-Saharan Africa. Lancet. 2011;377(9771):1113-21. Epub 2010/11/16. doi: S0140-6736(10)61961-7. PubMed PMID: 21074256.

125. Excler JL. AIDS vaccine efficacy trials: expand capacity and prioritize. 'Throughout Africa, Asia and Latin America state-of-the-art clinics and laboratories...exist where, 4 years ago, there were none'. Expert Rev Vaccines. 2006;5(2):167-70. Epub 2006/04/13. doi: 10.1586/14760584.5.2.167. PubMed PMID: 16608417.

126. Gilmour JW, Stevens WS, Gray C, de Souza M. Laboratory expansion to large-scale international HIV preventive vaccine trials. Curr Opin HIV AIDS. 2007;2(3):201-6. Epub 2007/05/01. doi: 10.1097/COH.0b013e3280eec77a. PubMed PMID: 19372887.

127. Guindo MA, Shott JP, Saye R, Diakite ML, Sanogo S, Dembele MB, et al. Promoting good clinical laboratory practices and laboratory accreditation to support clinical trials in sub-Saharan Africa. Am J Trop Med Hyg. 2012;86(4):573-9. Epub 2012/04/12. doi: 10.4269/ajtmh.2012.11-0691. PubMed PMID: 22492138; PubMed Central PMCID: PMC3403781.

128. Kilama WL. The 10/90 gap in sub-Saharan Africa: resolving inequities in health research. Acta Trop. 2009;112 Suppl 1:S8-S15. Epub 2009/08/22. doi: S0001-706X(09)00244-7 [pii] 10.1016/j.actatropica.2009.08.015. PubMed PMID: 19695211.

129. Rerks-Ngarm S, Pitisuttithum P, Ganguly N, Zhang L, Tamashiro H, Cooper DA, et al. Defining the objectives of the AIDS vaccine for Asia network: report of the WHO-UNAIDS/Global HIV vaccine enterprise regional consultation on expanding AIDS vaccine research and development capacity in Asia. Curr Opin HIV AIDS. 2010;5(5):435-52. Epub 2010/10/28. doi: 10.1097/COH.0b013e32833c95c1. PubMed PMID: 20978386; PubMed Central PMCID: PMC3125721.

130. Nachega JB, Uthman OA, Ho YS, Lo M, Anude C, Kayembe P, et al. Current status and future prospects of epidemiology and public health training and research in the WHO African region. Int J Epidemiol. 2012;41(6):1829-46. Epub 2013/01/04. doi: 10.1093/ije/dys189. PubMed PMID: 23283719; PubMed Central PMCID: PMC3535755.

131. Bates I, Taegtmeyer M, Squire SB, Ansong D, Nhlema-Simwaka B, Baba A, et al. Indicators of sustainable capacity building for health research: analysis of four African case studies. Health Res Policy Syst. 2011;9:14. Epub 2011/03/30. doi: 10.1186/1478-4505-9-14. PubMed PMID: 21443780; PubMed Central PMCID: PMC3078899.

132. Marchetti E, Mazarin-Diop V, Chaumont J, Martellet L, Makadi MF, Viviani S, et al. Conducting vaccine clinical trials in sub-Saharan Africa: operational challenges and lessons learned from the Meningitis Vaccine Project. Vaccine. 2012;30(48):6859-63. Epub 2012/09/20. doi: 10.1016/j.vaccine.2012.09.008. PubMed PMID: 22989686.

133. Casale M, Lane T, Sello L, Kuo C, Cluver L. Conducting health survey research in a deep rural South African community: challenges and adaptive strategies. Health Res Policy Syst. 2013;11:14. Epub 2013/04/27. doi: 10.1186/1478-4505-11-14. PubMed PMID: 23618363; PubMed Central PMCID: PMCPmc3640973.

134. Louisa M, Takeuchi M, Setiabudy R, Nafrialdi. Current status of phase I clinical trials in Asia: an academic perspectives. Acta Med Indones. 2012;44(1):71-7. Epub 2012/03/28. PubMed PMID: 22451190.

135. Tugwell P, Sitthi-Amorn C, Hatcher-Roberts J, Neufeld V, Makara P, Munoz F, et al. Health Research Profile to assess the capacity of low and middle income countries for equity-oriented research. BMC Public Health. 2006;6:151. Epub 2006/06/14. doi: 10.1186/1471-2458-6-151. PubMed PMID: 16768792; PubMed Central PMCID: PMC1539005.

136. World Health Organisation. Strategic Initiative for Developing Capacity in Ethical Review Geneva: World health Organisation; 2014 [cited 2014 04/06/2014]. Available from: http://www.who.int/sidcer/en/.

137. TDR. ESSENCE on Health Research (Enhancing Support for Strengthening the Effectiveness of National Capacity Efforts) Geneva: World Health Organisation; 2014 [cited 2014 04/06/2014]. Available from: http://www.who.int/tdr/partnerships/initiatives/essence/en/.

138. The Global Health Network. The Global Health Network: The Global Health Network; 2014 [cited 2014 04/06/2014]. Available from: www.tghn.org.

Supplementary file captions

S1: Full list of papers included in the systematic review

S2: Key terminology and definitions used in this synthesis

S3: Typology of capacity development actors

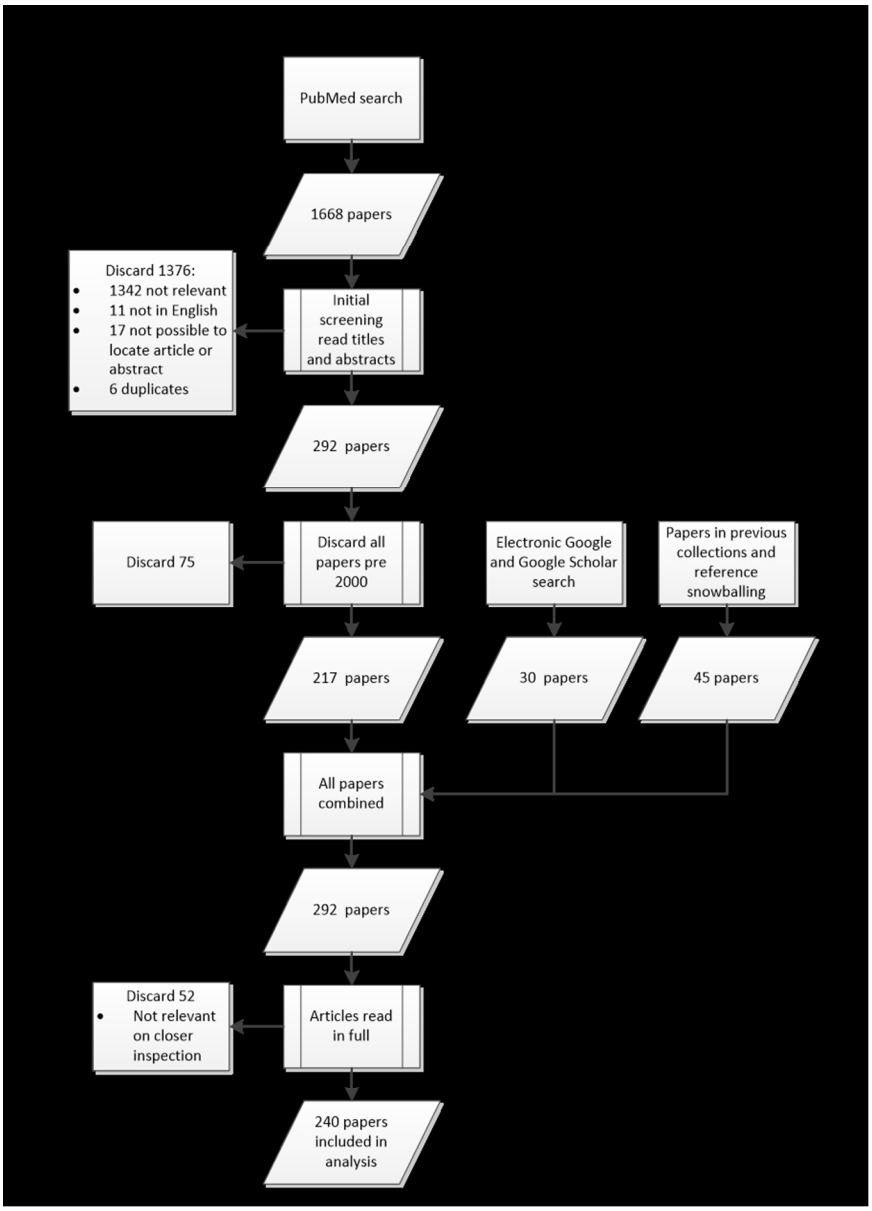


Figure 1: Search and study selection process
Figure 1
153x212mm (150 x 150 DPI)

Supplementary file S1: All papers included in the systematic review

ABBOOD, S. A. 2002. Medical research in developing countries still in Cinderella status. *Saudi Med J,* 23**,** 1554-6.

ABU-ZIDAN, F. M. & RIZK, D. E. 2005. Research in developing countries: problems and solutions. *Int Urogynecol J Pelvic Floor Dysfunct,* 16**,** 174-5.

ADAM, T., AHMAD, S., BIGDELI, M., GHAFFAR, A. & ROTTINGEN, J. A. 2011. Trends in health policy and systems research over the past decade: still too little capacity in low-income countries. *PLoS One,* 6**,** e27263.

ADDAE-MENSAH, I., FAKOREDE, F., HOLTEL, A. & NWAKA, S. 2011. Traditional medicines as a mechanism for driving research innovation in Africa. *Malar J,* 10 Suppl 1**,** S9.

AIRHIHENBUWA, C. O., SHISANA, O., ZUNGU, N., BELUE, R., MAKOFANI, D. M., SHEFER, T., SMITH, E. & SIMBAYI, L. 2011. Research capacity building: a US-South African partnership. *Glob Health Promot,* 18**,** 27-35.

AKHTAR, W., ARAIN, M. A., ALI, A. & SAJJAD, Z. 2012. Interventions for improving research productivity in clinical radiology. *J Coll Physicians Surg Pak,* 22**,** 478-9.

AKSOY, S. 2010. Solutions to neglected tropical diseases require vibrant local scientific communities. *PLoS Negl Trop Dis,* 4**,** e662.

ALEM, A. & KEBEDE, D. 2003. Conducting psychiatric research in the developing world: challenges and rewards. *Br J Psychiatry,* 182**,** 185-7.

ALI, R., FINLAYSON, A. & NETWORK, I. C. R. 2012. Building capacity for clinical research in developing countries: the INDOX cancer research network experience. *Global Health Action,* 5**,** 1-6.

ALI, R. & RAINA, V. 2008. Developing innovative models for North-South cooperation in clinical research--experience from the INDOX Cancer Research Network. *Ann Oncol,* 19**,** 831-3.

AMEH, E. A., DAUDA, M. M. & NMADU, P. T. 2008. Paediatric surgical research and publications in a developing country setting. *Afr J Paediatr Surg,* 5**,** 3-7.

ANDRONIKOU, S. & MNGOMEZULU, V. 2011. Paediatric radiology seen from Africa. Part II: recognising research advantages in a developing country. *Pediatr Radiol,* 41**,** 826-31.

ANDRUCHOW, J. E., SOSKOLNE, C. L., RACIOPPI, F. & BERTOLLINI, R. 2005. Capacity building for epidemiologic research: a case study in the newly independent state of Azerbaijan. *Ann Epidemiol,* 15**,** 228-31.

ANNERSTEDT, J. & LIYANAGE, S. 2008. Challenges when Shaping Capabilities for Research: Swedish Support to Bilateral Research Cooperation with Sri Lanka and Vietnam, 1976–2006, and a Look Ahead. *In:* COOPERATION, D. F. R. (ed.). Stockholm: SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY.

ARAI, R. J., MANO, M. S., DE CASTRO, G., DIZ, M. D. E. & HOFF, P. M. G. 2010. Building research capacity and clinical trials in developing countries. *Lancet Oncology,* 11**,** 712-713.

ARENAS-LOPEZ, S., FAJARDO, C., VALLS I SOLER, A., GARCIA-CORZO, J. R., LIMA-ROGEL, M. V., CALLE, G., LEITE, R., LOBOS, E., HUME-WRIGHT, Q.

& MACLEOD, S. 2011. Pediatric clinical trials in Latin America and Guyana: present views of local practitioners and ways to embrace the future. *Paediatr Drugs,* 13**,** 257-65.

ATUKORALA, K. R., SUMANASEKARA, D. R., WICKRAMASINGHE, K. H., RATNAYAKE, G. M., JAYASENA, G. M., WEERATUNGA, P. N., WICKRAMASINGHE, S. I. & JAYASINGHE, S. 2012. Medical student research output in a developing country: where has all the research gone? *Med Teach,* 34**,** 998.

BARBOUR, V., COHEN, B. & YAMEY, G. 2004. A new vision for clinical trials in Africa. *PLoS Med,* 1**,** e71.

BARRETO, M. L. 2009. Health research in developing countries. *BMJ,* 339**,** b4846.

BATES, I., AKOTO, A. Y., ANSONG, D., KARIKARI, P., BEDU-ADDO, G., CRITCHLEY, J., AGBENYEGA, T. & NSIAH-ASARE, A. 2006. Evaluating health research capacity building: an evidence-based tool. *PLoS Med,* 3**,** e299.

BATES, I., ANSONG, D., BEDU-ADDO, G., AGBENYEGA, T., AKOTO, A. Y., NSIAH-ASARE, A. & KARIKARI, P. 2007. Evaluation of a learner-designed course for teaching health research skills in Ghana. *BMC Med Educ,* 7**,** 18.

BATES, I., TAEGTMEYER, M., SQUIRE, S. B., ANSONG, D., NHLEMA-SIMWAKA, B., BABA, A. & THEOBALD, S. 2011. Indicators of sustainable capacity building for health research: analysis of four African case studies. *Health Res Policy Syst,* 9**,** 14.

BAUM, B. J., SCOTT, J., BICKEL, M., GOMBOS, G., GREENSPAN, J. S., GUO, W., PARK, N. H., PURDELL-LEWIS, D., RANNEY, R., SCHWARZ, E.,

SEYMOUR, G. & UOSHIMA, K. 2002. Global challenges in research and strategic planning. *Eur J Dent Educ,* 6 Suppl 3**,** 179-84.

BENNETT, S., ADAM, T., ZAROWSKY, C., TANGCHAROENSATHIEN, V., RANSON, K., EVANS, T. & MILLS, A. 2008. From Mexico to Mali: progress in health policy and systems research. *Lancet,* 372**,** 1571-8.

BENNETT, S., AGYEPONG, I. A., SHEIKH, K., HANSON, K., SSENGOOBA, F. & GILSON, L. 2011. Building the Field of Health Policy and Systems Research: An Agenda for Action. *PLoS medicine,* 8.

BODEKER, G. & WILLCOX, M. 2000. The first international meeting of the Research Initiative on Traditional Antimalarial Methods (RITAM). *J Altern Complement Med,* 6**,** 195-207.

BOSCH, X. 2004. Clinical trials partnership seeks to boost research in developing countries. *JAMA,* 292**,** 1290.

BROWN, K. H., MCLACHLAN, M., CARDOSA, P., TCHIBINDAT, F. & BAKER, S. K. 2010. Strengthening public health nutrition research and training capacities in West Africa: Report of a planning workshop convened in Dakar, Senegal, 26-28 March 2009. *Glob Public Health,* 5 Suppl 1**,** S1-19.

BURGESS, L. J. & SULZER, N. U. 2010. Clinical trials in South Africa: Need for capacity building and training. *S Afr Med J,* 100**,** 402.

CASALE, M., LANE, T., SELLO, L., KUO, C. & CLUVER, L. 2013. Conducting health survey research in a deep rural South African community: challenges and adaptive strategies. *Health Res Policy Syst,* 11**,** 14.

CHANDA-KAPATA, P., CAMPBELL, S. & ZAROWSKY, C. 2012. Developing a national health research system: participatory approaches to legislative,

institutional and networking dimensions in Zambia. *Health Res Policy Syst,* 10**,** 17.

CHANDIWANA, S. & ORNBJERG, N. 2003. Review of North-South and South-South cooperation and conditions necessary to sustain research capability in developing countries. *J Health Popul Nutr,* 21**,** 288-97.

CHATAWAY, J. & HANLIN, R. 2008. Sustainable (vaccine) development: the International AIDS Vaccine Initiative (IAVI) and capacity building. *In:* MATLIN, S., DE FRANCISCO, A., SUNDARAM, L., FALCH, H. & GEHNER, M. (eds.) *Health Partnerships Review.* Geneva: Global Forum for Health Research.

CHEN, C., GREYSEN, R., MIPANDO, M. & RUGARABAMU, P. 2009. SAMSS Site Visit Report: Faculty of Helath Sciences, School of Medicine, Jimma University, Ethiopia. SAMMS.

CHOI, H. Y. & KO, J. W. 2010. Facilitating large-scale clinical trials: in Asia. *Urol Oncol,* 28**,** 691-2.

COLLINS, F., BEAUDET, A., DRAGHIA-AKLI, R., GRUSS, P., SAVILL, J., SYROTA, A., DAUTRY, A., ULFENDAHL, M., WALPORT, M., ONKEN, J. & GLASS, R. I. 2013. A database on global health research in Africa. *The Lancet,* 1**,** e64-e65.

COLOMA, J. & HARRIS, E. 2009. From construction workers to architects: developing scientific research capacity in low-income countries. *PLoS Biol,* 7**,** e1000156.

COOKE, J. 2005. A framework to evaluate research capacity building in health care. *BMC Family Practice,* 6**,** 1-11.

COSTELLO, A. & ZUMLA, A. 2000. Moving to research partnerships in developing countries. *BMJ,* 321**,** 827-9.

COURTRIGHT, P. & FAAL, H. B. 2006. How can we strengthen ophthalmic research in Africa? *Can J Ophthalmol,* 41**,** 424-5.

CRANE, J. 2011. Scrambling for Africa? Universities and global health. *The Lancet,* 377**,** 1388-1390.

D'SOUZA, C. & SADANA, R. 2006. Why do case studies on national health research systems matter?: identifying common challenges in low- and middle-income countries. *Soc Sci Med,* 62**,** 2072-8.

DAKIK, H. A., KAIDBEY, H. & SABRA, R. 2006. Research productivity of the medical faculty at the American University of Beirut. *Postgrad Med J,* 82**,** 462-4.

DAVEY, S. 2004. The 10/90 Report on Health Research 2003-2004. *In:* GLOBAL FORUM FOR HEALTH RESEARCH (ed.). Geneva: Global Forum for Health Research.

DE OLIVEIRA, N. A., LUZ, M. R., SARAIVA, R. M. & ALVES, L. A. 2011. Student views of research training programmes in medical schools. *Med Educ,* 45**,** 748-55.

DE THE, G. & ZETTERSTROM, R. 2005. Mother-child health research (IRN-MCH): achievements and prospects of an international network. *Acta Paediatr,* 94**,** 964-7.

DE-GRAFT AIKINS, A., ARHINFUL, D. K., PITCHFORTH, E., OGEDEGBE, G., ALLOTEY, P. & AGYEMANG, C. 2012. Establishing and sustaining research partnerships in Africa: a case study of the UK-Africa Academic Partnership on Chronic Disease. *Global Health,* 8**,** 29.

DECKELBAUM, R. J., NTAMBI, J. M. & WOLGEMUTH, D. J. 2011. Basic science research and education: a priority for training and capacity building in developing countries. *Infect Dis Clin North Am,* 25**,** 669-76, x.

DELISLE, H., ROBERTS, J. H., MUNRO, M., JONES, L. & GYORKOS, T. W. 2005. The role of NGOs in global health research for development. *Health Res Policy Syst,* 3**,** 3.

DEVASENAPATHY, N., SINGH, K. & PRABHAKARAN, D. 2009. Conduct of clinical trials in developing countries: a perspective. *Current Opinion in Cardiology,* 24**,** 295-300.

DEVI, V., ABRAHAM, R. R., ADIGA, A., RAMNARAYAN, K. & KAMATH, A. 2010. Fostering research skills in undergraduate medical students through mentored students projects: example from an Indian medical school. *Kathmandu Univ Med J (KUMJ),* 8**,** 294-8.

DFID 2010. Capacity Building in Research. *In:* DEVELOPMENT, D. F. I. (ed.).

DODANI, S. & LAPORTE, R. E. 2008. Ways to strengthen research capacity in developing countries: effectiveness of a research training workshop in Pakistan. *Public Health,* 122**,** 578-87.

DODANI, S., SONGER, T., AHMED, Z. & LAPORTE, R. E. 2012. Building research capacity in developing countries: cost-effectiveness of an epidemiology course taught by traditional and video-teleconferencing methods in Pakistan. *Telemed J E Health,* 18**,** 621-8.

EDITORIAL 2000. Enabling research in developing countries. *Lancet,* 356**,** 1043.

EDITORIAL 2001. Strengthening research capacity's weakest link. *Lancet,* 358**,** 1381.

EDITORIAL 2008. The Bamako call to action: research for health. *Lancet,* 372**,** 1855-1855.

EDITORIAL 2009a. Bringing health research forward. *Tanzan J Health Res,* 11**,** iii-iv.

EDITORIAL 2009b. Strengthening research capacity in Africa. *Lancet,* 374**,** 1.

EDWARDS, N., WEBBER, J., MILL, J., KAHWA, E. & ROELOFS, S. 2009. Building capacity for nurse-led research. *Int Nurs Rev,* 56**,** 88-94.

ENOCH, S. 2005. The Mexico Summit on Health Research 2004: medical community in developing countries has duty to promote healthcare research. *BMJ,* 330**,** 421.

ESSENCE ON HEALTH RESEARCH 2011. Planning Monitoring and Evaluation; Framework for Capacity Strengthening in Health Research. *In:* ESSENCE GOOD PRACTICE DOCUMENT SERIES (ed.). Geneva: Copytrend.

EXCLER, J. L. 2006. AIDS vaccine efficacy trials: expand capacity and prioritize. 'Throughout Africa, Asia and Latin America state-of-the-art clinics and laboratories...exist where, 4 years ago, there were none'. *Expert Rev Vaccines,* 5**,** 167-70.

EXCLER, J. L., PITISUTTITHUM, P., RERKS-NGARM, S., SHAO, Y., ZHANG, L., TAMASHIRO, H., OSMANOV, S. & CONSULTATION, W.-U. R. 2008. Expanding research capacity and accelerating AIDS vaccine development in Asia. *Southeast Asian J Trop Med Public Health,* 39**,** 766-84.

EZEH, A. C., IZUGBARA, C. O., KABIRU, C. W., FONN, S., KAHN, K., MANDERSON, L., UNDIEH, A. S., OMIGBODUN, A. & THOROGOOD, M. 2010. Building capacity for public and population health research in Africa: the

consortium for advanced research training in Africa (CARTA) model. *Glob Health Action,* 3.

FATHALLA, M. F. 2004. Tapping the potential for health research in developing countries. *Bull World Health Organ,* 82**,** 722.

GADSBY, E. W. 2011. Research capacity strengthening: donor approaches to improving and assessing its impact in low- and middle-income countries. *Int J Health Plann Manage,* 26**,** 89-106.

GARCIA, P. J., COTRINA, A., GOTUZZO, E., GONZALEZ, E. & BUFFARDI, A. L. 2010. Research training needs in Peruvian national TB/HIV programs. *BMC Medical Education,* 10.

GARRETT, L. 2007. The Challenge of Global Health. (cover story). *Foreign Affairs,* 86**,** 14-38.

GAYM, A. 2008. Health research in Ethiopia--past, present and suggestions on the way forward. *Ethiop Med J,* 46**,** 287-308.

GELDENHUYS, H., VELDSMAN, A., TAMERIS, M., LUABEYA, A., HANEKOM, W., MAHOMED, H. & HATHERILL, M. 2013. Analysis of time to regulatory and ethical approval of SATVI TB vaccine trials in South Africa. *S Afr Med J,* 103**,** 85-9.

GELDENHUYS, H., WAGGIE, Z., JACKS, M., GELDENHUYS, M., TRAUT, L., TAMERIS, M., HATHERILL, M., HANEKOM, W. A., SUTTER, R., HUSSEY, G. & MAHOMED, H. 2012. Vaccine trials in the developing world: operational lessons learnt from a phase IV poliomyelitis vaccine trial in South Africa. *Vaccine,* 30**,** 5839-43.

GEZMU, M., DEGRUTTOLA, V., DIXON, D., ESSEX, M., HALLORAN, E., HOGAN, J., GROBLER, A., KIM, S., MCDERMOTT, J., MCKAIG, R. & NEATON, J. D. 2011. Strengthening biostatistics resources in sub-Saharan Africa: research collaborations through U.S. partnerships. *Stat Med,* 30**,** 695-708.

GILMOUR, J. W., STEVENS, W. S., GRAY, C. & DE SOUZA, M. 2007. Laboratory expansion to large-scale international HIV preventive vaccine trials. *Curr Opin HIV AIDS,* 2**,** 201-6.

GLOBAL FORUM FOR HEALTH RESEARCH 2000. The 10/90 report on health research 2000. *In:* RESEARCH, G. F. F. H. (ed.). Geneva: Global Forum for Health Research.

GONZALEZ-BLOCK, M. A., VARGAS-RIANO, E. M., SONELA, N., IDROVO, A. J., OUWE-MISSI-OUKEM-BOYER, O. & MONOT, J. J. 2011. Research capacity for institutional collaboration in implementation research on diseases of poverty. *Trop Med Int Health,* 16**,** 1285-90.

GOTCH, F. & GILMOUR, J. 2007. Science, medicine and research in the developing world: a perspective. *Nat Immunol,* 8**,** 1273-6.

GOTO, A., NGUYEN, T. N., NGUYEN, T. M. & HUGHES, J. 2005. Building postgraduate capacity in medical and public health research in Vietnam: an in-service training model. *Public Health,* 119**,** 174-83.

GRAY, G. E., DE BRUYN, G., SLACK, C., STEEL, G. & WILLIAMSON, C. 2006. Preparing developing countries for efficacy trials. *Curr Opin HIV AIDS,* 1**,** 330-5.

GREEN, A. & BENNETT, S. (eds.) 2007. *Sound Choices: Enhancing Capacity for Evidence-Informed Health Policy,* Geneva: World Health Organisation.

GREENWOOD, B., BHASIN, A. & TARGETT, G. 2012. The Gates Malaria Partnership: a consortium approach to malaria research and capacity development. *Trop Med Int Health,* 17**,** 558-63.

GREENWOOD, B. M., BHASIN, A., BOWLER, C. H., NAYLOR, H. & TARGETT, G. A. 2006. Capacity strengthening in malaria research: the Gates Malaria Partnership. *Trends Parasitol,* 22**,** 278-84.

GUINDO, M. A., SHOTT, J. P., SAYE, R., DIAKITE, M. L., SANOGO, S., DEMBELE, M. B., KEITA, S., NAGEL, M. C., ELLIS, R. D., AEBIG, J. A., DIALLO, D. A. & DOUMBO, O. K. 2012. Promoting good clinical laboratory practices and laboratory accreditation to support clinical trials in sub-Saharan Africa. *Am J Trop Med Hyg,* 86**,** 573-9.

GULLAND, A. 2012. Plan to stimulate research in developing countries is put on hold. *BMJ,* 344**,** e3771.

GYAPONG, J. & OFORI-ADJEI, D. 2011. Capacity building for relevant health research in developing countries. *In:* UNIT, H. R. (ed.). University of Ghana Medical School.

HALABI-NASSIF, H. & HATEM, M. 2008. [Evidence-based practice and the development of a nursing research culture]. *Perspect Infirm,* 5**,** 36-42.

HARGREAVES, S. 2002. Wellcome Trust promotes ethical research in developing world. *BMJ,* 325**,** 986.

HARRIES, A. D. 2003. Integration of operational research into National Tuberculosis Control Programmes. *Tuberculosis (Edinb),* 83**,** 143-7.

HARRIES, A. D., RUSEN, I. D., REID, T., DETJEN, A. K., BERGER, S. D., BISSELL, K., HINDERAKER, S. G., EDGINTON, M., FUSSELL, M., FUJIWARA, P. I. &

ZACHARIAH, R. 2011. The Union and Medecins Sans Frontieres approach to operational research. *Int J Tuberc Lung Dis,* 15**,** 144-54, i.

HARUN AR, R. 2004. Promoting road traffic injuries research in South Asia: capacity strengthening in health research. *J Coll Physicians Surg Pak,* 14**,** 736-8.

HIGGS, E. S., HAYDEN, F. G., CHOTPITAYASUNONDH, T., WHITWORTH, J. & FARRAR, J. 2008. The Southeast Asian Influenza Clinical Research Network: development and challenges for a new multilateral research endeavor. *Antiviral Res,* 78**,** 64-8.

HOYT, P. 2006. Problem Solving for Better Health Nursing: a working approach to the development and dissemination of applied research in developing countries. *Appl Nurs Res,* 19**,** 110-2; discussion 112.

HUSSEY, G. & HAWKRIDGE, A. 2012. The state and future of research at the University of Cape Town's Faculty of Health Sciences. *S Afr Med J,* 102**,** 412-4.

HYDER, A. A., AKHTER, T. & QAYYUM, A. 2003. Capacity development for health research in Pakistan: the effects of doctoral training. *Health Policy Plan,* 18**,** 338-43.

IACCARINO, M. 2004. Mastering science in the South. To develop much-needed research capacity, developing countries cannot rely on the industrialized world, but have to find their own specific solutions. *EMBO Rep,* 5**,** 437-41.

IJSSELMUIDEN, C., MARAIS, D. L., BECERRA-POSADA, F. & GHANNEM, H. 2012. Africa's neglected area of human resources for health research - the way forward. *S Afr Med J,* 102**,** 228-33.

JAFFAR, S., LAZARUS, J. V., ONYEBUJOH, P., CHAKAYA, J., GARRIB, A., MWABA, P., MBOUP, S., BELLIS, K., EGWAGA, S., CORRAH, T. & COUTINHO, A. 2010. Health services strengthening in Africa--research is a key component. *Trop Med Int Health,* 15**,** 1270-3.

JENTSCH, B. & PILLEY, C. 2003. Research relationships between the South and the North: Cinderella and the ugly sisters? *Soc Sci Med,* 57**,** 1957-67.

JOHNSON, K., KENNEDY, S. B., HARRIS, A. O., LINCOLN, A., NEACE, W. & COLLINS, D. 2005. Strengthening the HIV/AIDS service delivery system in Liberia: an international research capacity-building strategy. *J Eval Clin Pract,* 11**,** 257-73.

JONES, N., BAILEY, M. & LYYTIKAINEN, M. 2007. Research capacity strengthening in Africa: Trends, gaps and opportunities. *In:* INSTITUTE, O. D. (ed.). London: Overseas Development Institute.

KABIRU, C. W., IZUGBARA, C. O., WAMBUGU, S. W. & EZEH, A. C. 2010. Capacity development for health research in Africa: experiences managing the African Doctoral Dissertation Research Fellowship Program. *Health Res Policy Syst,* 8**,** 21.

KAMUNYORI, S., AL-BADER, S., SEWANKAMBO, N., SINGER, P. A. & DAAR, A. S. 2010. Science-based health innovation in Uganda: creative strategies for applying research to development. *BMC Int Health Hum Rights,* 10 Suppl 1**,** S5.

KARIUKI, T., PHILLIPS, R., NJENGA, S., OLESEN, O. F., KLATSER, P. R., PORRO, R., LOCK, S., CABRAL, M. H., GLIBER, M. & HANNE, D. 2011.

Research and capacity building for control of neglected tropical diseases: the need for a different approach. *PLoS Negl Trop Dis,* 5**,** e1020.

KASONDE, J. M. & CAMPBELL, S. 2012. Creating a Knowledge Translation Platform: nine lessons from the Zambia Forum for Health Research. *Health Res Policy Syst,* 10**,** 31.

KELLERMAN, R., KLIPSTEIN-GROBUSCH, K., WEINER, R., WAYLING, S. & FONN, S. 2012. Investing in African research training institutions creates sustainable capacity for Africa: the case of the University of the Witwatersrand School of Public Health masters programme in epidemiology and biostatistics. *Health Res Policy Syst,* 10**,** 11.

KENT, S. J., COOPER, D. A., CHHI VUN, M., SHAO, Y., ZHANG, L., GANGULY, N., BELA, B., TAMASHIRO, H., DITANGCO, R., RERKS-NGARM, S., PITISUTTITHUM, P., VAN KINH, N., BERNSTEIN, A., OSMANOV, S., INVESTIGATORS, A. V. F. A. N. & SUPPORTERS 2010. AIDS vaccine for Asia Network (AVAN): expanding the regional role in developing HIV vaccines. *PLoS Med,* 7**,** e1000331.

KHAN, F. A. 2010. Challenges of anaesthesia research in developing countries. *J Coll Physicians Surg Pak,* 20**,** 563-4.

KHAN, H., KHAN, S. & IQBAL, A. 2009. Knowledge, attitudes and practices around health research: the perspective of physicians-in-training in Pakistan. *BMC Med Educ,* 9**,** 46.

KHANNA, R., HOTA, P. & LAHARIYA, C. 2010. Health research strengthening and operational research needs for improving child survival in India. *Indian J Pediatr,* 77**,** 291-9.

KILAMA, W. L. 2001. The malaria burden and the need for research and capacity strengthening in Africa. *Am J Trop Med Hyg,* 64**,** iii.

KILAMA, W. L. 2009. The 10/90 gap in sub-Saharan Africa: resolving inequities in health research. *Acta Trop,* 112 Suppl 1**,** S8-S15.

KILAMA, W. L., CHILENGI, R. & WANGA, C. L. 2007. Towards an African-driven malaria vaccine development program: history and activities of the African Malaria Network Trust (AMANET). *Am J Trop Med Hyg,* 77**,** 282-8.

KIRIGIA, J. M. & WAMBEBE, C. 2006. Status of national health research systems in ten countries of the WHO African Region. *BMC Health Serv Res,* 6**,** 135.

KITUA, A. Y. 2007. Health research agenda for East Africa in the new millennium: looking ahead. *Tanzan Health Res Bull,* 9**,** 147-53.

KITUA, A. Y., CORRAH, T., HERBST, K., NYIRENDA, T., AGWALE, S., MAKANGA, M. & MGONE, C. S. 2009. Strengthening capacity, collaboration and quality of clinical research in Africa: EDCTP Networks of Excellence. *Tanzan J Health Res,* 11**,** 51-4.

KOK, M. O., RODRIGUES, A., SILVA, A. P. & DE HAAN, S. 2012. The emergence and current performance of a health research system: lessons from Guinea Bissau. *Health Res Policy Syst,* 10**,** 5.

KWONG, J. S. & YU, C. M. 2013. The need for multicentre cardiovascular clinical trials in Asia. *Nat Rev Cardiol,* 10**,** 355-62.

LAABES, E. P., DESAI, R., ZAWEDDE, S. M. & GLEW, R. H. 2011. How much longer will Africa have to depend on western nations for support of its capacity-building efforts for biomedical research? *Trop Med Int Health,* 16**,** 258-62.

LANG, T. 2011. Advancing global health research through digital technology and sharing data. *Science,* 331**,** 714-7.

LANG, T. & SIRIBADDANA, S. 2012. Clinical trials have gone global: is this a good thing? *PLoS Med,* 9**,** e1001228.

LANG, T. A. & KOKWARO, G. O. 2008. Malaria drug and vaccine trials in Africa: obstacles and opportunities. *Trans R Soc Trop Med Hyg,* 102**,** 7-10.

LANG, T. A., WHITE, N. J., TRAN, H. T., FARRAR, J. J., DAY, N. P., FITZPATRICK, R., ANGUS, B. J., DENIS, E., MERSON, L., CHEAH, P. Y., CHILENGI, R., KIMUTAI, R. & MARSH, K. 2010. Clinical research in resource-limited settings: enhancing research capacity and working together to make trials less complicated. *PLoS Negl Trop Dis,* 4**,** e619.

LANGER, A., DIAZ-OLAVARRIETA, C., BERDICHEVSKY, K. & VILLAR, J. 2004. Why is research from developing countries underrepresented in international health literature, and what can be done about it? *Bull World Health Organ,* 82**,** 802-3.

LANSANG M. & DENNIS R. 2007. The need to develop research capacity. *Global Forum Update on Research for Health Volume 4.* London: Pro-Brook Publishing Ltd.

LANSANG, M. A. & DENNIS, R. 2004. Building capacity in health research in the developing world. *Bull World Health Organ,* 82**,** 764-70.

LAZARUS, J. V., WALLACE, S. A. & LILJESTRAND, J. 2010. Improving African health research capacity. *Scand J Public Health,* 38**,** 670-1.

LEE, P. P. & LAU, Y. L. 2011. Improving care, education, and research: the Asian primary immunodeficiency network. *Ann N Y Acad Sci,* 1238**,** 33-41.

LEHNER, T., HOELSCHER, M., CLERICI, M., GOTCH, F., PEDNEAULT, L., TARTAGLIA, J., GRAY, C., MESTECKY, J., SATTENTAU, Q., VAN DE WIJGERT, J., TOURE, C., OSMANOV, S., SCHMIDT, R. E., DEBRE, P., ROMARIS, M., HOEVELER, A. & DI FABIO, S. 2005. European Union and EDCTP strategy in the global context: recommendations for preventive HIV/AIDS vaccines research. *Vaccine,* 23**,** 5551-6.

LESI, O. A., ORENUGA, O. O., ROBERTS, A. & ABUDU, O. O. 2009. Research productivity of junior academic staff at a tertiary medical college in south west, Nigeria. *Nig Q J Hosp Med,* 19**,** 119-24.

LEXCHIN, J. 2010. One step forward, one step sideways? Expanding research capacity for neglected diseases. *BMC Int Health Hum Rights,* 10**,** 20.

LI, M., WEI, L., LIU, H. & TANG, L. 2009. Integrative review of international nursing research in Mainland China. *Int Nurs Rev,* 56**,** 28-33.

LOUISA, M., TAKEUCHI, M., SETIABUDY, R. & NAFRIALDI 2012. Current status of phase I clinical trials in Asia: an academic perspectives. *Acta Med Indones,* 44**,** 71-7.

LUTUMBA, P., KANDE, V., BOELAERT, M., KAYEMBE, J. M. & MAMPUNZA, S. 2010. Research capacity strengthening in the DRC. *Lancet,* 375**,** 1080.

MAGWAZA, S., MATHAMBO, V., MAGONGO, B., MVO, E. & MAKHANYA, N. 2003. Health research Capacity Building in South Africa: Current knowledge and practices. Durban: Health Systems Trust.

MANABE, Y. C., KATABIRA, E., BROUGH, R. L., COUTINHO, A. G., SEWANKAMBO, N. & MERRY, C. 2011. Developing independent

investigators for clinical research relevant for Africa. *Health Res Policy Syst,* 9**,** 44.

MARAIS, D., TOOHEY, J., EDWARDS, D. & IJSSELMUIDEN, C. 2013. Where there is no lawyer: Guidance for fairer contract negotiation in collaborative research partnerships. *In:* DEVELOPMENT, C. I. H. R. F. (ed.). Geneva & Pietermaritzburg: Council in Health Research for Development.

MARCHETTI, E., MAZARIN-DIOP, V., CHAUMONT, J., MARTELLET, L., MAKADI, M. F., VIVIANI, S., KULKARNI, P. S. & PREZIOSI, M. P. 2012. Conducting vaccine clinical trials in sub-Saharan Africa: operational challenges and lessons learned from the Meningitis Vaccine Project. *Vaccine,* 30**,** 6859-63.

MARJANOVIC, S., HANLIN, R., DIEPEVEEN, S. & CHATAWAY, J. 2012. RESEARCH CAPACITY-BUILDING IN AFRICA: NETWORKS, INSTITUTIONS AND LOCAL OWNERSHIP. *Journal of International Development***,** n/a-n/a.

MARSHALL-LUCETTE, S., CORBETT, K., LARTEY, N., OPIO, D. & BIKAITWOHA, M. E. 2007. Developing locally based research capacity in Uganda. *Int Nurs Rev,* 54**,** 227-33.

MARTINS, N. & HAWKINS, Z. 2012. Striving for better health through health research in post-conflict Timor-Leste. *Health Res Policy Syst,* 10**,** 13.

MATEE, M. I., MANYANDO, C., NDUMBE, P. M., CORRAH, T., JAOKO, W. G., KITUA, A. Y., AMBENE, H. P., NDOUNGA, M., ZIJENAH, L., OFORI-ADJEI, D., AGWALE, S., SHONGWE, S., NYIRENDA, T. & MAKANGA, M. 2009. European and Developing Countries Clinical Trials Partnership (EDCTP): the path towards a true partnership. *BMC Public Health,* 9**,** 249.

MAYHEW, S. H., DOHERTY, J. & PITAYARANGSARIT, S. 2008. Developing health systems research capacities through north-south partnership: an evaluation of collaboration with South Africa and Thailand. *Health Res Policy Syst,* 6**,** 8.

MAZIAK, W. 2001. Global health research. Science aid programme could be set up to help researchers in developing countries. *BMJ,* 322**,** 173.

MBUAGBAW, L., ONGOLO-ZOGO, P. & THABANE, L. 2013. Investigating community ownership of a text message programme to improve adherence to antiretroviral therapy and provider-client communication: a mixed methods research protocol. *BMJ Open,* 3.

MBUAGBAW, L., THABANE, L., ONGOLO-ZOGO, P. & LANG, T. 2011. The challenges and opportunities of conducting a clinical trial in a low resource setting: the case of the Cameroon mobile phone SMS (CAMPS) trial, an investigator initiated trial. *Trials,* 12**,** 145.

MCKEE, M. 2008. Global research for health. *British Medical Journal,* 337.

MCKEE, M., STUCKLER, D. & BASU, S. 2012. Where there is no health research: what can be done to fill the global gaps in health research? *PLoS Med,* 9**,** e1001209.

MEDAGLINI, D. & HOEVELER, A. 2003. The European research effort for HIV/AIDS, malaria and tuberculosis. *Vaccine,* 21 Suppl 2**,** S116-20.

MELIS, T., ASHCROFT, K., MACFARLANE, I., RAYNER, P., SEMELA, T. & YIZENGAW, T. 2008. Human capacity building needs analysis of Ethiopian new public universities (NPUs). *In:* CENTRE FOR INTERNATIONAL COOPERATION, V. U. A. (ed.). Development Assistance Group, Ethiopia.

MGONE, C., VOLMINK, J., COLES, D., MAKANGA, M., JAFFAR, S. & SEWANKAMBO, N. 2010. Linking research and development to strengthen health systems in Africa. *Trop Med Int Health,* 15**,** 1404-6.

MGONE, C. S. 2010. Strengthening of the clinical research capacity for malaria: a shared responsibility. *Malar J,* 9 Suppl 3**,** S5.

MGONE, S. & MOCUMBI, P. 2008. Collaborative approach to clinical trials. *In:* MAITLIN, S., DE FRANCISCO, A., SUNDARAM, L., FAICH, H. & GEHNER, M. (eds.) *Health Partnerships Review.* Geneva: Global Forum for Health Research.

MIIRO, G. M., OUKEM-BOYER, O. O., SARR, O., RAHMANI, M., NTOUMI, F., DHEDA, K., PYM, A., MBOUP, S. & KALEEBU, P. 2013. EDCTP regional networks of excellence: initial merits for planned clinical trials in Africa. *BMC Public Health,* 13**,** 258.

MINJA, H., NSANZABANA, C., MAURE, C., HOFFMANN, A., RUMISHA, S., OGUNDAHUNSI, O., ZICKER, F., TANNER, M. & LAUNOIS, P. 2011. Impact of Health Research Capacity Strengthening in Low- and Middle-Income Countries: The Case of WHO/TDR Programmes. *Plos Neglected Tropical Diseases,* 5.

MONY, P. K., KURPAD, A. & VAZ, M. 2005. Capacity building in collaborative research is essential. *BMJ,* 331**,** 843-4.

MORAN, M., GUZMAN, J., ROPARS, A., JORGENSEN, M., POTTER, S., MCDONALD, A. & HAILE-SELASSIE, H. 2008. Clinical trial site capacity for malaria product development. *In:* MAITLIN, S., DE FRANCISCO, A.,

SUNDARAM, L., FAICH, H. & GEHNER, M. (eds.) *Health Partnerships Review.* Geneva: Global Forum for Health Research, Geneva.

MORENO-BORCHART, A. 2004. One problem at a time. Building research capacities in developing countries is necessary for economic success in the long term. But the numerous problems in doing so have to be solved for each country individually. *EMBO Rep,* 5**,** 127-30.

MULDOON, K. A., BIRUNGI, J., BERRY, N. S., NGOLOBE, M. H., MWESIGWA, R., SHANNON, K. & MOORE, D. M. 2012. Supporting southern-led research: implications for North-South research partnerships. *Can J Public Health,* 103**,** 128-31.

MULLAN, F., FREHYWOT, S., OMASWA, F., BUCH, E., CHEN, C., GREYSEN, S. R., WASSERMANN, T., ABUBAKR, D. E., AWASES, M., BOELEN, C., DIOMANDE, M. J., DOVLO, D., FERRO, J., HAILEAMLAK, A., IPUTO, J., JACOBS, M., KOUMARE, A. K., MIPANDO, M., MONEKOSSO, G. L., OLAPADE-OLAOPA, E. O., RUGARABAMU, P., SEWANKAMBO, N. K., ROSS, H., AYAS, H., CHALE, S. B., CYPRIEN, S., COHEN, J., HAILE-MARIAM, T., HAMBURGER, E., JOLLEY, L., KOLARS, J. C., KOMBE, G. & NEUSY, A. J. 2011. Medical schools in sub-Saharan Africa. *Lancet,* 377**,** 1113-21.

MUULA, A. S. 2007. What drives health research in a developing country? *Croat Med J,* 48**,** 261-7.

MWABA, P., BATES, M., GREEN, C., KAPATA, N. & ZUMLA, A. 2010. Research capacity strengthening in African countries. *Lancet,* 375**,** 1874.

MWANGOKA, G., OGUTU, B., MSAMBICHAKA, B., MZEE, T., SALIM, N., KAFURUKI, S., MPINA, M., SHEKALAGHE, S., TANNER, M. & ABDULLA, S. 2013. Experience and challenges from clinical trials with malaria vaccines in Africa. *Malar J,* 12**,** 86.

NACHEGA, J. B., UTHMAN, O. A., HO, Y. S., LO, M., ANUDE, C., KAYEMBE, P., WABWIRE-MANGEN, F., GOMO, E., SOW, P. S., OBIKE, U., KUSIAKU, T., MILLS, E. J., MAYOSI, B. M. & IJSSELMUIDEN, C. 2012. Current status and future prospects of epidemiology and public health training and research in the WHO African region. *Int J Epidemiol,* 41**,** 1829-46.

NANTULYA, F. N., KENGEYA-KAYONDO, J. F. & OGUNDAHUNSI, O. A. 2007. Research themes and advances in malaria research capacity made by the Multilateral Initiative on Malaria. *Am J Trop Med Hyg,* 77**,** 303-13.

NCHINDA, T. C. 2002. Research capacity strengthening in the South. *Soc Sci Med,* 54**,** 1699-711.

NJIE-CARR, V., KALENGE, S., KELLEY, J., WILSON, A., MULIIRA, J. K., NABIRYE, R. C., GLASS, N., BOLLINGER, R., ALAMO-TALISUNA, S. & CHANG, L. W. 2012. Research capacity-building program for clinicians and staff at a community-based HIV clinic in Uganda: A pre/post evaluation. *J Assoc Nurses AIDS Care,* 23**,** 431-41.

NTOUMI, F. 2010. Networking and capacity building for health research in Central Africa. *Wien Klin Wochenschr,* 122 Suppl 1**,** 23-6.

NUYENS, Y. 2005. No Development Without Research. Geneva: Global Forum for Health Research.

OGUTU, B. R., BAIDEN, R., DIALLO, D., SMITH, P. G. & BINKA, F. N. 2010. Sustainable development of a GCP-compliant clinical trials platform in Africa: the malaria clinical trials alliance perspective. *Malar J,* 9**,** 103.

OLVEDA, R., LEONARDO, L., ZHENG, F., SRIPA, B., BERGQUIST, R. & ZHOU, X. N. 2010. Coordinating research on neglected parasitic diseases in Southeast Asia through networking. *Adv Parasitol,* 72**,** 55-77.

PANG, T., SADANA, R., HANNEY, S., BHUTTA, Z., HYDER, A. & SIMON, J. 2003. Knowledge for better health — a conceptual framework and foundation for health research systems. *Bulletin of the World Health Organization,* 81**,** 815-820.

PARLIMENTARY OFFICE OF SCIENCE AND TECHNOLOGY 2004. Scientific Capacity In Developing Countries. *In:* TECHNOLOGY, P. O. O. S. A. (ed.). London: Parlimentary Office of Science and Technology.

PARRY, C., MOROJELE, N., MYERS, B. & PLUDDEMANN, A. 2013. Addiction research centres and the nurturing of creativity: The Alcohol & Drug Abuse Research Unit at the South African Medical Research Council - strengthening substance abuse research and policy in South Africa. *Addiction,* 108**,** 14-9.

PERKOVIC, V., PATIL, V., WEI, L., LV, J., PETERSEN, M. & PATEL, A. 2012. Global randomized trials: the promise of India and China. *J Bone Joint Surg Am,* 94 Suppl 1**,** 92-6.

PETERSEN, P. E. 2009. Global policy for improvement of oral health in the 21st century--implications to oral health research of World Health Assembly 2007, World Health Organization. *Community Dent Oral Epidemiol,* 37**,** 1-8.

PITAYARANGSARIT, S. & TANGCHAROENSATHIEN, V. 2009. Sustaining capacity in health policy and systems research in Thailand. *Bull World Health Organ,* 87**,** 72-4.

PITISUTTITHUM, P., CHOOPANYA, K. & RERK-NGNAM, S. 2010. HIV-vaccine research and development in Thailand: evolution and challenges. *Vaccine,* 28 Suppl 2**,** B45-9.

PURTY, A. J. 2008. Reflections for research capacity development in India. *Natl Med J India,* 21**,** 263.

RAB, M. A. 2003. Setting global health research priorities: investments for health research for developing countries must be increased. *BMJ,* 326**,** 1399.

RABIU, T. B. & BALOGUN, J. A. 2009. Repositioning health research in developing countries. *Arch Med Res,* 40**,** 223.

RAMJEE, G. 2008. Issues surrounding the implementation of multiple product development partnership clinical trials in developing countries. *In:* RESEARCH, G. F. F. H. (ed.). Geneva: Global Forum for Health Research.

REDMAN-MACLAREN, M., MACLAREN, D. J., HARRINGTON, H., ASUGENI, R., TIMOTHY-HARRINGTON, R., KEKEUBATA, E. & SPEARE, R. 2012. Mutual research capacity strengthening: a qualitative study of two-way partnerships in public health research. *Int J Equity Health,* 11**,** 79.

RERKS-NGARM, S., PITISUTTITHUM, P., GANGULY, N., ZHANG, L., TAMASHIRO, H., COOPER, D. A., VUN, M. C., BELA, B., DITANGCO, R., VAN KINH, N., BERNSTEIN, A., OSMANOV, S., MATHIESON, B., KENT, S. J. & SHAO, Y. 2010. Defining the objectives of the AIDS vaccine for Asia network: report of the WHO-UNAIDS/Global HIV vaccine enterprise regional

consultation on expanding AIDS vaccine research and development capacity in Asia. *Curr Opin HIV AIDS,* 5**,** 435-52.

RESNIK, D. B. 2004. The distribution of biomedical research resources and international justice. *Dev World Bioeth,* 4**,** 42-57.

SABZWARI, S., KAUSER, S. & KHUWAJA, A. K. 2009. Experiences, attitudes and barriers towards research amongst junior faculty of Pakistani medical universities. *BMC Med Educ,* 9**,** 68.

SADANA, R., D'SOUZA, C., HYDER, A. A. & CHOWDHURY, A. M. 2004. Importance of health research in South Asia. *BMJ,* 328**,** 826-30.

SAWYERR 2004. African Universities and the Challenge of Research Capacity Development. *JHEA/RESA Vol. 2, No. 1, 2004, pp. 211–240*.

SAYED, S. I., DUTTA, S., MATEEN, S., KAZI, R. & JAGADE, M. 2011. Clinical health research in India: is there a way forward? *J Indian Med Assoc,* 109**,** 270-1.

SCHLUGER, N., KARUNAKARA, U., LIENHARDT, C., NYIRENDA, T. & CHAISSON, R. 2007. Building Clinical Trials Capacity for Tuberculosis Drugs in High-Burden Countries. *PLoS Med,* 4**,** e302.

SEN, F. & MUTHUSWAMY, V. 2006. Capacity building for clinical trials in India. *Indian J Med Res,* 124**,** 605-7.

SHAFIQ, N., PANDHI, P. & MALHOTRA, S. 2009. Investigator-initiated pragmatic trials in developing countries--much needed but much ignored. *Br J Clin Pharmacol,* 67**,** 141-2.

SHANKAR, P. R. 2007. Mentoring a medical student towards applied research in a developing country. *Med Teach,* 29**,** 253-4.

SHANKAR, P. R., CHANDRASEKHAR, T. S., MISHRA, P. & SUBISH, P. 2006. Initiating and strengthening medical student research: time to take up the gauntlet. *Kathmandu Univ Med J (KUMJ),* 4**,** 135-8.

SHANN, F. 2002. Research in developing countries. *N Engl J Med,* 346**,** 627-8.

SHIRAHATTI, R. V., SURA, S., SUMANTHPRASAD, G. R. & KHURANA, L. 2010. Dental students research inventory: a questionnaire to assess research challenges and opportunities. *J Dent Educ,* 74**,** 1308-18.

SIEGFRIED, N. L. & HUGHES, G. 2012. Herbal medicine, randomised controlled trials and global core competencies. *S Afr Med J,* 102**,** 912-3.

SILKAVUTE, P., TUNG, D. X. & JONGUDOMSUK, P. 2013. Sustaining a regional emerging infectious disease research network: a trust-based approach. *Emerg Health Threats J,* 6.

SILOVE, D., REES, S., TAM, N., LIDDELL, B. & ZWI, A. 2011. Staff management and capacity building under conditions of insecurity: lessons from developing mental health service and research programs in post-conflict Timor-Leste. *Australas Psychiatry,* 19 Suppl 1**,** S90-4.

SIRIWARDHANA, C., SUMATHIPALA, A., SIRIBADDANA, S., SAMARAWEERA, S., ABEYSINGHE, N., PRINCE, M. & HOTOPF, M. 2011. Reducing the scarcity in mental health research from low and middle income countries: a success story from Sri Lanka. *Int Rev Psychiatry,* 23**,** 77-83.

SITTHI-AMORN, C., PONGPANICH, S., SOMRONGTHONG, R., LIKITKIRIRAT, T. & LIKITKIRIRAT, P. 2002. The Asian Voice in building equity in health for development - from the Asian Forum for Health Research, Manila, February 2000. *Health Policy Plan,* 17**,** 213-7.

SITTHI-AMORN, C. & SOMRONGTHONG, R. 2000. Strengthening health research capacity in developing countries: a critical element for achieving health equity. *BMJ,* 321**,** 813-7.

SMITH, R. 2002. Publishing research from developing countries. *Stat Med,* 21**,** 2869-77.

SPARKS, B. L. & GUPTA, S. K. 2004. Research in family medicine in developing countries. *Ann Fam Med,* 2 Suppl 2**,** S55-9.

STEPHEN, C. & DAIBES, I. 2010. Defining features of the practice of global health research: an examination of 14 global health research teams. *Glob Health Action,* 3.

SUAALII-SAUNI, T., AIAVAO, F., FAAFEU-HOPE, E., SOPOAGA, T., PAUL, C., RIGHARTS, A., MCCOOL, J., KIRIFI-ALAI, T. N., HILL, P. & FUATAI, F. L. 2011. Strengthening health research capacity from within Samoa. *Asia Pac J Public Health,* 23**,** 100-9.

SUMATHIPALA, A., SIRIBADDANA, S., SAMARAWEERA, S. & DAYARATNE, D. A. 2003. Capacity building through multi-disciplinary research: a report from Sri Lanka. *Br J Psychiatry,* 183**,** 457-8.

THAMARANGSI, T. 2013. Addiction research centres and the nurturing of creativity: Center for Alcohol Studies (CAS), Thailand. *Addiction,* 108**,** 1201-6.

THATTE, U. M. & BAVDEKAR, S. B. 2008. Clinical research in India: great expectations? *J Postgrad Med,* 54**,** 318-23.

THORNICROFT, G., COOPER, S., BORTEL, T. V., KAKUMA, R. & LUND, C. 2012. Capacity building in global mental health research. *Harv Rev Psychiatry,* 20**,** 13-24.

TIERNEY, W. M., NYANDIKO, W. N., SIIKA, A. M., WOOLS-KALOUSTIAN, K., SIDLE, J. E., KIPLAGAT, J., BELL, A. & INUI, T. S. 2013. "These are Good Problems to Have...": Establishing a Collaborative Research Partnership in East Africa. *J Gen Intern Med*.

TSAI, S. L. 2000. Nurses' participation and utilization of research in the Republic of China. *Int J Nurs Stud,* 37**,** 435-44.

TUGWELL, P., SITTHI-AMORN, C., HATCHER-ROBERTS, J., NEUFELD, V., MAKARA, P., MUNOZ, F., CZERNY, P., ROBINSON, V., NUYENS, Y. & OKELLO, D. 2006. Health Research Profile to assess the capacity of low and middle income countries for equity-oriented research. *BMC Public Health,* 6**,** 151.

UTHMAN, O. A. 2008. Performance, priorities, and future of biomedical research publications in Africa: Need for networks between scientists in developed and developing countries. *Pan Afr Med J,* 1**,** 5.

VAMADEVAN, A. S., SHAH, B. R., CALIFF, R. M. & PRABHAKARAN, D. 2011. Cardiovascular research in India: a perspective. *Am Heart J,* 161**,** 431-8.

VAN HELDEN, P. 2012. The cost of research in developing countries. *EMBO Rep,* 13**,** 395.

VAN ROYEN, K., LACHAT, C., HOLDSWORTH, M., SMIT, K., KINABO, J., ROBERFROID, D., NAGO, E., GARIMOI ORACH, C. & KOLSTEREN, P. 2013. How can the operating environment for nutrition research be improved in sub-saharan Africa? The views of african researchers. *PLoS One,* 8**,** e66355.

VARKEVISSER, C. M., MWALUKO, G. M. & LE GRAND, A. 2001. Research in action: the training approach of the Joint Health Systems Research Project for the Southern African Region. *Health Policy Plan,* 16**,** 281-91.

VASQUEZ, E., HIRSCH, J., GIANG, L. & PARKER, R. 2013. Rethinking health research capacity strengthening. *Global Public Health*.

VOGEL, I. 2011. Research Capacity Strengthening: Learning from Experience. *In:* (UKCDS), U. C. O. D. S. (ed.). UK Collaborative on Development Sciences (UKCDS).

VOLMINK, J. & DARE, L. 2005. Addressing inequalities in research capacity in Africa. *BMJ,* 331**,** 705-6.

WERTHEIM, H. F., PUTHAVATHANA, P., NGHIEM, N. M., VAN DOORN, H. R., NGUYEN, T. V., PHAM, H. V., SUBEKTI, D., HARUN, S., MALIK, S., ROBINSON, J., RAHMAN, M., TAYLOR, W., LINDEGARDH, N., WIGNALL, S., FARRAR, J. J. & DE JONG, M. D. 2010. Laboratory capacity building in Asia for infectious disease research: experiences from the South East Asia Infectious Disease Clinical Research Network (SEAICRN). *PLoS Med,* 7**,** e1000231.

WHITE, F. 2002. Capacity-building for health research in developing countries: a manager's approach. *Rev Panam Salud Publica,* 12**,** 165-72.

WHITE, M. T. 2007. A right to benefit from international research: a new approach to capacity building in less-developed countries. *Account Res,* 14**,** 73-92.

WHITE, N. W. 2004. Capacity building for research: report on a UNION Strategic Planning Workshop. Report of a workshop held during the International Union

Against Tuberculosis and Lung Disease World Conference on Lung Health, Montreal, Canada, 7 October 2002. *Int J Tuberc Lung Dis,* 8**,** 910-4.

WHITWORTH, J., SEWANKAMBO, N. K. & SNEWIN, V. A. 2010. Improving implementation: building research capacity in maternal, neonatal, and child health in Africa. *PLoS Med,* 7**,** e1000299.

WILLCOX, M., SIEGFRIED, N. & JOHNSON, Q. 2012. Capacity for clinical research on herbal medicines in Africa. *J Altern Complement Med,* 18**,** 622-8.

WILLIAMS, J. R., SCHATZ, E. J., CLARK, B. D., COLLINSON, M. A., CLARK, S. J., MENKEN, J., KAHN, K. & TOLLMAN, S. M. 2010. Improving public health training and research capacity in Africa: a replicable model for linking training to health and socio-demographic surveillance data. *Glob Health Action,* 3.

WORLD HEALTH ORGANISATION 2002. National Health Research Systems. Report of an international workshop, Cha-am, Thailand, 12–15 March 2001. Geneva: World Health Organisation.

WORLD HEALTH ORGANISATION 2004. World report on knowledge for better health: strengthening health systems. Geneva: World Health Organisation.

WORLD HEALTH ORGANISATION 2005. Ministerial Summit on Health Research (2004: Mexico City, Mexico). *In:* REPORT FROM THE MINISTERIAL SUMMIT ON HEALTH RESEARCH: IDENTIFY CHALLENGES, I. A., CORRECT INEQUITIES. (ed.). Geneva: World Health Organisation.

WORLD HEALTH ORGANISATION 2009. Scaling up research and learning for health systems: now is the time. *In:* REPORT OF A HIGH LEVEL TASK FORCE, P. A. E. A. T. G. M. F. O. R. F. H., BAMAKO, MALI (ed.). Geneva: World Health Organisation.

WORLD HEALTH ORGANISATION 2012. The WHO strategy on research for health. Geneva: World Health Organisation.

WRIGHT MDA, G., CAUFIELD, C., GRAY, G. & OLSON, J. 2005. International Research Capacity-Building Programs for Nurses to Study the Drug Phenomenon in Latin America: challenges and perspectives. *Rev Lat Am Enfermagem,* 13 Spec No**,** 1095-101.

YUSUF, S. 2002. Clinical research and trials in developing countries. *Stat Med,* 21**,** 2859-67.

ZACHARIAH, R., HARRIES, A. D., ISHIKAWA, N., RIEDER, H. L., BISSELL, K., LASERSON, K., MASSAQUOI, M., VAN HERP, M. & REID, T. 2009. Operational research in low-income countries: what, why, and how? *Lancet Infect Dis,* 9**,** 711-7.

ZACHARIAH, R., REID, T., SRINATH, S., CHAKAYA, J., LEGINS, K., KARUNAKARA, U. & HARRIES, A. D. 2011. Building leadership capacity and future leaders in operational research in low-income countries: why and how? *Int J Tuberc Lung Dis,* 15**,** 1426-35, i.

ZAIN, R. B., GHANI, W. M., RAZAK, I. A., LATIFAH, R. J., SAMSUDDIN, A. R., CHEONG, S. C., ABDULLAH, N., ISMAIL, A. R., HUSSAINI, H. B., TALIB, N. A. & JALLALUDIN, A. 2009. Building partnership in oral cancer research in a developing country: processes and barriers. *Asian Pac J Cancer Prev,* 10**,** 513-8.

ZHOU, X. N., WAYLING, S. & BERGQUIST, R. 2010. Concepts in research capabilities strengthening positive experiences of network approaches by TDR in the People's Republic of China and Eastern Asia. *Adv Parasitol,* 73**,** 1-19.

ZICKER, F. 2001. Strengthening capability for malaria research in Africa. *Emerg Infect Dis,* 7**,** 529-30.

ZUMLA, A., HUGGETT, J., DHEDA, K., GREEN, C., KAPATA, N. & MWABA, P. 2010. Trials and tribulations of an African-led research and capacity development programme: the case for EDCTP investments. *Trop Med Int Health,* 15**,** 489-94.

Supplementary file S2: Key terminology and definitions used in this synthesis

Term	Definition adopted	Examples	Comments and caveats
Health research capacity development (HRCD)	"Capacity development is defined as the ability of individuals, organisations or systems to perform appropriate functions effectively, efficiently and in a sustainable manner. When applied to health research, this translates to enabling both individuals and institutions to define health problems, set objectives and priorities, build sustainable institutions and organisations and identify solutions to key national health problems". [1]	Conducted by a large numbers of actors including: private foundations, multi and bi-lateral funders, international organisations, consortia, research councils, universities, NGOs and Industry. Examples include Rockefeller Foundation, The Swedish International Development Agency and WHO TDR. Usually involves knowledge or resource transfer at individual, institutional or macro levels.	This definition by Magwaza et al. [1] was found to be the most straightforward and encompassing definition of health research capacity development. Although the term "capacity development" has some pejorative connotations (assumption that there is little extant capacity), in its broadest sense capacity development could involve both building new capacity and strengthening existing capacity. It also semantically links capacity development to the international development agenda.
Research system	Concept representing a system designed to coordinate and manage health research at all stages of the knowledge cycle with the goal of improving health and health equity. The research system can be conceptualised as the environment or ecosystem that research takes place in [2].	Research systems encompass health research structures, regulations, governance, ethics, infrastructure, priority setting, financial and resource planning, acquisition and allocation at national, regional or global levels [3]. They include and connect all other levels, including the supra-national level.	Research system is not to be confused with "System Level". "System Level" is sometimes used to describe the "Macro Level".
Development modality	Modality refers to the methods or organisational setup used to deliver development interventions	May include basket funding to institutions, vertical support to projects, or horizontal capacity development, collaboration or partnerships [4].	Similar to research model. Modality is distinct from "strategy" which more specifically describes the development intervention.
Development strategy	Strategy refers to the selection and deployment of interventions aimed at resolving specific development barriers	Strategies can focussed at the individual, institutional, or macro level. Examples include training fellowships, building laboratories, or creating knowledge development platforms.	Modality is distinct from "strategy" which more specifically describes the development intervention.
Macro level capacity	The highest level of the national research system. Capacities at this level may be agenda setting, policies, national budgetary allocations, demand creation and strategic planning [5].	Government ministries such as Ministry of Health, Research or Education. Also includes regulatory and ethics bodies, funding bodies, top level administrative structures, professional associations and national registries.	Often used interchangeably with "System Level" [5]. However, this is confusing because the system encompasses individual, institutional, macro and supra-national levels.
Institutional	Refers to the ability of institutions to	Elements of institutions include: human	Based on the working definitions used by The

level capacity	fund, manage and sustain themselves to perform all tasks required to deliver their services or goals. Common institutions include: universities, hospitals, and ministerial departments.	resources, material resources (computers and machinery), infrastructure (libraries and laboratories), service connections (internet, water, and power), service delivery and finance and management systems.	Global Forum for Health Research and the World Health Organisation as they encompass the most common conceptualisations of the term [2, 5-7].
Organisational level capacity	The capacities of individual units within and governed by "institutions".	Usually include departments or research units within universities or research divisions within ministries of health	The term "institution" is often used interchangeably with "organisation". However, differentiating between these terms is useful because it distinguishes between the wider governing institution and organisational units within institutions [8].
Individual level capacity	Individual capacity development attempts to increase the capacities of individuals to perform their work effectively	Traditionally focused on producers of research. More recently extended to other stakeholders and includes "soft" skills training such as leadership.	Based on commonly accepted definitions used by The Global Forum for Health Research and the World Health Organisation [2, 5-7].

References

1. Magwaza S, Mathambo V, Magongo B, Mvo E, Makhanya N. Health research Capacity Building in South Africa: Current knowledge and practices. Durban: Health Systems Trust; 2003.

2. World Health Organisation. World report on knowledge for better health: strengthening health systems. Geneva: World Health Organisation; 2004.

3. Chanda-Kapata P, Campbell S, Zarowsky C. Developing a national health research system: participatory approaches to legislative, institutional and networking dimensions in Zambia. Health Res Policy Syst. 2012;10:17. Epub 2012/06/08. doi: 10.1186/1478-4505-10-17. PubMed PMID: 22672331; PubMed Central PMCID: PMC3463500.

4. Jones N, Bailey M, Lyytikainen M. Research capacity strengthening in Africa: Trends, gaps and opportunities. In: Institute OD, editor. London: Overseas Development Institute; 2007.

5. Nuyens Y. No Development Without Research. Geneva: Global Forum for Health Research; 2005.

6. Global Forum for Health Research. The 10/90 report on health research 2000. In: Research GFfH, editor. Geneva: Global Forum for Health Research; 2000.

7. World Health Organisation. National Health Research Systems. Report of an international workshop, Cha-am, Thailand, 12–15 March 2001. Geneva: World Health Organisation; 2002.

8. DFID. Capacity Building in Research. In: Development DfI, editor. 2010.

Supplementary file S3: Typology of capacity development actors

Actor	Examples	History	Roles	Development strategies	Research focus
Private foundations or charities	Wellcome Trust, Gates Foundation, Rockefeller Foundation	Most are relatively new to HRCD but some well-established	Funding	Mostly individual-level development to undertake specific projects. Little investment in local institutions.	Mostly support research generation but recent moves to translation
Multi-lateral agencies	World Health Organisation, World Bank, African Development Bank, Global Fund	WHO TDR & HRP are some of the oldest actors in HRCD. Most relatively new to HRCD.	Governance, stewardship, agenda setting, advocacy & funding	Usually channel funds through independent or subsidiary organisations. WHO offers individual-level development. Traditionally did not support institutions & had little system interest. However, now taking the lead in system approaches & may channel funds though local institutions.	Typically support research generation but increasing emphasis on translation, & dissemination
Bilateral agencies	Swedish International Development Agency, Department for International Development	Generally the longest running financial supporters of HRCD, but some are newer.	Varied	Usually support individual & institutional development. Little system development until very recently.	Historical focus on knowledge generation but progressively more emphasis on knowledge utilisation & dissemination
Global organisations	Global Forum for Health Research, European & Developing Countries Clinical Trial Partnership	Mostly since mid-1990s but some older. Often formed by, or as, a subsidiary of multi-laterals.	Stewardship roles set & promote global agendas. Also have multi-lateral funding brokerage roles.	Act as a catalyst to support & direct diverse actors to common goals. Usually fund & work with networks & consortia. Organise forums. Historically supported individual & institutional development but now support HRCD at most levels & modes. Provide advice & strong advocacy roles.	Originally interested in knowledge generation & translation but now tackle all stages of knowledge cycle
Consortia & networks	Alliance for Health Policy & Systems Research, International Network for Clinical Epidemiology, Central African Network on TB HIV/AIDS & Malaria	Largely a recent phenomenon forming mid-late 1990s onwards	Development, advocacy or funding brokerage roles Global, regional or local reach.	Individual & institutional support for specific projects or organisations that are thematically focussed. Not traditionally institution-wide or system development but recently more attention to those areas. Mixture of horizontal & vertical initiatives.	Collectively they cover the entire knowledge cycle but most have specific focus.
Public private partnerships & product development partnerships	Medicines for Malaria Venture, International AIDS Vaccine Initiative, Global Alliance for TB Drug Development	Largely a recent phenomenon forming mid-late 1990s onwards. Over 70 formed between 1995 & 2003.	Thematically based on disease or intervention of interest. Product development "upstream" R&D research.	Development approaches usually concentrated on building capacity to run specific studies through vertical interventions. Recently a little more attention to individual level & infrastructure development.	Knowledge generation & strong emphasis on translation

LMIC research councils & institutes of health	South African Medical Research Council, The National Research Council of Sri Lanka	Much less common than in HICs but increasing & some well-established.	Varies widely but usually in accordance with national priorities & focus on specific conditions or projects.	Funding is often limited but appears to be increasing. Formation of research sites, particularly centres of excellence. Individual & institutional development. Often in collaboration with international networks. Early moves towards system development. May also carry out own research.	Mostly knowledge generation
LMIC Governments	South Africa, Brazil, Zambia	Highly variable often according to GDP but also economic policies. Some investing a lot, others not at all. Typically only recent investments in HRCD.	Variable but usually in accordance with national priorities. May be linked to infrastructure development.	Some ministries have their own research centres & develop capacity "in house". Others provide project grants or individual development. Governments may upgrade or create research institutions. Investment value typically small due to resource constraints or low priority of research. However, some countries investing heavily. More recent attention to macro level capacities.	Varied. Knowledge generation common but recently agenda setting, stewardship, demand creation & knowledge utilisation
LMIC academic & healthcare institutions	University of KwaZulu-Natal, Makerere University, Fundação Oswaldo Cruz	Varied history. Some very well established in research but most new to HRCD. May be public or private.	Variable. Research may be in accordance with national or global priorities, or investigator interest.	Mainly undergraduate & some graduate training. Provide institutional resources for research. Development of institutions usually reliant on governmental funds, unless private. Normally training & education takes precedence over research.	Knowledge generation
HIC research councils & institutes of health	Medical Research Council (UK), NIH (USA), Canadian Institutes for Health Research, Royal Society	Institutions with a long history but only recently (around 2000) expanding their role in HRCD	Varied. But no specific remit to conduct capacity development.	Provide various funding & scholarships for individuals to undertake post graduate training. Also fund specific research projects which may include institutional development. Normally work in collaboration with institutions from donor country. Usually not system level. Some encourage scientific excellence by forming links with other LMIC societies, but do not conduct HRCD directly.	May conduct research themselves. Mostly support knowledge generation but may have smaller investments in knowledge utilisation.
HIC academic & healthcare institutions	University of Oxford, Institut Pasteur, Johns Hopkins University	A long history of research in LMICs. Some project specific HRCD but only recently taking on more explicit capacity development.	Project focused around research goals. Mostly investigator-led but may follow national priorities.	Development is usually to facilitate a specific project. May involve developing research sites & staff. Often focus on centres of excellence. Individual development either in-country or at HIC universities. System development not common. Normally in partnership with local groups which increases knowledge transfer.	Mostly knowledge generation. Specific projects may target knowledge utilisation & sometimes dissemination but much rarer.

Industry	GlaxoSmithKline, IBM, local industries	Pharmaceutical companies important but IT companies increasingly involved. International & national industry involved.	Product development & innovation technologies. Mostly in Asia. Currently less reach to Africa.	Develop capacity through technology or "know how" transfer. Infrastructure strengthening, particularly IT. May fund individual training or institutional development. May also provide services at favourable rate or free. Usually work in partnership with other actors.	Knowledge generation & translation but also knowledge management. May work in other areas depending on company.
Non-governmental organisations (NGO)	Medicine Sans Frontiers, Drugs for Neglected Diseases Initiative, One World Health, local NGOS	Recent involvement in research & HRCD (post 2005)	Either highly applied research or product development R&D. Some work in partnerships with other actors.	Strengthen research within networks or embedded in health delivery. Usually individual or specialised institutional support. As part of civil society, have strong advocacy & moderation roles. Can mobilise resources towards non-profit activities	All stages of knowledge cycle.
Academic journals	International Committee of Medical Journal Editors, Lancet, PLOS, Tanzanian Journal of Health Research	Long history of discussion on HRCD but becoming increasingly prominent in last 5 years.	Advocacy & opinion leaders. Role as moderators & amplifiers. Provide access to information & publishing.	Improve access to information & enable individuals to publish by changing publication & subscription policies. Promoting best practice & improving quality & reliability of publications. Encourage debate & advocate.	Knowledge dissemination

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Page 1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	Pages 2-3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	Pages 5-6
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	Page 6 (end)
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	No formal protocol exists
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Section 2.1, page 7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	Section 2.2., pages 7
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Box 1, page 8
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	Sections 2.2 & 2.3, pages 7. Also figure 1.
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	Section 2.4, pages 9
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Section 2.4, pages 9.
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	Section 2.3. Page 8
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	Section 2.4,

PRISMA 2009 Checklist

			pages 9
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	Section 2.4, pages 9

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	Section 4.4., pages 27, and section 3.6, pages 22
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	NA
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Section 2.2., Pages 7. Figure 1.
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Section 3.2, pages 11. Table 2.
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	NA – See section 2.3, page 8.
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	NA
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Sections 3.3. and 3.4, pages

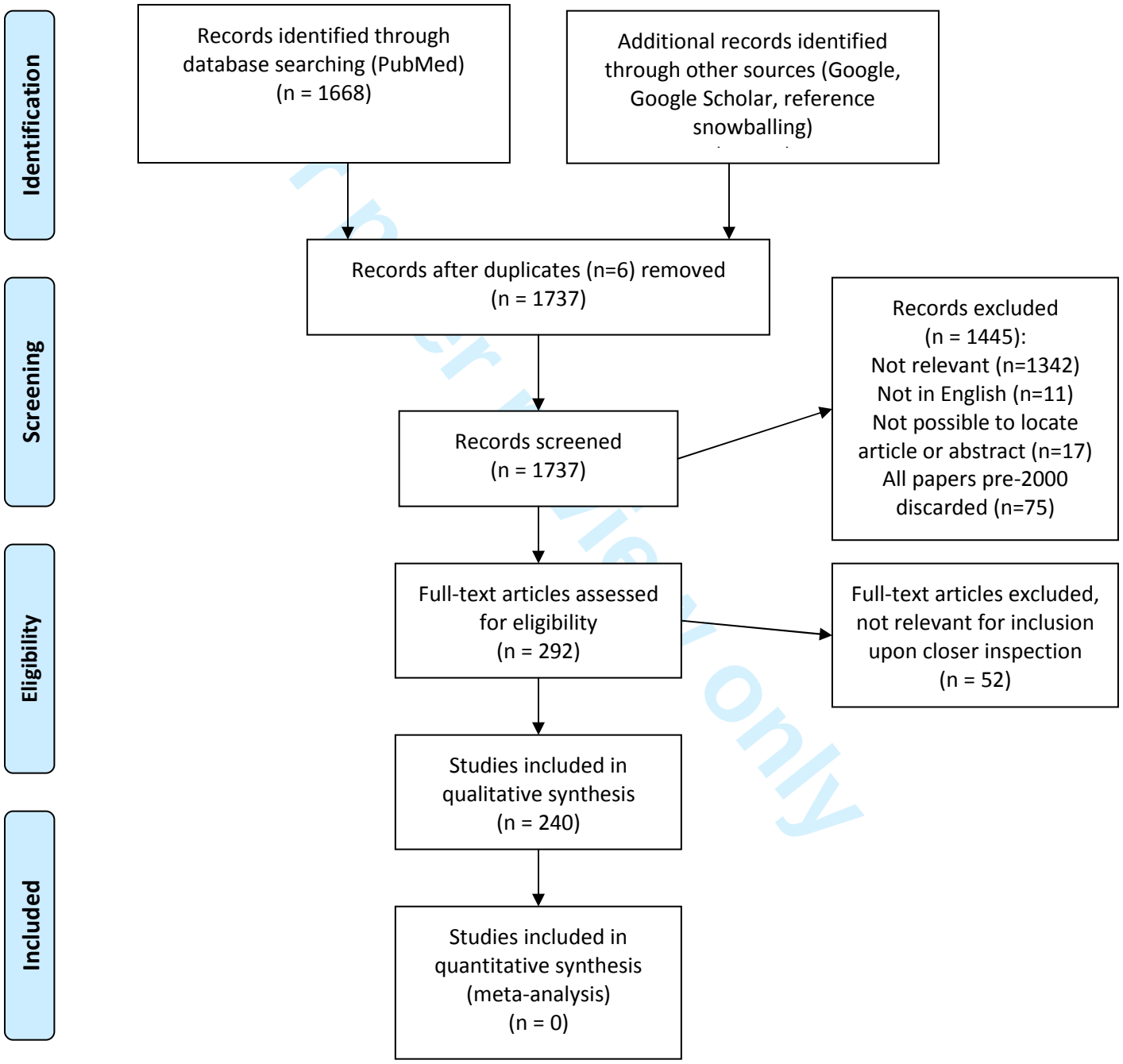
PRISMA 2009 Checklist

			12-22
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	NA – See section 2.3, page 8.
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	NA
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	Section 4.1, page 25, and 4.3 pages 27
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	Section 4.4, pages 28-29
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	Sections 4.2 pages 27 & 4.5 page 28
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	Funding statement, page 29

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

PRISMA 2009 Flow Diagram: Health research capacity development in Low and Middle Income Countries: reality or rhetoric? A systematic meta-narrative review of the qualitative literature



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit www.prisma-statement.org.

BMJ Open

Health research capacity development in Low and Middle Income Countries: reality or rhetoric? A systematic meta-narrative review of the qualitative literature

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2016-012332.R1
Article Type:	Research
Date Submitted by the Author:	25-Aug-2016
Complete List of Authors:	Franzen, Samuel; Oxford Policy Management; University of Oxford, The Global Health Network, Centre for Tropical Medicine and Global Health Chandler, Clare; London School of Hygiene & Tropical Medicine, Global Health and Development Lang, Trudie; University of Oxford, The Global Health Network, Centre for Tropical Medicine and Global Health
Primary Subject Heading:	Global health
Secondary Subject Heading:	Evidence based practice, Qualitative research, Research methods
Keywords:	QUALITATIVE RESEARCH, TROPICAL MEDICINE, EDUCATION & TRAINING (see Medical Education & Training)

Title

Health research capacity development in Low and Middle Income Countries: reality or rhetoric? A systematic meta-narrative review of the qualitative literature

Authors

Dr Samuel R P Franzen[1,2], Dr Clare Chandler[3], Prof Trudie Lang[1]

Corresponding author's address

Samuel R P Franzen, Oxford Policy Management, The Clarendon Centre, 52 Cornmarket Street, Oxford, OX1 3HJ, United Kingdom; Email: sam.franzen@opml.co.uk; Telephone: +44 (0)1865 410 846

Affiliations

1 The Global Health Network, Centre for Tropical Medicine and Global Health, University of Oxford, Oxford, UK.

2 Oxford Policy Management, Oxford, UK.

3 Department of Global Health and Development, London School of Hygiene & Tropical Medicine, London W, UK.

Key words

Health Research, Capacity Development, Low and Middle Income Countries, Research Systems, Clinical Trials

Word count

5653

Abstract

Objectives: Locally-led health research in Low and Middle Income Countries (LMIC) is critical for overcoming global health challenges. Yet, despite over 25 years of international efforts, health research capacity in LMICs remains insufficient and development attempts continue to be fragmented. The aim of this systematic review is to identify and critically examine the main approaches and trends in health research capacity development and consolidate key thinking to identify a more coherent approach.

Methods: This review includes academic and grey literature published between Jan 2000 and July 2013. Using a predetermined search strategy, we systematically searched PubMed, hand-searched Google Scholar, and checked reference lists. This process yielded 1668 papers. 240 papers were selected based on a priori criteria. A modified version of meta-narrative synthesis was used to analyse the papers.

Results: Three key narratives were identified: the effect of power relations on capacity development; demand for stronger links between research, policy, and practice; and the importance of a systems approach. Capacity development was delivered through 4 main modalities: vertical research projects, centres of excellence, North-South partnerships, and networks; all were controversial and each had their strengths and weaknesses. A plurality of development strategies was employed to address specific barriers to health research. However, lack of empirical research and monitoring and evaluation meant that their effectiveness was unclear and learning was weak.

Conclusions: There has been steady progress in LMIC health research capacity but major barriers to research persist and more empirical evidence on development strategies is required. Despite an evolution in development thinking, international actors continue to use outdated development models that are recognised as ineffective. To realise newer development thinking, research capacity outcomes need to be equally valued as research

outputs. While some development actors are now adopting this dedicated capacity development approach, they are in the minority.

Strengths and limitations of this study

- This systematic review goes beyond previous attempts that lacked reflexivity, to provide a nuanced, in-depth, and enquiring critique of health research capacity development approaches.

- This review integrates diverse qualitative literature that largely lacked formal reporting procedures or empirical base, allowing the inclusion of voices that are traditionally excluded in other styles of systematic analyses.

- Some academic articles may have been missed because PubMed was the only formal database used, and there was limited inclusion of evaluation and programme-level data due to poor grey literature indexing in Google and Google Scholar.

- However, the meta-narrative method aims to develop overarching narratives through saturation of themes, rather than include every eligible article, so inclusion of additional papers would be unlikely to change the findings of the study.

1 Introduction

Locally-led health research is critical for overcoming global health challenges in Low and Middle Income Countries (LMICs) [1]. This research is needed to "propose culturally apt and cost-effective individual and collective interventions, to investigate their implementation, and to explore the obstacles that prevent recommended strategies from being implemented" [2]. Such research is now the focus of key capacity development efforts, such as the regional educational centres supported by the Special Programme for Research and Training in Tropical Diseases (TDR) [3].

However, these arguments are not new; the importance of LMIC research capacity has been recognised for well over two decades. The 1990 Commission on Health Research for Development stated that strengthening research capacity in LMICs is "one of the most powerful, cost-effective, and sustainable means of advancing health and development" [4]. This marked the beginning of a "revolution" in health research [5] where there was a surge of investment and concerted effort to conduct health research aimed at solving health problems in LMICs [6].

Nevertheless, at the turn of the millennium LMICs accounted for 85% of the world's population, 92% of the global disease burden, but only 10% of global funding for health research was devoted to addressing these persistent health challenges [6]. Recognition of this "10/90" gap led to renewed calls for health research capacity development in LMICs and further investment [5].

Yet nearly 15 years later, many LMICs still lack sufficient health research capacity to build a local evidence-base with which to inform policy and improve population health. This was recently and profoundly described in The 2013 World Health Report which argued that "all nations should be producers and users of research as well as consumers", noting that this was not yet the case [1].

Therefore, despite years of international collaborations and investment, development of LMIC nation's capacity to address their own health problems appears enduringly problematic. Where there has been progress, such gains often do not appear sustainable without continued strong foreign support [7, 8], which is itself questionable in light of recent austerity and bilateral aid agency restructuring [1, 9, 10].

Although there is a large and diverse body of literature on health research capacity development, it remains confusing, controversial, and poorly defined, with various contradictory understandings [11] and conceptualisations [1]. Since capacity development is now something that most research actors are expected to participate in, or at least be knowledgeable on [5, 12], this is problematic. To increase the likelihood of future capacity development efforts being effective, there is a need to take stock of past experiences and learn from successes and failures. Such an exercise would not only provide a unifying picture to appraise previous capacity development efforts, but also encourage discussion and reflection that could lead to fresh thinking.

The aim of this systematic review is to identify and critically examine the main approaches, strategies, and trends in health research capacity development and consolidate key thinking in order to identify a more coherent approach. This review should prove useful to all stakeholders interested in learning how to undertake the complex business of capacity development, and will be of particular interest to actors working to make locally-led and sustainable health research capacity in LMICs a reality.

2 Methods

Our systematic review followed the 6 stages of the meta-narrative methodology developed by Greenhalgh *et al* [13]. The meta-narrative method is a "systematic, theory-driven interpretative technique, which [was] developed to help make sense of heterogeneous evidence about complex interventions applied in diverse contexts in a way that informs policy" [14]. Since the Health Research Capacity Development (HRCD) literature shares these characteristics, the meta-narrative method was highly suited to the purposes of this study.

2.1 Inclusion criteria

This review considers the perspectives of all actors involved in HRCD that have published within academic and grey literature from the year 2000 onwards. We included any papers that broadly discussed HRCD or its more specific components. Papers that mentioned HRCD but did not discuss the issue further were not included. Non-English language publications were excluded due to lack of resources for translation. Papers published before the year 2000 were initially included, but after screening it became clear that paradigm shifts in global health at the turn of the millennium [5, 6] meant that much of their content was not relevant to current day. Furthermore, many papers published post 2000 effectively summarised historically important issues. Therefore, all papers published pre-2000 were excluded.

2.2 Search strategy and study selection

The search and study selection process is presented in Figure 1. We searched PubMed using the search terms presented in Box 1 for all papers published up to 20 June 2013. This search yielded 1668 potentially relevant papers. The titles and abstracts of these papers were then screened for eligibility, resulting in 1376 papers being excluded

based on pre-screening, with an additional 75 papers excluded after it was decided that papers published before 1 January 2000 should not be included.

Fig 1: Search and study selection process

Box 1: Search terms used in PubMed search

((((((((((((((((capacity building[MeSH Terms]) OR ((("developing"[Title/Abstract]) OR "develop"[Title/Abstract]) OR "capacity"[Title/Abstract]))))) OR "strengthen"[Title/Abstract]) OR "strengthening"[Title/Abstract])) AND ((((developing country[MeSH Terms]) OR Africa) OR Asia) OR Latin America))) AND ((("trial"[Title]) OR "trials"[Title]) OR "research"[Title])))) NOT clinical trial[Publication Type]) NOT informed consent[MeSH Terms]) NOT waste management[MeSH Terms]) NOT air pollution[MeSH Terms]) NOT agriculture[MeSH Terms]) NOT ("Na6(H2O)8(ZnAsO4)6" [Supplementary Concept] OR "K3Zn4O(AsO4)3" [Supplementary Concept])

The PubMed search was complemented by a search of Google and Google Scholar using the terms “Health AND research AND capacity AND strengthening OR Building OR Development”. All literature added from Google were found in the first 10 pages (n=30). After the first 10 pages, no search results were relevant to the study. Literature collections of the authors and other experts were also hand searched and references snowballed (n=45). A total of 292 papers were read in full and considered for eligibility. Based on this screening, the final synthesis involved 240 papers. The full list of papers included in this review can be found in supplementary file S1.

Relevant papers published between June 20 2013 and December 14 2014 were scanned and read to determine if the synthesis findings were still valid post-search. Although there were some pertinent new articles, their content would not have changed the findings of this synthesis.

2.3 Quality assessment

No papers were excluded based on assessment of quality because the majority of papers lacked an empirical or explicit study design, and all stakeholders' views regardless of their perceived validity were considered important. Furthermore, capacity development discussion is inherently political and most contributions are based on personal opinion informed by theoretical, ethical, or experiential standpoint. Accordingly much of it is biased. Rather than attempt to remove the bias, assumptions and motivations were explicitly studied to undercover authors' implicit logic, so that readers can make their own informed opinion.

Instead of using quality criteria, similarity of arguments within the literature was used as an indicator of current agreement on a topic or popularity of an idea. This allowed a comprehensive analysis of all the HRCD narratives, while still highlighting and giving emphasis to the most widely accepted opinions.

2.4 Data extraction and synthesis

To synthesise the literature, papers need to be framed within a "storyline" that recognises where the contribution came from [13]. *Greenhalgh et al.'s* method explicitly catalogues these storylines as "meta-narratives" [13]. Developing meta-narratives provides context to contributions whose underlying assumptions and interests would otherwise be opaque. Although less prescribed than a quantitative systematic review, this approach pragmatically allows a plurality of ideas, recognising there may be no single correct answer.

To ensure that source content was interpreted alongside its context, even when broken into themes and narratives, a tagging system was used instead of a traditional extraction form. All sources were organised in EndNote X7 (Thomson Reuters) and associated citations, metadata and PDF copies of the documents were attached. These

data were then imported into Nvivo 9 qualitative analysis software (QSR International) where the sources were given tags using deductive codes for key characteristics.

Meta-narratives were then identified inductively by reading each paper and coding for meta-narratives where several authors in the literature discussed and presented topics similarly. This is an interpretive approach similar to that used in thematic coding analysis, where reoccurring themes that are conceptually related are grouped into concepts. Once the meta-narratives had been finalised they were systematically applied to all relevant papers. No prior theory beyond the guidance presented by Greenhalgh *et al.* [13] was explicitly used to help identify and categorise the meta-narratives. Instead, iterative rounds of open data-driven inductive coding were used.

2.5 Role and position of the authors

This systematic review was undertaken, in part, to inform the design of a larger body of empirical research on health research capacity development in LMICs. All authors have backgrounds in social science and global health. Initial coding was conducted by Samuel Franzen, and then refined based on face-to-face discussions with other authors around the coding framework and preliminary findings. The authors of this paper do not include individuals from LMICs, but this paper was reviewed and commented on by individuals from LMICs who collaborated on and participated in the parallel empirical research, and discussed with other relevant experts at meetings and conferences. These team processes represent a deviation from the meta-narrative method presented by Greenhalgh *et al.* [13] because the authors did not constitute a multi-disciplinary team and input from external peers was largely ad hoc, rather than through regular planned inputs. These methodological deviations were required to enable the systematic review to feed into the evolving parallel empirical research.

3 Results

3.1 Definitions and actors

The concept of capacity development can be confusing because there are multiple and conflicting terminologies for development activities and actors. To assist the reader, typologies of key definitions and development actors were produced. Supplementary file S2 presents these definitions alongside reasons for adopting them, and supplementary file S3 categorises and provides background to development actors' activities.

3.2 Characteristics of included papers

Table 1 summarises the main characteristics of the papers included in the review. Based on first author characteristics, the greatest number of articles came from LMIC academic and healthcare institutions (31.3%), closely followed by HIC academic and healthcare institutions (29.6%). Contributions from funders were very low (0.8%), and industry and civil society were absent, potentially reflecting the sampling from academic databases. Europe was the greatest contributing region (32.9%) followed by Sub-Saharan Africa at 23.8% and North America at 13.8%. Contributions from Latin America (2.5%), Middle East (1.7%) and North Africa (0.8%) were low. Although most articles were concerned with capacity development across all LMICs (42.1%), Sub-Saharan Africa dominated the regional specific discussions (34.6%). The main basis for viewpoints were opinion, debate or personal perspectives (34.2%); sharing experiences represented 21.7%, and empirical work 20.8%.

Table 1: Characteristics of papers included in this review

Category* of development actor (for first author)	%	Location of first author's institution	%	Region of interest	%	Main topic of development interest	%	Main disease of interest	%	Basis for viewpoint	%
LMIC Academic and Healthcare Institutions	31.3	Europe	32.9	All LMIC countries	42.1	Multiple broad issues discussed	24.6	Not disease specific or address multiple	72.5	Opinion, debate, perspective	34.2
HIC Academic and Healthcare Institutions	29.6	Sub Saharan Africa	23.8	Sub Saharan Africa	34.6	Individual level development	15.8	HIV	6.3	Experience report	21.7
Multi-laterals	10.4	North America	13.8	South Asia	10	Partnerships networking, consortia	15.8	Malaria	5.8	Empirical research	20.8
Consortia & Networks, NGOs and Public-Private Partnerships	8.8	South Asia	10	East Asia	6.7	Operational challenges & opportunities	11.3	Other	4.6	Literature review, summary or synthesis	7.9
Academic Journals	5.4	East Asia	9.2	All Asia	2.9	System approaches and macro level development	9.2	Mental Health and Addiction	2.5	Proceedings or conference report	7.5
LMIC Governmental	4.6	Australia	2.9	Latin America	1.7	Agenda and priority setting	6.3	Maternal Child Health and Paediatrics	2.5	Organisation document	4.6
LMIC Funders, Research Councils and Institutes of Health	4.6	Latin America	2.5	Pacific	0.8	Institution level development	5.4	Tuberculosis	2.1	News report	3.3
Bi-lateral aid agencies	2.1	Not specific	2.1	Middle East	0.8	Monitoring and evaluation	2.9	Non-communicable diseases	2.1		
HIC Research Councils and Institutes of Health	2.1	Middle East	1.7	Central Asia	0.4	Research and development	2.1	Dental or oral health	1.7		
Private Foundations or Charity Funders	0.8	North Africa	0.8			Ethics and regulations	1.7				
Industry	0	Pacific	0.4			Knowledge cycle	0.8				
Civil Society and Media	0										

* Some categories have been merged because they could not be separated

3.3 Meta-narratives in health research capacity development

Three key narratives ran though the literature: the effect of power relations on capacity development; demand for stronger links between research, policy, and practice; and the importance of a systems approach to HRCD. Each narrative is described below with reference to the key papers that discussed these narratives in detail.

3.3.1 Effect of power relations on capacity development

The effect of power relations on capacity development was the most common narrative running through the literature (present in 29% of papers). The main concerns of this topic are that research agendas in LMICs are set more by international funders than by LMIC institutions, and research conducted in LMICs is predominantly led by HIC researchers with little involvement of LMIC individuals or institutions. This is argued to erode national sovereignty [15], prevent capacity development [16, 17], and create research priorities that more closely match funder agendas than countries' needs [18-20] leading to a situation of "he who pays the piper calls the tune" [20, 21]. Examples include "spotlight issues", which receive funding regardless of relative need [22], and "parachute" research where data is collected in LMICs but all other work is conducted in HIC institutions.

"North-South" collaborations between HIC and LMIC research institutions are considered to be better mechanisms for developing research capacity [8], but many authors still thought that they comparatively disadvantage the LMIC partner [9, 12, 15]. The perceived situation of "treating Africa as a repository of raw materials for expatriate-driven research" [9] led to the development of guidelines for research collaboration. To reflect the change in approach, there was a rhetorical shift to using the term "partnership" to describe collaborations that were equitable [17]. These partnerships should be built on mutual trust and shared decision making, national ownership, early planning for translation of research findings and development of national research capacity [17]. Importantly, it is

now expected that all partnerships should have capacity development at their forefront [12]. However, despite discussion for well over a decade, a good proportion of the international community still feels that partnerships are not yet equal [12, 23, 24], and they cannot be until the power divide is addressed [15] because LMICs are unable to negotiate for a fairer deal [15, 25, 26].

In an effort to adjust the power balance there have been conscious efforts towards recognising local research capacity in LMICs [12, 20]. This change is again reflected in rhetoric through the evolution of the term “capacity development” which gradually places stronger emphasis on extant capacity; changing from “capacity building” to “capacity strengthening” [20] to “capacity utilisation” [27], “unleashing” and “releasing” [20]. Many authors now propose that research and capacity development in LMICs should be locally owned and led [17, 20, 28, 29]. This is because LMIC researchers have the best understanding of evidence gaps [17] and can present research to policy makers with an understanding of the political and cultural context which increases the chance of evidence uptake [30, 31]. Locally-led studies are also thought to be better aligned with national agendas [32] and address more applied implementation topics than foreign-led research [17].

Most stakeholders now agree that research and capacity development should, at a minimum, include the local research community in the design and conduct of research studies [33]. Development actors are also advised to be more sensitive to the power dynamics they create and ensure they strengthen, not weaken, the role of national governments by responding specifically to their priorities [20, 29, 34] and including the “recipients” in any agenda setting [35]. However, others argue that this situation will inevitably continue so long as foreign countries are the majority financers of research in LMICs [36]; only through greater national investment and commitment will LMICs have a stronger voice to make relations more equitable [7, 9, 37]. Nevertheless, the vast majority

of development efforts reportedly still focus on international collaborative research meaning local investigator-led studies are largely ignored [38]. This is evidenced by only 3 papers in this review being focussed on supporting locally-led clinical trials, compared to 33 papers aimed at developing international clinical trials.

3.3.2 Demand for stronger links between research, policy and practice

Arguments for stronger links between research, policy and practice were present in 16% of sources. These emerged due to concerns that much research was failing to be translated into policy [25, 39], and was too narrowly conceived and disease-specific to have impact [40].

Accordingly, applied fields now deemed to be highly relevant to decision makers and those that promote sustainable adoption and implementation of evidence based medicine have been called for [30, 41, 42]. These include health policy and systems research [43], health services research [44], implementation research, and operations research [45-47]. These arguments formed the backbone of the WHO strategy on "research for health" which "gives priority to research and innovation that has the greatest potential to improve global health security, accelerate health-related development, redress health inequities and help to attain the Millennium Development Goals" [48] .

Despite these discussions, much research is still regarded as uncoordinated and concentrating on a few high profile diseases [49] such as the "big 3": HIV/AIDS, Malaria and Tuberculosis. Furthermore, the majority of research is critiqued as largely technology development focused, even though many argue that the impact of this research is low [44] and more lives could be saved by improving service delivery of existing interventions [25, 43, 50].

3.3.3 The importance of a systems approach to capacity development

The importance of taking a systems approach to HRCD was discussed in 24% of sources. Conceived in the 1990s and popularized after the Ministerial Summit on Health Research in Mexico in 2004 [25], systems approaches to HRCD emerged in response to perceived failings of capacity development targeted at only one level. Particular weaknesses cited included: lack of provision for trained individuals to use their skills [6] leading to "brain drain" of LMIC researchers to HICs [51, 52]; exclusively focusing on high performing individuals [53] rather than strengthening local institutions to develop researchers [54]; absence of national bodies to coordinate priorities, develop policy, and translate evidence into action [55]; and the fragmentation of capacity development activities [56, 57].

Proponents of systems approaches argue that for capacity development to be effective and sustainable [8, 58], new approaches to addressing all three levels of the national research system are needed; macro, institutional and individual [58] (for definitions of these levels, please see supplementary file 2). Macro-level capacity development should include: priority setting, planning and coordinating research, governance and regulation, and knowledge translation and dissemination [48, 57, 59]. Individual development should include a broader range of stakeholders than just research producers (e.g. policy makers, administrators, medical personnel and ethics board members) and teach a wider variety of skills and disciplines, particularly "soft skills" such as organisation, management and leadership [55]. Institutional development should focus on the ability to generate, retain and utilise individual capacity through improving curricula, training support, mentorship, and research resources [60-62].

Although presented as a complex task with long time frames [63], taking a systems approach is said to result in more dynamic capacity development that produces endogenous change, greater local ownership, and removal of perennial system barriers

[20] which helps countries to effectively target their own health needs [19]. This is in stark contrast to previous approaches that established parallel structures to deliberately bypass local systems because they were deemed to be chronically ineffective [24]. However, despite the accepted importance of research systems development, little is known about how health research systems can be formed [19], there are few successful examples of research system strengthening, and little guidance is available [64].

3.4 A summary of modern health research capacity development modalities

After attempts at aligning human, material and technical capacities failed in the 1980s, research models that directed funds and technology through HIC institutions became the preferred HRCD mechanism [5]. These mechanisms are now the most common approach to HRCD. The justification for requiring LMICs to collaborate with HICs is that knowledge transfer and HIC expertise are required to achieve capacity development [65, 66]. However, others argue that such development models propagate inequities in research and development [17, 36]. Discussions on development modalities are therefore contentious. The following sections summarise the justifications, benefits, drawbacks and controversies of the main development modalities.

3.4.1 Vertical research projects

One of the earliest and most persistent research models arising from the HIC fund channelling mechanism was vertical research projects [5]. This involves a HIC research collaborator working in a LMIC to conduct applied, normally short-term research projects with narrow objectives [54]. The theoretical advantage of a vertical strategy is that it maintains focus on a specific scientific mission [67]. This allows the necessary capacity to be developed more rapidly and can quickly produce research outputs [5] even where major expansion of R&D is required [35]. These approaches now account for the biggest

share of health research funding [58]. Examples include product development partnerships such as The Global Alliance for TB Drug Development, and many commercial or non-commercial clinical trials [68].

HRCD is often included in these programmes, but development of capacity is usually not the primary objective [59]. Rather it is designed to develop capacities that will benefit the successful completion of the project [60] and result in high quality research outputs [54]. Vertical projects often have strong expatriate leadership and are frequently managed by external institutions [54], which is argued to result in parallel structures that bypass local research institutions [69]. Where individual-level development is provided, it is typically short term and project specific [70].

Critics of vertical projects argue that local researchers often only have support roles [16], samples may be shipped abroad for analysis [23] and there can be little investment in local institutions because they are bypassed [15, 69]. Therefore when these short-term projects finish, research sites and individuals are rarely left with the skills or resources to run their own studies [41, 68]. Another criticism is that vertical approaches force the research community to work separately on overlapping issues [71] leading to fragmentation of national research systems [55].

Proponents of vertical interventions are however mindful that there is a trade-off between the speed and quality of research, and capacity development [72]. They argue that in the case of health emergencies, investment should be made in excellent research, not excellent capacity development.

3.4.2 Centres of excellence

A common modality for developing long-term capacity to conduct advanced research in LMICs is “centres of excellence”. These have taken various forms, but the approach generally concentrates investment within a few institutions that show potential to excel and

become high quality self-sustaining sites. These models are reportedly useful because they increase the likelihood of high quality research and renewed investment in an otherwise challenging environment [52, 55, 73].

Early forms of this concept were criticised as being “annexed” research sites, effectively led and managed by expatriate staff [74]. Others argue that they create parallel research structures outside of the national system that further depletes the local resource pool by diverting investment and human resources towards these better funded sites [17, 24, 44]. More recent forms of “centres of excellence”, such as those championed by the European and Developing Countries Clinical Trials Partnership, strive for greater Southern leadership and better integration with local research systems [75].

3.4.3 North-South partnership

Another common development model is North-South partnerships. They are distinct forms of collaboration between HIC and LMIC researchers because unlike “centres of excellence”, they are usually project specific rather than institution building, and they put more emphasis on sustainable research, shared leadership and mutual benefit than vertical research projects. However, depending on the nature of the partnership, these demarcations can become blurred.

Since the millennium, North-South partnerships and have been heavily promoted by organisations such as The Global Forum for Health Research [6] and The European and Developing Countries Clinical Trial Partnership (EDCTP) [75]. Such partnerships are said to be responsible for increasing resource flows to LMICs [31] and have been advocated for: increasing scientific productivity [76], training of graduates, staff exchange and knowledge sharing, exposure to cutting edge technology [52], strengthening local education programmes and moderate levels of institutional strengthening [6, 77, 78]. This is argued to result in more sustainable development [54], greater cost-efficiency and a

broader research scope than exclusively expatriate-led or locally-led research could achieve alone [17, 20].

Despite their popularity, a greater proportion of the literature is dedicated to discussing problems with North-South partnerships than their benefits. Many authors still feel that despite much guidance for entering into partnerships [12, 17, 53, 79, 80], too few benefits are accrued by the Southern partner [9, 12, 23, 24, 81] because they are forced to collaborate with HIC institutions to meet funding requirements [82]. Accordingly, LMIC partners are reported to sometimes receive little financial benefit, go unrecognised in publications, and release intellectual property rights [9, 12]. Proposed amendments to this model have involved adapting partnerships to be driven by LMIC demand [60], led by the Southern partner [20] or supporting more South-South partnerships [28, 83].

3.4.4 Networks and consortia

Networks and consortia development models emerged in the mid-1990s. By the mid-2000s they were used to tackle whole programmes of research [60] and are now very popular with funders [60]. Actors adopting network models are highly diverse and can sometimes be hard to separate from partnership models or vertical programmes. However, they all involve linking multiple research departments, groups or institutions.

Networks are considered advantageous because they encourage less-hierarchical leadership and competitive and individualistic attitudes. They are therefore reportedly useful for working cooperatively on shared problems at regional or global levels [84, 85]. Because networks facilitate information exchange and pooling of resources to achieve a critical mass [86], they are seen as particularly important where groups may be isolated [87] or when one group alone would have insufficient capacity to address an issue [88]. Networks are also thought to: help focus on common research priorities [60, 89]; increase knowledge exchange and speed diffusion of innovations [57, 64]; and help forge long term

relationships [5, 87], and sustainability [37, 86, 90, 91]. However, some authors point out that most networks focus on highly thematic research projects [60] and only develop capacity of individual research groups, not research systems [87].

3.5 Specific development strategies

The reviewed literature contained a multitude of development strategies targeted at all levels of the health research system; macro, institutional and individual. These are presented in Table 2 and grouped according to the barrier that they address. The research barrier groupings were identified by the authors through thematic coding of the literature content. The popularity of the development strategies are indicated as a percentage of the reviewed sources that proposed them as a solution to a health research barrier.

Table 2: Summary of capacity development strategies designed to address specific barriers to health research

Barrier to research	Strategies designed to address barriers to research	Popularity (% of sources)
Fragmented research systems	• Undertake a situational analysis & build on existing assets [28, 29, 57, 92] • Collaboratively develop research agendas with LMIC stakeholders [55, 70, 75] • Create a research coordinating body or scientific councils [29, 64, 93]	Recently gaining popularity (12%)
Insufficient research funding	• Establish a research finance system using innovative revenue generation [52, 94, 95] • Provide long-term funding & flexible grants [8, 63, 96] • Advocate for funding through shared causes & engaging with the media [68, 97]	Growing popularity (21%)
Limited use of research evidence	• Build capacities of policy makers to demand & scrutinise research [25, 84, 98] • Develop evidence repositories & use Research-to-Action-Groups as knowledge brokers to package findings appropriately [39, 99] • Create knowledge translation platforms to support evidence dissemination & dialogue between research producers and users [30, 39, 64, 100]	Consistent popularity (11%)
Limited governance & regulatory capacity	• Work research into a legislative framework [64, 101, 102] • Clarify guidelines, map review capacity, & streamline procedures [74, 103] • Strengthen regulatory & ethical review capacity [42, 64]	Growing popularity (21%)
Insufficient networking	• Develop and share a database of researchers and their expertise [31] • Utilise or develop professional networks, especially web-based communities [42, 104] • Organise conferences & working groups on locally important topics [2, 105]	Very popular (26%)
Inefficient admin & research management	• Train management & research support staff [29, 106] • Set up a research support office to help with grant management, reporting & contracts, & develop information and finance systems [20, 28, 72] • Develop transparent & accountable policies & procedures [69, 107]	Unpopular but increasing (8%)

Inadequate material capacity	• Upgrade libraries & journal availability and invest in laboratories [28, 91, 108] • Improve Information Technology, particularly internet [6, 78] • Ensure stable power & water supplies [108]	Widely recognised (20%)
Insufficient human capacity with research knowledge & skills	• Develop LMIC university research training capacity using "train the trainer" programmes, LMIC-HIC "sandwich" courses, or visiting research fellowships [20, 70, 92, 96, 109-111] • Make research principles & skills key components of undergraduate & continuing professional medical education [37, 70, 112] • Develop a variety of research roles: nurses, data managers, statisticians, laboratory personnel, managers, data collectors [9, 63, 70, 109, 113-115] • Increase distance learning via e-technologies or e-learning resources [26, 41, 70, 116, 117] • Training in major skills gaps: data collection, data management, data analysis & statistics, GCP, laboratory skills, computer literacy & ethics [46, 51, 54, 109, 118] • Training in core capabilities: protocol development, writing for grant applications & publication, grant management & budgeting, & policy dialogue [29, 45, 55, 63, 119]	Extremely popular (41%). Training in core capabilities less popular (15%)
Insufficient practical research experience	• Supplement didactic training with research "learning by doing" opportunities [40, 47, 55] • Involve more LMIC institutional staff in research projects [54] • Exchange visits to advanced research sites to update skills [120] • Pilot or small grants for early stage researchers to gain experience [53, 121]	Fairly accepted (11%)
Too few research leaders	• Develop leadership, project and human resource management skills [8, 72] • Opportunities for junior staff to take responsibility within a supportive environment [20] • In collaborative projects, local staff must be involved in the entire research process [122]	Gaining popularity (13%)
Too few mentors & role models	• Support mentors with long term funded positions & recognition [73, 78] • Where mentoring is not available locally, institutional partnerships/exchanges or peer mentorship can be used [9, 11, 55]	Popular (15%)
Lack of research culture	• Promote academic departmental leaders based on research experience [112] • Set up a departmental committee to promote research [123] • Journal clubs & seminars to develop interest in research & critical thinking [70, 120]	Not popular (6%)
Low motivation to conduct research	• Protected research time & longer term contracts [54, 76] • Re-entry grants or guaranteed jobs to encourage "brain drain" diaspora to return home [109, 110] • Higher salaries or funded research time to off-set private-practice incentives [76, 124]	Popular (18%)

3.6 Reported success and effectiveness of development efforts

Broadly, authors consider capacity to conduct health research in Africa to have increased considerably since the millennium [12] with potential to leverage further gains from current efforts [59]. This is best exemplified by increases in the number of clinical trials conducted in LMICs [103, 125] with reports of enhanced trial capacity [68],

particularly laboratories [126] and quality standards [38, 117, 127], and greater LMIC inclusion [106, 128]. Such institutional strengthening is also thought to have helped reduce brain drain in specific cases [109]. Although some countries still lag behind in regulatory and ethical review capacity, several publications indicate that LMICs have made good progress [108, 129].

The increase in research capacity is thought to have been driven by recognition of the importance of health research over the last 20 years [5], a revised strategic focus [30], and the expansion of networks and partnerships for addressing research needs [60, 67, 91]. However, it is not possible to attribute success to these development approaches due to lack of monitoring and evaluation data; in Africa, positive outcomes in the quality and quantity of published research have been recorded [60, 109, 130], but their connection to development inputs and outputs is not established [131]. Operational research and sharing of on-the-ground experiences is thought to be a useful learning resource, but with the exception of a few examples [42, 132], little published material on operations is thought to exist [133]. This is argued to make it hard to learn from previous efforts and experience [60] and determine why and how successes were achieved [28].

The paucity of monitoring and evaluation data is a recognised problem [5, 58, 60], with authors attributing it to long time-lags to achieve objectives [11], outcomes such as organisational culture being difficult to measure [11], lack of commonly agreed and conceptually robust indicators [59, 60, 102], and most evaluation data not being published [131]. To remedy this situation, guidance on planning and implementing monitoring and evaluation for health research has been developed [29], and one research group provides online resources to help record and share operational guidance [41].

It was also clear from the literature that significant capacity gaps remain in many LMICs. Following the example of clinical trials, authors point out that early phase studies are still lacking [134] and there are too few quality research sites to meet demand [103].

Despite increases in some capacities, translation of findings into policy is considered an enduringly difficult outcome [60, 135] and LMIC leadership and authorship in studies is still thought to be too low [43]. Reportedly insufficient political buy-in for strengthening investment in health research has also raised concerns over the sustainability of capacity development achievements [7, 8]. Some authors argue that longer term projects and planning for sustainability of research staff and services is needed [103], but little literature explores this [63].

4 Discussion

4.1 An evolution in health research capacity development thinking

This literature synthesis has objectively presented the main HRCD modalities and strategies, and shows that some development actors continue to operate research models that are contrary to widely accepted views of best practice e.g. ex-patriate led parallel research units. Nevertheless, the literature reveals that there has been steady progress in health research capacity in LMICs. Development actors have continuously reassessed their approaches and have become much more reflexive of their actions. National stakeholders have taken on a stronger voice and greater ownership, and are generally in a more self-sufficient position.

Overall, development actors now agree that there is no panacea or one-size-fits-all model to HRCD. Instead a plurality of solutions exists, the choice of which should be determined by the specific capacities constraints and research goals of LMIC institutions. However, despite progress, major barriers to health research persist, there is little evidence to support decision-making, and the sustainability of HRCD achievements is questionable.

4.2 Health research capacity development, reality or just rhetoric?

The evolution in HRCD thinking appears promising, but the literature demonstrates that good HRCD practices are not always enacted. While the requirement for short term projects is recognised [5], the vertical model has been the dominant model for almost 20 years [58]. This would indicate that vertical approaches have been used in situations that would be better served by longer term systems strengthening strategies [5]. However, there are far fewer programmes dedicated to implementing systems approaches to capacity development. Other examples include: focusing on a few high profile diseases,

donor-led research agendas, compulsory requirements for collaboration with HICs, setting up parallel structures, and fragmentary competitive research. To make the HRCD rhetoric a reality, there is a need to understand why research models that do not enhance or potentially inhibit locally-led research remain the *modus operandi*, even though there is clear agreement that they are bad practice.

The literature findings clearly and frequently show that the persistence of flawed development strategies is driven by approaching capacity development within the context of a dedicated research model. This creates a trade-off between doing good research and doing good capacity development. Projects prioritising good research place research outputs as the primary goal and assume capacity will be developed through limited LMIC involvement in research activities. This means that specific development strategies designed to improve capacity are not used. This "implicit" capacity development is known to be largely ineffective [63, 72], yet is it regularly used. As a result, local research systems may fail to develop or deteriorate [22], and development efforts are likely to become multiplicative and fragmented [60, 92], despite overlapping interests and generic requirements [104].

The other main alternative is "explicit" capacity development. This refers to research projects that place more priority on capacity development and use specific strategies designed to address capacity gaps. There is wide recognition that this is a superior approach and is more likely to improve capacity sustainably [11, 63]. However, because the research component is usually more valued by the research community, capacity development receives less attention and often focusses on developing project-specific capacities, not addressing systemic deficiencies. Accordingly, the capacity development component often becomes "bolted-on" and *ad hoc* [11, 28]; thus making it "implicit" in disguise.

Instead, the review findings suggest that conducting research to improve health in LMICs, and developing health research capacity in LMICs, must be considered two, sometimes diverging objectives. Recognising this leads to a third way; “dedicated” capacity development. This implies that developing local capacity is as equally valued as the research outputs and should be considered as carefully as the research designs. Due to the additional resources this requires, previous efforts have been limited to individual capacity development or centres of excellence [91]. However, some capacity development actors are now attempting to do this at a more systemic level. Examples include: The Special Programme for Research and Training in Tropical Disease’s (TDR) implementation research programmes [3], ESSENCE on Health Research [136], and The Global Health Network [137].

4.3 Implications for policy and practice

This systematic literature review provides an important synthesis of HRCD that should prove useful for policy makers and practitioners alike. It identifies the strengths, limitations and, controversies of the main development approaches and summarises strategies that can be used to overcome specific research system barriers.

Dedicated capacity development appears to offer the best approach for achieving the WHO’s vision of all nations becoming producers and users of research [1]. However, a key barrier to designing development strategies based on this thinking is the lack of empirical evidence. Without operational and implementation research and quality evaluation data, it is not possible to know the relative effectiveness of different development strategies and difficult to predict if they will be appropriate for a given context. The current experience of sharing data is a good start, but more systematic empirical research is required. This should be done with the same rigorous attention to

methodological design, analysis, and reporting standards as any other research endeavour.

4.4 Study strengths and limitations

Previous reviews of capacity development have lacked sufficient reflexivity and questioning of assumptions implicit in many strategies [40]. This systematic review produced a nuanced and enquiring critique of HRCD approaches in LMICs and has identified dedicated capacity development as a promising strategy for future HRCD efforts. It also integrated diverse qualitative literature that largely lacked formal reporting procedures or empirical base, allowing the inclusion of voices that are traditionally excluded in other styles of systematic analyses.

Some academic articles may have been missed because PubMed was the only formal database used and non-English language articles were excluded. However, the meta-narrative method aims to develop overarching narratives through saturation of themes, rather than include every eligible article, so using additional databases would add little to the study. More problematic was the limited availability and inclusion of programme evaluations and evidence supporting operational learning. While expert opinion and the popularity of development strategies was presented, it was apparent that this is not a reliable indicator of good development practice. Searching Google and Google Scholar, hand searching literature collections, and snowballing references did identify the most seminal papers, but some useful organisational documents will have been missed due to poor grey literature indexing. Furthermore, most articles had a general focus or related only to sub-Saharan Africa, meaning that context and research specific differences could not be examined in detail. The focus of the literature on sub-Saharan Africa is likely due to the high publishing rates of African authors and many papers' disease specific-focus on high burden diseases of sub-Saharan Africa (HIV and Malaria). However, it may also be

possible that the English-language search restriction excluded papers from authors publishing about their region in non-English languages. Regardless, the HRCD evidence gap in other developing regions is notable.

The limited number of authors working on this review reduced the breadth of perspectives involved during analysis which could have biased interpretation towards the authors' particular knowledge paradigms and world views. However, this was mitigated to some extent by drawing on perspectives and experiences from concurrent research collaborators and participants, and seeking feedback from relevant experts at meetings and conferences. While some context-specific differences in experiences were inevitably raised, all individuals who were consulted considered the findings of this study to be relevant and consistent with their broad view of health research capacity development in LMICs. Although it may have been desirable to have a second coder, this would not have necessarily improved the validity of findings through inter-coder reliability comparisons because regardless of the number of coders, the emerging coding scheme and findings would always be subjective. Ensuring quality of interpretation relies, rather, on being transparent in offering explanations of meanings rather than presenting definitive causations, and explicitly acknowledging the subjective nature of the analysis and the bias this creates. These principles were adhered to in the research process and the publication.

4.5 Conclusion

Despite gains in health research capacity and progress in development thinking, further work is needed to develop sustainable health research systems in LMICs. One promising option is dedicated capacity development in which capacity outcomes are as equally valued as research outputs. However, more empirical research is needed to identify the

most effective strategies. If these issues are successfully addressed, health research in all nations could become a reality, rather than just rhetoric.

Funding Statement

This work was supported by a grant from The Bill and Melinda Gates Foundation to Prof Trudie Lang (grant reference: OPP1053843), and in part by a Nuffield Department of Medicine Doctoral Prize Studentship to Dr Samuel Franzen (http://www.ndm.ox.ac.uk/ndm-prize-studentships). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Contributors

SF, CC, and TL conceived and designed the study. SF collected and analysed the data and drafted the manuscript with intellectual input and assistance from CC and TL. All authors approved the final version of the manuscript.

Acknowledgments

The authors would like to thank Professor Sisira Siribaddana and Dr Julius Atashili for their technical advice and intellectual input.

Competing interests

The authors declare that they have no competing interests.

Data sharing statement

No additional data are available.

References

1. Dye C, Boerma T, Evans D, Harries AD, Lienhardt C, McManus J, et al. The World Health Report 2013: Research for universal health coverage. In: Organisation WH, editor. Geneva: World Health Organisation; 2013.
2. Thornicroft G, Cooper S, Bortel TV, Kakuma R, Lund C. Capacity building in global mental health research. Harv Rev Psychiatry. 2012;20(1):13-24. Epub 2012/02/18. doi: 10.3109/10673229.2012.649117. PubMed PMID: 22335179; PubMed Central PMCID: PMC3335140.
3. TDR Special Programme for Research and Training in Tropical Diseases. Seven universities selected to host international postgraduate training scheme. Geneva: World Health Organisation; 2015.
4. The Commission on Health Research for Development. Health Research: Essential Link to Equity in Development. In: Development TCoHRf, editor. New York: Oxford University Press; 1990.
5. Davey S. The 10/90 Report on Health Research 2003-2004. In: Global Forum for Health Research, editor. Geneva, Switzerland: Global Forum for Health Research; 2004.
6. Global Forum for Health Research. The 10/90 report on health research 2000. In: Research GFfH, editor. Geneva: Global Forum for Health Research; 2000.
7. Gulland A. Plan to stimulate research in developing countries is put on hold. BMJ. 2012;344:e3771. Epub 2012/05/30. PubMed PMID: 22641833.
8. Annerstedt J, Liyanage S. Challenges when Shaping Capabilities for Research: Swedish Support to Bilateral Research Cooperation with Sri Lanka and Vietnam, 1976–2006, and a Look Ahead. In: Cooperation DfR, editor. Stockholm: SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY; 2008.
9. Laabes EP, Desai R, Zawedde SM, Glew RH. How much longer will Africa have to depend on western nations for support of its capacity-building efforts for biomedical research? Trop Med Int Health. 2011;16(3):258-62. Epub 2011/03/05. doi: 10.1111/j.1365-3156.2010.02709.x. PubMed PMID: 21371216.
10. Davies R. Dismantling AusAID: taking a leaf out of the Canadian book? DevPolicyBlog: Development Policy Centre; 2013.
11. Bates I, Akoto AY, Ansong D, Karikari P, Bedu-Addo G, Critchley J, et al. Evaluating health research capacity building: an evidence-based tool. PLoS Med. 2006;3(8):e299. Epub 2006/09/01. doi: 10.1371/journal.pmed.0030299. PubMed PMID: 16942394; PubMed Central PMCID: PMC1502158.
12. Marais D, Toohey J, Edwards D, IJsselmuiden C. Where there is no lawyer: Guidance for fairer contract negotiation in collaborative research partnerships. In: Development CiHRf, editor. Geneva & Pietermaritzburg: Council in Health Research for Development; 2013.
13. Greenhalgh T, Robert G, Macfarlane F, Bate P, Kyriakidou O, Peacock R. Storylines of research in diffusion of innovation: a meta-narrative approach to systematic review. Soc Sci Med. 2005;61(2):417-30. doi: http://dx.doi.org/10.1016/j.socscimed.2004.12.001.
14. Greenhalgh T, Wong G, Westhorp G, Pawson R. Protocol - realist and meta-narrative evidence synthesis: Evolving Standards (RAMESES). BMC Medical Research Methodology. 2011;11(1):115. doi: info:pmid/21843376.
15. White MT. A right to benefit from international research: a new approach to capacity building in less-developed countries. Account Res. 2007;14(2):73-92. Epub 2007/09/12. doi: 10.1080/08989620701290341. PubMed PMID: 17844784.

16. Mony PK, Kurpad A, Vaz M. Capacity building in collaborative research is essential. BMJ. 2005;331(7520):843-4. Epub 2005/10/08. doi: 10.1136/bmj.331.7520.843-b. PubMed PMID: 16210297; PubMed Central PMCID: PMC1246129.
17. Costello A, Zumla A. Moving to research partnerships in developing countries. BMJ. 2000;321(7264):827-9. Epub 2000/09/29. PubMed PMID: 11009530; PubMed Central PMCID: PMC1118627.
18. Sitthi-Amorn C, Somrongthong R. Strengthening health research capacity in developing countries: a critical element for achieving health equity. BMJ. 2000;321(7264):813-7. Epub 2000/09/29. PubMed PMID: 11009525; PubMed Central PMCID: PMC1118622.
19. Kok MO, Rodrigues A, Silva AP, de Haan S. The emergence and current performance of a health research system: lessons from Guinea Bissau. Health Res Policy Syst. 2012;10:5. Epub 2012/02/11. doi: 10.1186/1478-4505-10-5. PubMed PMID: 22321566; PubMed Central PMCID: PMC3295730.
20. Green A, Bennett S, editors. Sound Choices: Enhancing Capacity for Evidence-Informed Health Policy. Geneva: World Health Organisation; 2007.
21. Jentsch B, Pilley C. Research relationships between the South and the North: Cinderella and the ugly sisters? Soc Sci Med. 2003;57(10):1957-67. Epub 2003/09/23. PubMed PMID: 14499518.
22. Coloma J, Harris E. From construction workers to architects: developing scientific research capacity in low-income countries. PLoS Biol. 2009;7(7):e1000156. Epub 2009/07/22. doi: 10.1371/journal.pbio.1000156. PubMed PMID: 19621063; PubMed Central PMCID: PMC2704958.
23. Gonzalez-Block MA, Vargas-Riano EM, Sonela N, Idrovo AJ, Ouwe-Missi-Oukem-Boyer O, Monot JJ. Research capacity for institutional collaboration in implementation research on diseases of poverty. Trop Med Int Health. 2011;16(10):1285-90. Epub 2011/07/19. doi: 10.1111/j.1365-3156.2011.02834.x. PubMed PMID: 21762393.
24. Crane J. Scrambling for Africa? Universities and global health. The Lancet. 2011;377(9775):1388-90.
25. World Health Organisation. Ministerial Summit on Health Research (2004: Mexico City, Mexico). In: Report from the Ministerial Summit on Health Research: identify challenges ia, correct inequities., editor. Geneva: World Health Organisation; 2005.
26. Lansang M., Dennis R. The need to develop research capacity. Global Forum Update on Research for Health Volume 4. 4. London: Pro-Brook Publishing Ltd; 2007. p. 123-7.
27. Silove D, Rees S, Tam N, Liddell B, Zwi A. Staff management and capacity building under conditions of insecurity: lessons from developing mental health service and research programs in post-conflict Timor-Leste. Australas Psychiatry. 2011;19 Suppl 1:S90-4. Epub 2011/09/09. doi: 10.3109/10398562.2011.583076. PubMed PMID: 21878030.
28. DFID. Capacity Building in Research. In: Development DfI, editor. 2010.
29. ESSENCE on Health Research. Planning Monitoring and Evaluation; Framework for Capacity Strengthening in Health Research. In: ESSENCE Good Practice Document Series, editor. Geneva: Copytrend; 2011.
30. Aksoy S. Solutions to neglected tropical diseases require vibrant local scientific communities. PLoS Negl Trop Dis. 2010;4(3):e662. Epub 2010/04/03. doi: 10.1371/journal.pntd.0000662. PubMed PMID: 20361026; PubMed Central PMCID: PMC2846929.
31. Chandiwana S, Ornbjerg N. Review of North-South and South-South cooperation and conditions necessary to sustain research capability in developing countries. J Health Popul Nutr. 2003;21(3):288-97. Epub 2004/01/14. PubMed PMID: 14717574.

32. Devasenapathy N, Singh K, Prabhakaran D. Conduct of clinical trials in developing countries: a perspective. Curr Opin Cardiol. 2009;24(4):295-300. doi: Doi 10.1097/Hco.0b013e32832af21b. PubMed PMID: ISI:000267279500004.
33. Ali R, Finlayson A, Network ICR. Building capacity for clinical research in developing countries: the INDOX cancer research network experience. Global Health Action. 2012;5:1-6. doi: DOI 10.3402/gha.v5i0.17288. PubMed PMID: ISI:000304003100001.
34. Editorial. The Bamako call to action: research for health. Lancet. 2008;372(9653):1855-. PubMed PMID: WOS:000261388700001.
35. Lexchin J. One step forward, one step sideways? Expanding research capacity for neglected diseases. BMC Int Health Hum Rights. 2010;10:20. Epub 2010/07/16. doi: 1472-698X-10-20 [pii]
10.1186/1472-698X-10-20. PubMed PMID: 20630063; PubMed Central PMCID: PMC2922093.
36. Khanna R, Hota P, Lahariya C. Health research strengthening and operational research needs for improving child survival in India. Indian J Pediatr. 2010;77(3):291-9. Epub 2010/05/01. doi: 10.1007/s12098-010-0037-x. PubMed PMID: 20431966.
37. Mgone CS. Strengthening of the clinical research capacity for malaria: a shared responsibility. Malar J. 2010;9 Suppl 3:S5. Epub 2010/12/22. doi: 10.1186/1475-2875-9-s3-s5. PubMed PMID: 21144085; PubMed Central PMCID: PMC3002146.
38. Shafiq N, Pandhi P, Malhotra S. Investigator-initiated pragmatic trials in developing countries--much needed but much ignored. Br J Clin Pharmacol. 2009;67(1):141-2. Epub 2008/11/14. doi: BCP3291 [pii]10.1111/j.1365-2125.2008.03291.x. PubMed PMID: 19006544; PubMed Central PMCID: PMC2668099.
39. Kasonde JM, Campbell S. Creating a Knowledge Translation Platform: nine lessons from the Zambia Forum for Health Research. Health Res Policy Syst. 2012;10:31. Epub 2012/10/05. doi: 10.1186/1478-4505-10-31. PubMed PMID: 23034056; PubMed Central PMCID: PMC3491024.
40. vasquez E, Hirsch J, Giang L, Parker R. Rethinking health research capacity strengthening. Global Public Health. 2013.
41. Lang TA, White NJ, Hien TT, Farrar JJ, Day NPJ, Fitzpatrick R, et al. Clinical Research in Resource-Limited Settings: Enhancing Research Capacity and Working Together to Make Trials Less Complicated. PLoS Negl Trop Dis. 2010;4(6):e619.
42. Mbuagbaw L, Thabane L, Ongolo-Zogo P, Lang T. The challenges and opportunities of conducting a clinical trial in a low resource setting: the case of the Cameroon mobile phone SMS (CAMPS) trial, an investigator initiated trial. Trials. 2011;12:145. Epub 2011/06/11. doi: 1745-6215-12-145 PubMed PMID: 21658262; PubMed Central PMCID: PMC3138444.
43. Adam T, Ahmad S, Bigdeli M, Ghaffar A, Rottingen JA. Trends in health policy and systems research over the past decade: still too little capacity in low-income countries. PLoS One. 2011;6(11):e27263. Epub 2011/12/02. doi: 10.1371/journal.pone.0027263. PubMed PMID: 22132094; PubMed Central PMCID: PMC3222652.
44. Mgone C, Volmink J, Coles D, Makanga M, Jaffar S, Sewankambo N. Linking research and development to strengthen health systems in Africa. Trop Med Int Health. 2010;15(12):1404-6. Epub 2010/10/20. doi: 10.1111/j.1365-3156.2010.02661.x. PubMed PMID: 20955373.
45. Courtright P, Faal HB. How can we strengthen ophthalmic research in Africa? Can J Ophthalmol. 2006;41(4):424-5. Epub 2006/08/03. doi: 10.1016/s0008-4182(06)80003-7. PubMed PMID: 16883358.
46. Garcia PJ, Cotrina A, Gotuzzo E, Gonzalez E, Buffardi AL. Research training needs in Peruvian national TB/HIV programs. BMC Med Educ. 2010;10(1). doi: 10.1186/1472-6920-10-63.

47. Harries AD, Rusen ID, Reid T, Detjen AK, Berger SD, Bissell K, et al. The Union and Medecins Sans Frontieres approach to operational research. Int J Tuberc Lung Dis. 2011;15(2):144-54, i. Epub 2011/01/12. PubMed PMID: 21219672.
48. World Health Organisation. The WHO strategy on research for health. Geneva: World Health Organisation; 2012.
49. Garrett L. The Challenge of Global Health. (cover story). Foreign Affairs. 2007;86(1):14-38.
50. Whitworth J, Sewankambo NK, Snewin VA. Improving implementation: building research capacity in maternal, neonatal, and child health in Africa. PLoS Med. 2010;7(7):e1000299. Epub 2010/07/14. doi: 10.1371/journal.pmed.1000299. PubMed PMID: 20625547; PubMed Central PMCID: PMC2897765.
51. Goto A, Nguyen TN, Nguyen TM, Hughes J. Building postgraduate capacity in medical and public health research in Vietnam: an in-service training model. Public Health. 2005;119(3):174-83. Epub 2005/01/22. doi: 10.1016/j.puhe.2004.05.005. PubMed PMID: 15661126.
52. Lansang MA, Dennis R. Building capacity in health research in the developing world. Bull World Health Organ. 2004;82(10):764-70. Epub 2005/01/13. PubMed PMID: 15643798; PubMed Central PMCID: PMC2623028.
53. Nchinda TC. Research capacity strengthening in the South. Soc Sci Med. 2002;54(11):1699-711. Epub 2002/07/13. PubMed PMID: 12113452.
54. Magwaza S, Mathambo V, Magongo B, Mvo E, Makhanya N. Health research Capacity Building in South Africa: Current knowledge and practices. Durban: Health Systems Trust; 2003.
55. Nuyens Y. No Development Without Research. Geneva: Global Forum for Health Research; 2005.
56. Pang T, Sadana R, Hanney S, Bhutta Z, Hyder A, Simon J. Knowledge for better health — a conceptual framework and foundation for health research systems. Bulletin of the World Health Organization. 2003;81(11):815-20.
57. World Health Organisation. National Health Research Systems. Report of an international workshop, Cha-am, Thailand, 12–15 March 2001. Geneva: World Health Organisation; 2002.
58. Bennett S, Adam T, Zarowsky C, Tangcharoensathien V, Ranson K, Evans T, et al. From Mexico to Mali: progress in health policy and systems research. Lancet. 2008;372(9649):1571-8. Epub 2008/11/06. doi: 10.1016/s0140-6736(08)61658-x. PubMed PMID: 18984191.
59. Ijsselmuiden C, Marais DL, Becerra-Posada F, Ghannem H. Africa's neglected area of human resources for health research - the way forward. S Afr Med J. 2012;102(4):228-33. Epub 2012/04/03. PubMed PMID: 22464504.
60. Jones N, Bailey M, Lyytikainen M. Research capacity strengthening in Africa: Trends, gaps and opportunities. In: Institute OD, editor. London: Overseas Development Institute; 2007.
61. Kariuki T, Phillips R, Njenga S, Olesen OF, Klatser PR, Porro R, et al. Research and capacity building for control of neglected tropical diseases: the need for a different approach. PLoS Negl Trop Dis. 2011;5(5):e1020. Epub 2011/06/10. doi: 10.1371/journal.pntd.0001020. PubMed PMID: 21655352; PubMed Central PMCID: PMC3104960.
62. Minja H, Nsanzabana C, Maure C, Hoffmann A, Rumisha S, Ogundahunsi O, et al. Impact of health research capacity strengthening in low- and middle-income countries: the case of WHO/TDR programmes. PLoS Negl Trop Dis. 2011;5(10):e1351. Epub 2011/10/25. doi: 10.1371/journal.pntd.0001351. PubMed PMID: 22022630; PubMed Central PMCID: PMC3191138.

63. Vogel I. Research Capacity Strengthening: Learning from Experience. In: (UKCDS) UCoDS, editor.: UK Collaborative on Development Sciences (UKCDS); 2011.
64. Chanda-Kapata P, Campbell S, Zarowsky C. Developing a national health research system: participatory approaches to legislative, institutional and networking dimensions in Zambia. Health Res Policy Syst. 2012;10:17. Epub 2012/06/08. doi: 10.1186/1478-4505-10-17. PubMed PMID: 22672331; PubMed Central PMCID: PMC3463500.
65. Cooke J. A framework to evaluate research capacity building in health care. BMC Family Practice. 2005;6(1):1-11. doi: 10.1186/1471-2296-6-44.
66. Iaccarino M. Mastering science in the South. To develop much-needed research capacity, developing countries cannot rely on the industrialized world, but have to find their own specific solutions. EMBO Rep. 2004;5(5):437-41. Epub 2004/06/09. doi: 10.1038/sj.embor.7400159. PubMed PMID: 15184971; PubMed Central PMCID: PMC1299062.
67. Higgs ES. The Southeast Asian Influenza Clinical Research Network: development and challenges for a new multilateral research endeavor. Antiviral Res. 2008;78(1):64.
68. Ogutu BR, Baiden R, Diallo D, Smith PG, Binka FN. Sustainable development of a GCP-compliant clinical trials platform in Africa: the malaria clinical trials alliance perspective. Malar J. 2010;9:103. Epub 2010/04/22. doi: 10.1186/1475-2875-9-103. PubMed PMID: 20406478; PubMed Central PMCID: PMC2873521.
69. Sawyerr. African Universities and the Challenge of Research Capacity Development. JHEA/RESA Vol 2, No 1, 2004, pp 211–240. 2004.
70. Gezmu M, DeGruttola V, Dixon D, Essex M, Halloran E, Hogan J, et al. Strengthening biostatistics resources in sub-Saharan Africa: research collaborations through U.S. partnerships. Stat Med. 2011;30(7):695-708. Epub 2011/03/12. doi: 10.1002/sim.4144. PubMed PMID: 21394746.
71. Lang T. Advancing global health research through digital technology and sharing data. Science. 2011;331(6018):714-7. Epub 2011/02/12. doi: 10.1126/science.1199349. PubMed PMID: 21311011.
72. Marjanovic S, Hanlin R, Diepeveen S, Chataway J. RESEARCH CAPACITY-BUILDING IN AFRICA: NETWORKS, INSTITUTIONS AND LOCAL OWNERSHIP. Journal of International Development. 2012:n/a-n/a. doi: 10.1002/jid.2870.
73. Whitworth JA, Kokwaro G, Kinyanjui S, Snewin VA, Tanner M, Walport M, et al. Strengthening capacity for health research in Africa. Lancet. 2008;372(9649):1590-3. Epub 2008/11/06. doi: S0140-6736(08)61660-8 [pii]
10.1016/S0140-6736(08)61660-8. PubMed PMID: 18984193; PubMed Central PMCID: PMC2607030.
74. Andronikou S, Mngomezulu V. Paediatric radiology seen from Africa. Part II: recognising research advantages in a developing country. Pediatr Radiol. 2011;41(7):826-31. Epub 2011/05/10. doi: 10.1007/s00247-011-2080-9. PubMed PMID: 21553039.
75. Matee MI, Manyando C, Ndumbe PM, Corrah T, Jaoko WG, Kitua AY, et al. European and Developing Countries Clinical Trials Partnership (EDCTP): the path towards a true partnership. BMC Public Health. 2009;9:249. Epub 2009/07/22. doi: 1471-2458-9-249 [pii]
10.1186/1471-2458-9-249. PubMed PMID: 19619283; PubMed Central PMCID: PMC2719636.
76. Dakik HA, Kaidbey H, Sabra R. Research productivity of the medical faculty at the American University of Beirut. Postgrad Med J. 2006;82(969):462-4. Epub 2006/07/11. doi: 10.1136/pgmj.2005.042713. PubMed PMID: 16822923; PubMed Central PMCID: PMC2563770.
77. Mayhew SH, Doherty J, Pitayarangsarit S. Developing health systems research capacities through north-south partnership: an evaluation of collaboration with South Africa

and Thailand. Health Res Policy Syst. 2008;6:8. Epub 2008/08/05. doi: 10.1186/1478-4505-6-8. PubMed PMID: 18673541; PubMed Central PMCID: PMC2559830.
78. Andruchow JE, Soskolne CL, Racioppi F, Bertollini R. Capacity building for epidemiologic research: a case study in the newly independent state of Azerbaijan. Ann Epidemiol. 2005;15(3):228-31. Epub 2005/02/23. doi: 10.1016/j.annepidem.2004.06.004. PubMed PMID: 15723769.
79. de-Graft Aikins A, Arhinful DK, Pitchforth E, Ogedegbe G, Allotey P, Agyemang C. Establishing and sustaining research partnerships in Africa: a case study of the UK-Africa Academic Partnership on Chronic Disease. Global Health. 2012;8:29. Epub 2012/08/18. doi: 10.1186/1744-8603-8-29. PubMed PMID: 22897937; PubMed Central PMCID: PMC3475042.
80. Gadsby EW. Research capacity strengthening: donor approaches to improving and assessing its impact in low- and middle-income countries. Int J Health Plann Manage. 2011;26(1):89-106. Epub 2010/04/28. doi: 10.1002/hpm.1031. PubMed PMID: 20422620.
81. Jones AC, Geneau R. Assessing research activity on priority interventions for non-communicable disease prevention in low- and middle-income countries: a bibliometric analysis. Glob Health Action. 2012;5:1-13. Epub 2012/09/05. PubMed PMID: 22944364; PubMed Central PMCID: PMC3427597.
82. Muula AS. What drives health research in a developing country? Croat Med J. 2007;48(2):261-7. Epub 2007/04/17. PubMed PMID: 17436392; PubMed Central PMCID: PMC2080513.
83. Siriwardhana C, Sumathipala A, Siribaddana S, Samaraweera S, Abeysinghe N, Prince M, et al. Reducing the scarcity in mental health research from low and middle income countries: a success story from Sri Lanka. Int Rev Psychiatry. 2011;23(1):77-83. Epub 2011/02/23. doi: 10.3109/09540261.2010.545991. PubMed PMID: 21338302.
84. Sadana R, D'Souza C, Hyder AA, Chowdhury AM. Importance of health research in South Asia. BMJ. 2004;328(7443):826-30. doi: 10.1136/bmj.328.7443.826. PubMed PMID: 15070643; PubMed Central PMCID: PMC383385.
85. Choi HY, Ko JW. Facilitating large-scale clinical trials: in Asia. Urol Oncol. 2010;28(6):691-2. Epub 2010/11/11. doi: 10.1016/j.urolonc.2009.12.016. PubMed PMID: 21062654.
86. Editorial. Strengthening research capacity in Africa. Lancet. 2009;374(9683):1. Epub 2009/07/07. doi: 10.1016/s0140-6736(09)61213-7. PubMed PMID: 19577676.
87. Bennett S, Agyepong IA, Sheikh K, Hanson K, Ssengooba F, Gilson L. Building the Field of Health Policy and Systems Research: An Agenda for Action. PLoS Med. 2011;8(8). doi: ARTN e1001081
DOI 10.1371/journal.pmed.1001081. PubMed PMID: ISI:000294477300015.
88. Lee PP, Lau YL. Improving care, education, and research: the Asian primary immunodeficiency network. Ann N Y Acad Sci. 2011;1238:33-41. Epub 2011/12/02. doi: 10.1111/j.1749-6632.2011.06225.x. PubMed PMID: 22129051.
89. Excler JL, Pitisuttithum P, Rerks-Ngarm S, Shao Y, Zhang L, Tamashiro H, et al. Expanding research capacity and accelerating AIDS vaccine development in Asia. Southeast Asian J Trop Med Public Health. 2008;39(4):766-84. PubMed PMID: 19058617.
90. Kilama WL, Chilengi R, Wanga CL. Towards an African-driven malaria vaccine development program: history and activities of the African Malaria Network Trust (AMANET). Am J Trop Med Hyg. 2007;77(6 Suppl):282-8. Epub 2008/01/31. doi: 77/6_Suppl/282 [pii]. PubMed PMID: 18165504.
91. Miiro GM, Oukem-Boyer OO, Sarr O, Rahmani M, Ntoumi F, Dheda K, et al. EDCTP regional networks of excellence: initial merits for planned clinical trials in Africa. BMC Public Health. 2013;13:258. Epub 2013/03/23. doi: 10.1186/1471-2458-13-258. PubMed PMID: 23517572; PubMed Central PMCID: PMCPmc3623728.

92. Editorial. Bringing health research forward. Tanzan J Health Res. 2009;11(4):iii-iv. Epub 2010/08/26. PubMed PMID: 20734693.
93. Kamunyori S, Al-Bader S, Sewankambo N, Singer PA, Daar AS. Science-based health innovation in Uganda: creative strategies for applying research to development. BMC Int Health Hum Rights. 2010;10 Suppl 1:S5. Epub 2010/12/15. doi: 1472-698X-10-S1-S5 [pii] 10.1186/1472-698X-10-S1-S5. PubMed PMID: 21144076; PubMed Central PMCID: PMC3001613.
94. Barreto ML. Health research in developing countries. BMJ. 2009;339:b4846. Epub 2009/11/26. doi: 10.1136/bmj.b4846. PubMed PMID: 19933304.
95. Zachariah R, Reid T, Srinath S, Chakaya J, Legins K, Karunakara U, et al. Building leadership capacity and future leaders in operational research in low-income countries: why and how? Int J Tuberc Lung Dis. 2011;15(11):1426-35, i. Epub 2011/10/20. doi: 10.5588/ijtld.11.0316. PubMed PMID: 22008755.
96. Lang TA, Kokwaro GO. Malaria drug and vaccine trials in Africa: obstacles and opportunities. Trans R Soc Trop Med Hyg. 2008;102(1):7-10. Epub 2007/10/05. doi: S0035-9203(07)00279-9 [pii] 10.1016/j.trstmh.2007.08.008. PubMed PMID: 17915267.
97. Ntoumi F. Networking and capacity building for health research in Central Africa. Wien Klin Wochenschr. 2010;122 Suppl 1:23-6. Epub 2010/04/14. doi: 10.1007/s00508-010-1331-3. PubMed PMID: 20376720.
98. Sitthi-Amorn C, Pongpanich S, Somrongthong R, Likitkirirat T, Likitkirirat P. The Asian Voice in building equity in health for development - from the Asian Forum for Health Research, Manila, February 2000. Health Policy Plan. 2002;17(2):213-7. Epub 2002/05/10. PubMed PMID: 12000783.
99. World Health Organisation. Scaling up research and learning for health systems: now is the time. In: Report of a High Level Task Force paeatGMFoRfH, Bamako, Mali, editor. Geneva: World Health Organisation; 2009.
100. Van Royen K, Lachat C, Holdsworth M, Smit K, Kinabo J, Roberfroid D, et al. How can the operating environment for nutrition research be improved in sub-saharan Africa? The views of african researchers. PLoS One. 2013;8(6):e66355. Epub 2013/06/19. doi: 10.1371/journal.pone.0066355. PubMed PMID: 23776663; PubMed Central PMCID: PMC3680459.
101. Kirigia JM, Wambebe C. Status of national health research systems in ten countries of the WHO African Region. BMC Health Serv Res. 2006;6:135. Epub 2006/10/21. doi: 10.1186/1472-6963-6-135. PubMed PMID: 17052326; PubMed Central PMCID: PMC1622748.
102. McKee M, Stuckler D, Basu S. Where there is no health research: what can be done to fill the global gaps in health research? PLoS Med. 2012;9(4):e1001209. Epub 2012/05/01. doi: 10.1371/journal.pmed.1001209. PubMed PMID: 22545025; PubMed Central PMCID: PMC3335864.
103. Mwangoka G, Ogutu B, Msambichaka B, Mzee T, Salim N, Kafuruki S, et al. Experience and challenges from clinical trials with malaria vaccines in Africa. Malar J. 2013;12:86. Epub 2013/03/19. doi: 10.1186/1475-2875-12-86. PubMed PMID: 23496910; PubMed Central PMCID: PMCPmc3599886.
104. Lang T. Advancing Global Health Research Through Digital Technology and Data Sharing. Science. 2011;In Press.
105. Thamarangsi T. Addiction research centres and the nurturing of creativity: Center for Alcohol Studies (CAS), Thailand. Addiction. 2013;108(7):1201-6. Epub 2012/03/27. doi: 10.1111/j.1360-0443.2012.03795.x. PubMed PMID: 22443475.
106. Ali R, Finlayson A, Indox Cancer Research N. Building capacity for clinical research in developing countries: the INDOX Cancer Research Network experience. Glob Health

Action. 2012;5. Epub 2012/05/09. doi: 10.3402/gha.v5i0.17288. PubMed PMID: 22566788; PubMed Central PMCID: PMC3343878.
107. White F. Capacity-building for health research in developing countries: a manager's approach. Rev Panam Salud Publica. 2002;12(3):165-72. Epub 2002/10/25. PubMed PMID: 12396634.
108. Excler JL, Pitisuttithum P, Rerks-Ngarm S, Shao Y, Zhang L, Tamashiro H, et al. Expanding research capacity and accelerating AIDS vaccine development in Asia. Southeast Asian J Trop Med Public Health. 2008;39(4):766-84. Epub 2008/12/09. PubMed PMID: 19058617.
109. Kellerman R, Klipstein-Grobusch K, Weiner R, Wayling S, Fonn S. Investing in African research training institutions creates sustainable capacity for Africa: the case of the University of the Witwatersrand School of Public Health masters programme in epidemiology and biostatistics. Health Res Policy Syst. 2012;10(1):11. Epub 2012/04/06. doi: 10.1186/1478-4505-10-11. PubMed PMID: 22475629; PubMed Central PMCID: PMC3378446.
110. Greenwood B, Bhasin A, Targett G. The Gates Malaria Partnership: a consortium approach to malaria research and capacity development. Trop Med Int Health. 2012;17(5):558-63. Epub 2012/03/17. doi: 10.1111/j.1365-3156.2012.02970.x. PubMed PMID: 22420422.
111. Kabiru CW, Izugbara CO, Wambugu SW, Ezeh AC. Capacity development for health research in Africa: experiences managing the African Doctoral Dissertation Research Fellowship Program. Health Res Policy Syst. 2010;8:21. Epub 2010/07/01. doi: 10.1186/1478-4505-8-21. PubMed PMID: 20587016; PubMed Central PMCID: PMC2907373.
112. Baum BJ, Scott J, Bickel M, Gombos G, Greenspan JS, Guo W, et al. Global challenges in research and strategic planning. Eur J Dent Educ. 2002;6 Suppl 3:179-84. Epub 2002/10/23. PubMed PMID: 12390276.
113. Halabi-Nassif H, Hatem M. [Evidence-based practice and the development of a nursing research culture]. Perspect Infirm. 2008;5(7):36-42. Epub 2009/03/10. PubMed PMID: 19266791.
114. Edwards N, Webber J, Mill J, Kahwa E, Roelofs S. Building capacity for nurse-led research. Int Nurs Rev. 2009;56(1):88-94. Epub 2009/02/26. doi: 10.1111/j.1466-7657.2008.00683.x. PubMed PMID: 19239521.
115. Gaym A. Health research in Ethiopia--past, present and suggestions on the way forward. Ethiop Med J. 2008;46(3):287-308. Epub 2009/03/11. PubMed PMID: 19271395.
116. Dodani S, Songer T, Ahmed Z, Laporte RE. Building research capacity in developing countries: cost-effectiveness of an epidemiology course taught by traditional and video-teleconferencing methods in Pakistan. Telemed J E Health. 2012;18(8):621-8. Epub 2012/10/16. doi: 10.1089/tmj.2011.0262. PubMed PMID: 23061643.
117. Gotch F, Gilmour J. Science, medicine and research in the developing world: a perspective. Nat Immunol. 2007;8(12):1273-6. Epub 2007/10/24. doi: 10.1038/ni1531. PubMed PMID: 17952077.
118. Manabe YC, Katabira E, Brough RL, Coutinho AG, Sewankambo N, Merry C. Developing independent investigators for clinical research relevant for Africa. Health Res Policy Syst. 2011;9:44. Epub 2011/12/31. doi: 10.1186/1478-4505-9-44. PubMed PMID: 22206247; PubMed Central PMCID: PMC3283488.
119. Siegfried NL, Hughes G. Herbal medicine, randomised controlled trials and global core competencies. S Afr Med J. 2012;102(12):912-3. Epub 2013/03/19. PubMed PMID: 23498035.
120. Abu-Zidan FM, Rizk DE. Research in developing countries: problems and solutions. Int Urogynecol J Pelvic Floor Dysfunct. 2005;16(3):174-5. Epub 2005/02/09. doi: 10.1007/s00192-004-1278-x. PubMed PMID: 15700105.

121. Tierney WM, Nyandiko WN, Siika AM, Wools-Kaloustian K, Sidle JE, Kiplagat J, et al. "These are Good Problems to Have...": Establishing a Collaborative Research Partnership in East Africa. J Gen Intern Med. 2013. Epub 2013/06/26. doi: 10.1007/s11606-013-2459-4. PubMed PMID: 23797916.
122. Muldoon KA, Birungi J, Berry NS, Ngolobe MH, Mwesigwa R, Shannon K, et al. Supporting southern-led research: implications for North-South research partnerships. Can J Public Health. 2012;103(2):128-31. Epub 2012/04/26. PubMed PMID: 22530536.
123. Akhtar W, Arain MA, Ali A, Sajjad Z. Interventions for improving research productivity in clinical radiology. J Coll Physicians Surg Pak. 2012;22(7):478-9. Epub 2012/07/04. doi: 07.2012/jcpsp.478479. PubMed PMID: 22747876.
124. Mullan F, Frehywot S, Omaswa F, Buch E, Chen C, Greysen SR, et al. Medical schools in sub-Saharan Africa. Lancet. 2011;377(9771):1113-21. Epub 2010/11/16. doi: S0140-6736(10)61961-7. PubMed PMID: 21074256.
125. Excler JL. AIDS vaccine efficacy trials: expand capacity and prioritize. 'Throughout Africa, Asia and Latin America state-of-the-art clinics and laboratories...exist where, 4 years ago, there were none'. Expert Rev Vaccines. 2006;5(2):167-70. Epub 2006/04/13. doi: 10.1586/14760584.5.2.167. PubMed PMID: 16608417.
126. Gilmour JW, Stevens WS, Gray C, de Souza M. Laboratory expansion to large-scale international HIV preventive vaccine trials. Curr Opin HIV AIDS. 2007;2(3):201-6. Epub 2007/05/01. doi: 10.1097/COH.0b013e3280eec77a. PubMed PMID: 19372887.
127. Guindo MA, Shott JP, Saye R, Diakite ML, Sanogo S, Dembele MB, et al. Promoting good clinical laboratory practices and laboratory accreditation to support clinical trials in sub-Saharan Africa. Am J Trop Med Hyg. 2012;86(4):573-9. Epub 2012/04/12. doi: 10.4269/ajtmh.2012.11-0691. PubMed PMID: 22492138; PubMed Central PMCID: PMC3403781.
128. Kilama WL. The 10/90 gap in sub-Saharan Africa: resolving inequities in health research. Acta Trop. 2009;112 Suppl 1:S8-S15. Epub 2009/08/22. doi: S0001-706X(09)00244-7 [pii]
10.1016/j.actatropica.2009.08.015. PubMed PMID: 19695211.
129. Rerks-Ngarm S, Pitisuttithum P, Ganguly N, Zhang L, Tamashiro H, Cooper DA, et al. Defining the objectives of the AIDS vaccine for Asia network: report of the WHO-UNAIDS/Global HIV vaccine enterprise regional consultation on expanding AIDS vaccine research and development capacity in Asia. Curr Opin HIV AIDS. 2010;5(5):435-52. Epub 2010/10/28. doi: 10.1097/COH.0b013e32833c95c1. PubMed PMID: 20978386; PubMed Central PMCID: PMC3125721.
130. Nachega JB, Uthman OA, Ho YS, Lo M, Anude C, Kayembe P, et al. Current status and future prospects of epidemiology and public health training and research in the WHO African region. Int J Epidemiol. 2012;41(6):1829-46. Epub 2013/01/04. doi: 10.1093/ije/dys189. PubMed PMID: 23283719; PubMed Central PMCID: PMC3535755.
131. Bates I, Taegtmeyer M, Squire SB, Ansong D, Nhlema-Simwaka B, Baba A, et al. Indicators of sustainable capacity building for health research: analysis of four African case studies. Health Res Policy Syst. 2011;9:14. Epub 2011/03/30. doi: 10.1186/1478-4505-9-14. PubMed PMID: 21443780; PubMed Central PMCID: PMC3078899.
132. Marchetti E, Mazarin-Diop V, Chaumont J, Martellet L, Makadi MF, Viviani S, et al. Conducting vaccine clinical trials in sub-Saharan Africa: operational challenges and lessons learned from the Meningitis Vaccine Project. Vaccine. 2012;30(48):6859-63. Epub 2012/09/20. doi: 10.1016/j.vaccine.2012.09.008. PubMed PMID: 22989686.
133. Casale M, Lane T, Sello L, Kuo C, Cluver L. Conducting health survey research in a deep rural South African community: challenges and adaptive strategies. Health Res Policy Syst. 2013;11:14. Epub 2013/04/27. doi: 10.1186/1478-4505-11-14. PubMed PMID: 23618363; PubMed Central PMCID: PMCPmc3640973.

134. Louisa M, Takeuchi M, Setiabudy R, Nafrialdi. Current status of phase I clinical trials in Asia: an academic perspectives. Acta Med Indones. 2012;44(1):71-7. Epub 2012/03/28. PubMed PMID: 22451190.
135. Tugwell P, Sitthi-Amorn C, Hatcher-Roberts J, Neufeld V, Makara P, Munoz F, et al. Health Research Profile to assess the capacity of low and middle income countries for equity-oriented research. BMC Public Health. 2006;6:151. Epub 2006/06/14. doi: 10.1186/1471-2458-6-151. PubMed PMID: 16768792; PubMed Central PMCID: PMC1539005.
136. TDR. ESSENCE on Health Research (Enhancing Support for Strengthening the Effectiveness of National Capacity Efforts) Geneva: World Health Organisation; 2014 [cited 2014 04/06/2014]. Available from: http://www.who.int/tdr/partnerships/initiatives/essence/en/.
137. The Global Health Network. The Global Health Network: The Global Health Network; 2014 [cited 2014 04/06/2014]. Available from: www.tghn.org.

Supplementary file captions

S1: Full list of papers included in the systematic review

S2: Key terminology and definitions used in this synthesis

S3: Typology of capacity development actors

Figure 1: Search and study selection process

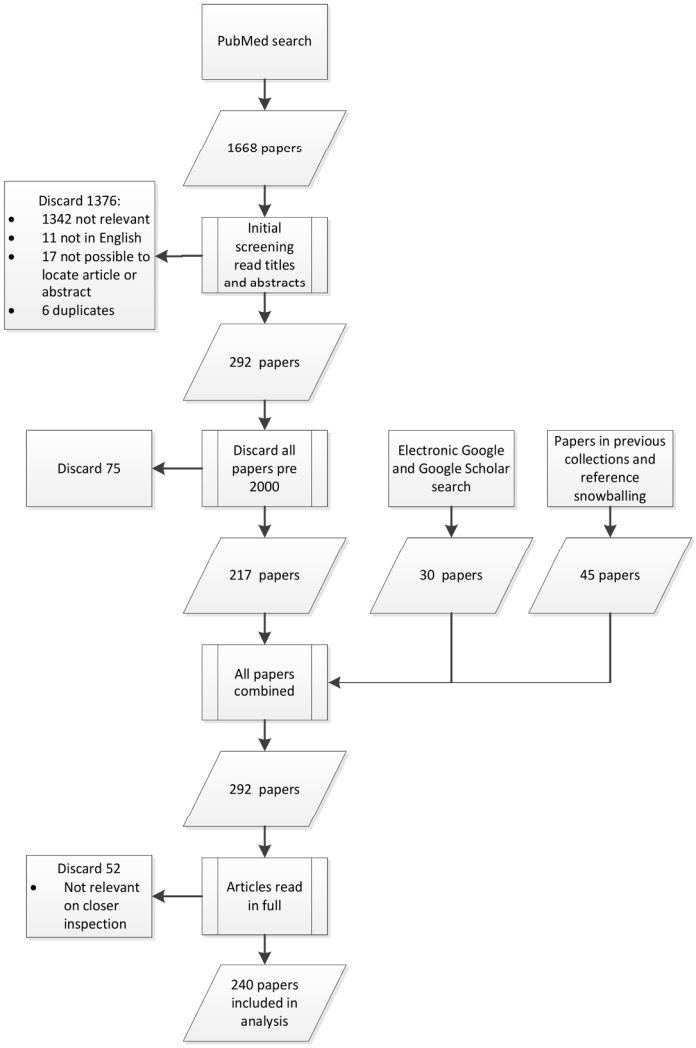


Figure 1: Search and study selection process
Figure 1
149x230mm (300 x 300 DPI)

Supplementary file S1: All papers included in the systematic review

ABBOOD, S. A. 2002. Medical research in developing countries still in Cinderella status. *Saudi Med J,* 23**,** 1554-6.

ABU-ZIDAN, F. M. & RIZK, D. E. 2005. Research in developing countries: problems and solutions. *Int Urogynecol J Pelvic Floor Dysfunct,* 16**,** 174-5.

ADAM, T., AHMAD, S., BIGDELI, M., GHAFFAR, A. & ROTTINGEN, J. A. 2011. Trends in health policy and systems research over the past decade: still too little capacity in low-income countries. *PLoS One,* 6**,** e27263.

ADDAE-MENSAH, I., FAKOREDE, F., HOLTEL, A. & NWAKA, S. 2011. Traditional medicines as a mechanism for driving research innovation in Africa. *Malar J,* 10 Suppl 1**,** S9.

AIRHIHENBUWA, C. O., SHISANA, O., ZUNGU, N., BELUE, R., MAKOFANI, D. M., SHEFER, T., SMITH, E. & SIMBAYI, L. 2011. Research capacity building: a US-South African partnership. *Glob Health Promot,* 18**,** 27-35.

AKHTAR, W., ARAIN, M. A., ALI, A. & SAJJAD, Z. 2012. Interventions for improving research productivity in clinical radiology. *J Coll Physicians Surg Pak,* 22**,** 478-9.

AKSOY, S. 2010. Solutions to neglected tropical diseases require vibrant local scientific communities. *PLoS Negl Trop Dis,* 4**,** e662.

ALEM, A. & KEBEDE, D. 2003. Conducting psychiatric research in the developing world: challenges and rewards. *Br J Psychiatry,* 182**,** 185-7.

ALI, R., FINLAYSON, A. & NETWORK, I. C. R. 2012. Building capacity for clinical research in developing countries: the INDOX cancer research network experience. *Global Health Action,* 5**,** 1-6.

ALI, R. & RAINA, V. 2008. Developing innovative models for North-South cooperation in clinical research--experience from the INDOX Cancer Research Network. *Ann Oncol,* 19**,** 831-3.

AMEH, E. A., DAUDA, M. M. & NMADU, P. T. 2008. Paediatric surgical research and publications in a developing country setting. *Afr J Paediatr Surg,* 5**,** 3-7.

ANDRONIKOU, S. & MNGOMEZULU, V. 2011. Paediatric radiology seen from Africa. Part II: recognising research advantages in a developing country. *Pediatr Radiol,* 41**,** 826-31.

ANDRUCHOW, J. E., SOSKOLNE, C. L., RACIOPPI, F. & BERTOLLINI, R. 2005. Capacity building for epidemiologic research: a case study in the newly independent state of Azerbaijan. *Ann Epidemiol,* 15**,** 228-31.

ANNERSTEDT, J. & LIYANAGE, S. 2008. Challenges when Shaping Capabilities for Research: Swedish Support to Bilateral Research Cooperation with Sri Lanka and Vietnam, 1976–2006, and a Look Ahead. *In:* COOPERATION, D. F. R. (ed.). Stockholm: SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY.

ARAI, R. J., MANO, M. S., DE CASTRO, G., DIZ, M. D. E. & HOFF, P. M. G. 2010. Building research capacity and clinical trials in developing countries. *Lancet Oncology,* 11**,** 712-713.

ARENAS-LOPEZ, S., FAJARDO, C., VALLS I SOLER, A., GARCIA-CORZO, J. R., LIMA-ROGEL, M. V., CALLE, G., LEITE, R., LOBOS, E., HUME-WRIGHT, Q.

& MACLEOD, S. 2011. Pediatric clinical trials in Latin America and Guyana: present views of local practitioners and ways to embrace the future. *Paediatr Drugs,* 13**,** 257-65.

ATUKORALA, K. R., SUMANASEKARA, D. R., WICKRAMASINGHE, K. H., RATNAYAKE, G. M., JAYASENA, G. M., WEERATUNGA, P. N., WICKRAMASINGHE, S. I. & JAYASINGHE, S. 2012. Medical student research output in a developing country: where has all the research gone? *Med Teach,* 34**,** 998.

BARBOUR, V., COHEN, B. & YAMEY, G. 2004. A new vision for clinical trials in Africa. *PLoS Med,* 1**,** e71.

BARRETO, M. L. 2009. Health research in developing countries. *BMJ,* 339**,** b4846.

BATES, I., AKOTO, A. Y., ANSONG, D., KARIKARI, P., BEDU-ADDO, G., CRITCHLEY, J., AGBENYEGA, T. & NSIAH-ASARE, A. 2006. Evaluating health research capacity building: an evidence-based tool. *PLoS Med,* 3**,** e299.

BATES, I., ANSONG, D., BEDU-ADDO, G., AGBENYEGA, T., AKOTO, A. Y., NSIAH-ASARE, A. & KARIKARI, P. 2007. Evaluation of a learner-designed course for teaching health research skills in Ghana. *BMC Med Educ,* 7**,** 18.

BATES, I., TAEGTMEYER, M., SQUIRE, S. B., ANSONG, D., NHLEMA-SIMWAKA, B., BABA, A. & THEOBALD, S. 2011. Indicators of sustainable capacity building for health research: analysis of four African case studies. *Health Res Policy Syst,* 9**,** 14.

BAUM, B. J., SCOTT, J., BICKEL, M., GOMBOS, G., GREENSPAN, J. S., GUO, W., PARK, N. H., PURDELL-LEWIS, D., RANNEY, R., SCHWARZ, E., SEYMOUR,

G. & UOSHIMA, K. 2002. Global challenges in research and strategic planning. *Eur J Dent Educ,* 6 Suppl 3**,** 179-84.

BENNETT, S., ADAM, T., ZAROWSKY, C., TANGCHAROENSATHIEN, V., RANSON, K., EVANS, T. & MILLS, A. 2008. From Mexico to Mali: progress in health policy and systems research. *Lancet,* 372**,** 1571-8.

BENNETT, S., AGYEPONG, I. A., SHEIKH, K., HANSON, K., SSENGOOBA, F. & GILSON, L. 2011. Building the Field of Health Policy and Systems Research: An Agenda for Action. *PLoS medicine,* 8.

BODEKER, G. & WILLCOX, M. 2000. The first international meeting of the Research Initiative on Traditional Antimalarial Methods (RITAM). *J Altern Complement Med,* 6**,** 195-207.

BOSCH, X. 2004. Clinical trials partnership seeks to boost research in developing countries. *JAMA,* 292**,** 1290.

BROWN, K. H., MCLACHLAN, M., CARDOSA, P., TCHIBINDAT, F. & BAKER, S. K. 2010. Strengthening public health nutrition research and training capacities in West Africa: Report of a planning workshop convened in Dakar, Senegal, 26-28 March 2009. *Glob Public Health,* 5 Suppl 1**,** S1-19.

BURGESS, L. J. & SULZER, N. U. 2010. Clinical trials in South Africa: Need for capacity building and training. *S Afr Med J,* 100**,** 402.

CASALE, M., LANE, T., SELLO, L., KUO, C. & CLUVER, L. 2013. Conducting health survey research in a deep rural South African community: challenges and adaptive strategies. *Health Res Policy Syst,* 11**,** 14.

CHANDA-KAPATA, P., CAMPBELL, S. & ZAROWSKY, C. 2012. Developing a national health research system: participatory approaches to legislative,

institutional and networking dimensions in Zambia. *Health Res Policy Syst,* 10**,** 17.

CHANDIWANA, S. & ORNBJERG, N. 2003. Review of North-South and South-South cooperation and conditions necessary to sustain research capability in developing countries. *J Health Popul Nutr,* 21**,** 288-97.

CHATAWAY, J. & HANLIN, R. 2008. Sustainable (vaccine) development: the International AIDS Vaccine Initiative (IAVI) and capacity building. *In:* MATLIN, S., DE FRANCISCO, A., SUNDARAM, L., FALCH, H. & GEHNER, M. (eds.) *Health Partnerships Review.* Geneva: Global Forum for Health Research.

CHEN, C., GREYSEN, R., MIPANDO, M. & RUGARABAMU, P. 2009. SAMSS Site Visit Report: Faculty of Helath Sciences, School of Medicine, Jimma University, Ethiopia. SAMMS.

CHOI, H. Y. & KO, J. W. 2010. Facilitating large-scale clinical trials: in Asia. *Urol Oncol,* 28**,** 691-2.

COLLINS, F., BEAUDET, A., DRAGHIA-AKLI, R., GRUSS, P., SAVILL, J., SYROTA, A., DAUTRY, A., ULFENDAHL, M., WALPORT, M., ONKEN, J. & GLASS, R. I. 2013. A database on global health research in Africa. *The Lancet,* 1**,** e64-e65.

COLOMA, J. & HARRIS, E. 2009. From construction workers to architects: developing scientific research capacity in low-income countries. *PLoS Biol,* 7**,** e1000156.

COOKE, J. 2005. A framework to evaluate research capacity building in health care. *BMC Family Practice,* 6**,** 1-11.

COSTELLO, A. & ZUMLA, A. 2000. Moving to research partnerships in developing countries. *BMJ,* 321**,** 827-9.

COURTRIGHT, P. & FAAL, H. B. 2006. How can we strengthen ophthalmic research in Africa? *Can J Ophthalmol,* 41**,** 424-5.

CRANE, J. 2011. Scrambling for Africa? Universities and global health. *The Lancet,* 377**,** 1388-1390.

D'SOUZA, C. & SADANA, R. 2006. Why do case studies on national health research systems matter?: identifying common challenges in low- and middle-income countries. *Soc Sci Med,* 62**,** 2072-8.

DAKIK, H. A., KAIDBEY, H. & SABRA, R. 2006. Research productivity of the medical faculty at the American University of Beirut. *Postgrad Med J,* 82**,** 462-4.

DAVEY, S. 2004. The 10/90 Report on Health Research 2003-2004. *In:* GLOBAL FORUM FOR HEALTH RESEARCH (ed.). Geneva: Global Forum for Health Research.

DE OLIVEIRA, N. A., LUZ, M. R., SARAIVA, R. M. & ALVES, L. A. 2011. Student views of research training programmes in medical schools. *Med Educ,* 45**,** 748-55.

DE THE, G. & ZETTERSTROM, R. 2005. Mother-child health research (IRN-MCH): achievements and prospects of an international network. *Acta Paediatr,* 94**,** 964-7.

DE-GRAFT AIKINS, A., ARHINFUL, D. K., PITCHFORTH, E., OGEDEGBE, G., ALLOTEY, P. & AGYEMANG, C. 2012. Establishing and sustaining research partnerships in Africa: a case study of the UK-Africa Academic Partnership on Chronic Disease. *Global Health,* 8**,** 29.

DECKELBAUM, R. J., NTAMBI, J. M. & WOLGEMUTH, D. J. 2011. Basic science research and education: a priority for training and capacity building in developing countries. *Infect Dis Clin North Am,* 25**,** 669-76, x.

DELISLE, H., ROBERTS, J. H., MUNRO, M., JONES, L. & GYORKOS, T. W. 2005. The role of NGOs in global health research for development. *Health Res Policy Syst,* 3**,** 3.

DEVASENAPATHY, N., SINGH, K. & PRABHAKARAN, D. 2009. Conduct of clinical trials in developing countries: a perspective. *Current Opinion in Cardiology,* 24**,** 295-300.

DEVI, V., ABRAHAM, R. R., ADIGA, A., RAMNARAYAN, K. & KAMATH, A. 2010. Fostering research skills in undergraduate medical students through mentored students projects: example from an Indian medical school. *Kathmandu Univ Med J (KUMJ),* 8**,** 294-8.

DFID 2010. Capacity Building in Research. *In:* DEVELOPMENT, D. F. I. (ed.).

DODANI, S. & LAPORTE, R. E. 2008. Ways to strengthen research capacity in developing countries: effectiveness of a research training workshop in Pakistan. *Public Health,* 122**,** 578-87.

DODANI, S., SONGER, T., AHMED, Z. & LAPORTE, R. E. 2012. Building research capacity in developing countries: cost-effectiveness of an epidemiology course taught by traditional and video-teleconferencing methods in Pakistan. *Telemed J E Health,* 18**,** 621-8.

EDITORIAL 2000. Enabling research in developing countries. *Lancet,* 356**,** 1043.

EDITORIAL 2001. Strengthening research capacity's weakest link. *Lancet,* 358**,** 1381.

EDITORIAL 2008. The Bamako call to action: research for health. *Lancet,* 372**,** 1855-1855.

EDITORIAL 2009a. Bringing health research forward. *Tanzan J Health Res,* 11**,** iii-iv.

EDITORIAL 2009b. Strengthening research capacity in Africa. *Lancet,* 374**,** 1.

EDWARDS, N., WEBBER, J., MILL, J., KAHWA, E. & ROELOFS, S. 2009. Building capacity for nurse-led research. *Int Nurs Rev,* 56**,** 88-94.

ENOCH, S. 2005. The Mexico Summit on Health Research 2004: medical community in developing countries has duty to promote healthcare research. *BMJ,* 330**,** 421.

ESSENCE ON HEALTH RESEARCH 2011. Planning Monitoring and Evaluation; Framework for Capacity Strengthening in Health Research. *In:* ESSENCE GOOD PRACTICE DOCUMENT SERIES (ed.). Geneva: Copytrend.

EXCLER, J. L. 2006. AIDS vaccine efficacy trials: expand capacity and prioritize. 'Throughout Africa, Asia and Latin America state-of-the-art clinics and laboratories...exist where, 4 years ago, there were none'. *Expert Rev Vaccines,* 5**,** 167-70.

EXCLER, J. L., PITISUTTITHUM, P., RERKS-NGARM, S., SHAO, Y., ZHANG, L., TAMASHIRO, H., OSMANOV, S. & CONSULTATION, W.-U. R. 2008. Expanding research capacity and accelerating AIDS vaccine development in Asia. *Southeast Asian J Trop Med Public Health,* 39**,** 766-84.

EZEH, A. C., IZUGBARA, C. O., KABIRU, C. W., FONN, S., KAHN, K., MANDERSON, L., UNDIEH, A. S., OMIGBODUN, A. & THOROGOOD, M. 2010. Building capacity for public and population health research in Africa: the consortium for advanced research training in Africa (CARTA) model. *Glob Health Action,* 3.

FATHALLA, M. F. 2004. Tapping the potential for health research in developing countries. *Bull World Health Organ,* 82**,** 722.

GADSBY, E. W. 2011. Research capacity strengthening: donor approaches to improving and assessing its impact in low- and middle-income countries. *Int J Health Plann Manage,* 26**,** 89-106.

GARCIA, P. J., COTRINA, A., GOTUZZO, E., GONZALEZ, E. & BUFFARDI, A. L. 2010. Research training needs in Peruvian national TB/HIV programs. *BMC Medical Education,* 10.

GARRETT, L. 2007. The Challenge of Global Health. (cover story). *Foreign Affairs,* 86**,** 14-38.

GAYM, A. 2008. Health research in Ethiopia--past, present and suggestions on the way forward. *Ethiop Med J,* 46**,** 287-308.

GELDENHUYS, H., VELDSMAN, A., TAMERIS, M., LUABEYA, A., HANEKOM, W., MAHOMED, H. & HATHERILL, M. 2013. Analysis of time to regulatory and ethical approval of SATVI TB vaccine trials in South Africa. *S Afr Med J,* 103**,** 85-9.

GELDENHUYS, H., WAGGIE, Z., JACKS, M., GELDENHUYS, M., TRAUT, L., TAMERIS, M., HATHERILL, M., HANEKOM, W. A., SUTTER, R., HUSSEY, G. & MAHOMED, H. 2012. Vaccine trials in the developing world: operational lessons learnt from a phase IV poliomyelitis vaccine trial in South Africa. *Vaccine,* 30**,** 5839-43.

GEZMU, M., DEGRUTTOLA, V., DIXON, D., ESSEX, M., HALLORAN, E., HOGAN, J., GROBLER, A., KIM, S., MCDERMOTT, J., MCKAIG, R. & NEATON, J. D. 2011. Strengthening biostatistics resources in sub-Saharan Africa: research collaborations through U.S. partnerships. *Stat Med,* 30**,** 695-708.

GILMOUR, J. W., STEVENS, W. S., GRAY, C. & DE SOUZA, M. 2007. Laboratory expansion to large-scale international HIV preventive vaccine trials. *Curr Opin HIV AIDS,* 2**,** 201-6.

GLOBAL FORUM FOR HEALTH RESEARCH 2000. The 10/90 report on health research 2000. *In:* RESEARCH, G. F. F. H. (ed.). Geneva: Global Forum for Health Research.

GONZALEZ-BLOCK, M. A., VARGAS-RIANO, E. M., SONELA, N., IDROVO, A. J., OUWE-MISSI-OUKEM-BOYER, O. & MONOT, J. J. 2011. Research capacity for institutional collaboration in implementation research on diseases of poverty. *Trop Med Int Health,* 16**,** 1285-90.

GOTCH, F. & GILMOUR, J. 2007. Science, medicine and research in the developing world: a perspective. *Nat Immunol,* 8**,** 1273-6.

GOTO, A., NGUYEN, T. N., NGUYEN, T. M. & HUGHES, J. 2005. Building postgraduate capacity in medical and public health research in Vietnam: an in-service training model. *Public Health,* 119**,** 174-83.

GRAY, G. E., DE BRUYN, G., SLACK, C., STEEL, G. & WILLIAMSON, C. 2006. Preparing developing countries for efficacy trials. *Curr Opin HIV AIDS,* 1**,** 330-5.

GREEN, A. & BENNETT, S. (eds.) 2007. *Sound Choices: Enhancing Capacity for Evidence-Informed Health Policy,* Geneva: World Health Organisation.

GREENWOOD, B., BHASIN, A. & TARGETT, G. 2012. The Gates Malaria Partnership: a consortium approach to malaria research and capacity development. *Trop Med Int Health,* 17**,** 558-63.

GREENWOOD, B. M., BHASIN, A., BOWLER, C. H., NAYLOR, H. & TARGETT, G. A. 2006. Capacity strengthening in malaria research: the Gates Malaria Partnership. *Trends Parasitol,* 22**,** 278-84.

GUINDO, M. A., SHOTT, J. P., SAYE, R., DIAKITE, M. L., SANOGO, S., DEMBELE, M. B., KEITA, S., NAGEL, M. C., ELLIS, R. D., AEBIG, J. A., DIALLO, D. A. & DOUMBO, O. K. 2012. Promoting good clinical laboratory practices and laboratory accreditation to support clinical trials in sub-Saharan Africa. *Am J Trop Med Hyg,* 86**,** 573-9.

GULLAND, A. 2012. Plan to stimulate research in developing countries is put on hold. *BMJ,* 344**,** e3771.

GYAPONG, J. & OFORI-ADJEI, D. 2011. Capacity building for relevant health research in developing countries. *In:* UNIT, H. R. (ed.). University of Ghana Medical School.

HALABI-NASSIF, H. & HATEM, M. 2008. [Evidence-based practice and the development of a nursing research culture]. *Perspect Infirm,* 5**,** 36-42.

HARGREAVES, S. 2002. Wellcome Trust promotes ethical research in developing world. *BMJ,* 325**,** 986.

HARRIES, A. D. 2003. Integration of operational research into National Tuberculosis Control Programmes. *Tuberculosis (Edinb),* 83**,** 143-7.

HARRIES, A. D., RUSEN, I. D., REID, T., DETJEN, A. K., BERGER, S. D., BISSELL, K., HINDERAKER, S. G., EDGINTON, M., FUSSELL, M., FUJIWARA, P. I. & ZACHARIAH, R. 2011. The Union and Medecins Sans Frontieres approach to operational research. *Int J Tuberc Lung Dis,* 15**,** 144-54, i.

HARUN AR, R. 2004. Promoting road traffic injuries research in South Asia: capacity strengthening in health research. *J Coll Physicians Surg Pak,* 14**,** 736-8.

HIGGS, E. S., HAYDEN, F. G., CHOTPITAYASUNONDH, T., WHITWORTH, J. & FARRAR, J. 2008. The Southeast Asian Influenza Clinical Research Network: development and challenges for a new multilateral research endeavor. *Antiviral Res,* 78**,** 64-8.

HOYT, P. 2006. Problem Solving for Better Health Nursing: a working approach to the development and dissemination of applied research in developing countries. *Appl Nurs Res,* 19**,** 110-2; discussion 112.

HUSSEY, G. & HAWKRIDGE, A. 2012. The state and future of research at the University of Cape Town's Faculty of Health Sciences. *S Afr Med J,* 102**,** 412-4.

HYDER, A. A., AKHTER, T. & QAYYUM, A. 2003. Capacity development for health research in Pakistan: the effects of doctoral training. *Health Policy Plan,* 18**,** 338-43.

IACCARINO, M. 2004. Mastering science in the South. To develop much-needed research capacity, developing countries cannot rely on the industrialized world, but have to find their own specific solutions. *EMBO Rep,* 5**,** 437-41.

IJSSELMUIDEN, C., MARAIS, D. L., BECERRA-POSADA, F. & GHANNEM, H. 2012. Africa's neglected area of human resources for health research - the way forward. *S Afr Med J,* 102**,** 228-33.

JAFFAR, S., LAZARUS, J. V., ONYEBUJOH, P., CHAKAYA, J., GARRIB, A., MWABA, P., MBOUP, S., BELLIS, K., EGWAGA, S., CORRAH, T. & COUTINHO, A.

2010. Health services strengthening in Africa--research is a key component. *Trop Med Int Health,* 15**,** 1270-3.

JENTSCH, B. & PILLEY, C. 2003. Research relationships between the South and the North: Cinderella and the ugly sisters? *Soc Sci Med,* 57**,** 1957-67.

JOHNSON, K., KENNEDY, S. B., HARRIS, A. O., LINCOLN, A., NEACE, W. & COLLINS, D. 2005. Strengthening the HIV/AIDS service delivery system in Liberia: an international research capacity-building strategy. *J Eval Clin Pract,* 11**,** 257-73.

JONES, N., BAILEY, M. & LYYTIKAINEN, M. 2007. Research capacity strengthening in Africa: Trends, gaps and opportunities. *In:* INSTITUTE, O. D. (ed.). London: Overseas Development Institute.

KABIRU, C. W., IZUGBARA, C. O., WAMBUGU, S. W. & EZEH, A. C. 2010. Capacity development for health research in Africa: experiences managing the African Doctoral Dissertation Research Fellowship Program. *Health Res Policy Syst,* 8**,** 21.

KAMUNYORI, S., AL-BADER, S., SEWANKAMBO, N., SINGER, P. A. & DAAR, A. S. 2010. Science-based health innovation in Uganda: creative strategies for applying research to development. *BMC Int Health Hum Rights,* 10 Suppl 1**,** S5.

KARIUKI, T., PHILLIPS, R., NJENGA, S., OLESEN, O. F., KLATSER, P. R., PORRO, R., LOCK, S., CABRAL, M. H., GLIBER, M. & HANNE, D. 2011. Research and capacity building for control of neglected tropical diseases: the need for a different approach. *PLoS Negl Trop Dis,* 5**,** e1020.

KASONDE, J. M. & CAMPBELL, S. 2012. Creating a Knowledge Translation Platform: nine lessons from the Zambia Forum for Health Research. *Health Res Policy Syst,* 10**,** 31.

KELLERMAN, R., KLIPSTEIN-GROBUSCH, K., WEINER, R., WAYLING, S. & FONN, S. 2012. Investing in African research training institutions creates sustainable capacity for Africa: the case of the University of the Witwatersrand School of Public Health masters programme in epidemiology and biostatistics. *Health Res Policy Syst,* 10**,** 11.

KENT, S. J., COOPER, D. A., CHHI VUN, M., SHAO, Y., ZHANG, L., GANGULY, N., BELA, B., TAMASHIRO, H., DITANGCO, R., RERKS-NGARM, S., PITISUTTITHUM, P., VAN KINH, N., BERNSTEIN, A., OSMANOV, S., INVESTIGATORS, A. V. F. A. N. & SUPPORTERS 2010. AIDS vaccine for Asia Network (AVAN): expanding the regional role in developing HIV vaccines. *PLoS Med,* 7**,** e1000331.

KHAN, F. A. 2010. Challenges of anaesthesia research in developing countries. *J Coll Physicians Surg Pak,* 20**,** 563-4.

KHAN, H., KHAN, S. & IQBAL, A. 2009. Knowledge, attitudes and practices around health research: the perspective of physicians-in-training in Pakistan. *BMC Med Educ,* 9**,** 46.

KHANNA, R., HOTA, P. & LAHARIYA, C. 2010. Health research strengthening and operational research needs for improving child survival in India. *Indian J Pediatr,* 77**,** 291-9.

KILAMA, W. L. 2001. The malaria burden and the need for research and capacity strengthening in Africa. *Am J Trop Med Hyg,* 64**,** iii.

KILAMA, W. L. 2009. The 10/90 gap in sub-Saharan Africa: resolving inequities in health research. *Acta Trop,* 112 Suppl 1**,** S8-S15.

KILAMA, W. L., CHILENGI, R. & WANGA, C. L. 2007. Towards an African-driven malaria vaccine development program: history and activities of the African Malaria Network Trust (AMANET). *Am J Trop Med Hyg,* 77**,** 282-8.

KIRIGIA, J. M. & WAMBEBE, C. 2006. Status of national health research systems in ten countries of the WHO African Region. *BMC Health Serv Res,* 6**,** 135.

KITUA, A. Y. 2007. Health research agenda for East Africa in the new millennium: looking ahead. *Tanzan Health Res Bull,* 9**,** 147-53.

KITUA, A. Y., CORRAH, T., HERBST, K., NYIRENDA, T., AGWALE, S., MAKANGA, M. & MGONE, C. S. 2009. Strengthening capacity, collaboration and quality of clinical research in Africa: EDCTP Networks of Excellence. *Tanzan J Health Res,* 11**,** 51-4.

KOK, M. O., RODRIGUES, A., SILVA, A. P. & DE HAAN, S. 2012. The emergence and current performance of a health research system: lessons from Guinea Bissau. *Health Res Policy Syst,* 10**,** 5.

KWONG, J. S. & YU, C. M. 2013. The need for multicentre cardiovascular clinical trials in Asia. *Nat Rev Cardiol,* 10**,** 355-62.

LAABES, E. P., DESAI, R., ZAWEDDE, S. M. & GLEW, R. H. 2011. How much longer will Africa have to depend on western nations for support of its capacity-building efforts for biomedical research? *Trop Med Int Health,* 16**,** 258-62.

LANG, T. 2011. Advancing global health research through digital technology and sharing data. *Science,* 331**,** 714-7.

LANG, T. & SIRIBADDANA, S. 2012. Clinical trials have gone global: is this a good thing? *PLoS Med,* 9**,** e1001228.

LANG, T. A. & KOKWARO, G. O. 2008. Malaria drug and vaccine trials in Africa: obstacles and opportunities. *Trans R Soc Trop Med Hyg,* 102**,** 7-10.

LANG, T. A., WHITE, N. J., TRAN, H. T., FARRAR, J. J., DAY, N. P., FITZPATRICK, R., ANGUS, B. J., DENIS, E., MERSON, L., CHEAH, P. Y., CHILENGI, R., KIMUTAI, R. & MARSH, K. 2010. Clinical research in resource-limited settings: enhancing research capacity and working together to make trials less complicated. *PLoS Negl Trop Dis,* 4**,** e619.

LANGER, A., DIAZ-OLAVARRIETA, C., BERDICHEVSKY, K. & VILLAR, J. 2004. Why is research from developing countries underrepresented in international health literature, and what can be done about it? *Bull World Health Organ,* 82**,** 802-3.

LANSANG M. & DENNIS R. 2007. The need to develop research capacity. *Global Forum Update on Research for Health Volume 4.* London: Pro-Brook Publishing Ltd.

LANSANG, M. A. & DENNIS, R. 2004. Building capacity in health research in the developing world. *Bull World Health Organ,* 82**,** 764-70.

LAZARUS, J. V., WALLACE, S. A. & LILJESTRAND, J. 2010. Improving African health research capacity. *Scand J Public Health,* 38**,** 670-1.

LEE, P. P. & LAU, Y. L. 2011. Improving care, education, and research: the Asian primary immunodeficiency network. *Ann N Y Acad Sci,* 1238**,** 33-41.

LEHNER, T., HOELSCHER, M., CLERICI, M., GOTCH, F., PEDNEAULT, L., TARTAGLIA, J., GRAY, C., MESTECKY, J., SATTENTAU, Q., VAN DE WIJGERT, J., TOURE, C., OSMANOV, S., SCHMIDT, R. E., DEBRE, P.,

ROMARIS, M., HOEVELER, A. & DI FABIO, S. 2005. European Union and EDCTP strategy in the global context: recommendations for preventive HIV/AIDS vaccines research. *Vaccine,* 23**,** 5551-6.

LESI, O. A., ORENUGA, O. O., ROBERTS, A. & ABUDU, O. O. 2009. Research productivity of junior academic staff at a tertiary medical college in south west, Nigeria. *Nig Q J Hosp Med,* 19**,** 119-24.

LEXCHIN, J. 2010. One step forward, one step sideways? Expanding research capacity for neglected diseases. *BMC Int Health Hum Rights,* 10**,** 20.

LI, M., WEI, L., LIU, H. & TANG, L. 2009. Integrative review of international nursing research in Mainland China. *Int Nurs Rev,* 56**,** 28-33.

LOUISA, M., TAKEUCHI, M., SETIABUDY, R. & NAFRIALDI 2012. Current status of phase I clinical trials in Asia: an academic perspectives. *Acta Med Indones,* 44**,** 71-7.

LUTUMBA, P., KANDE, V., BOELAERT, M., KAYEMBE, J. M. & MAMPUNZA, S. 2010. Research capacity strengthening in the DRC. *Lancet,* 375**,** 1080.

MAGWAZA, S., MATHAMBO, V., MAGONGO, B., MVO, E. & MAKHANYA, N. 2003. Health research Capacity Building in South Africa: Current knowledge and practices. Durban: Health Systems Trust.

MANABE, Y. C., KATABIRA, E., BROUGH, R. L., COUTINHO, A. G., SEWANKAMBO, N. & MERRY, C. 2011. Developing independent investigators for clinical research relevant for Africa. *Health Res Policy Syst,* 9**,** 44.

MARAIS, D., TOOHEY, J., EDWARDS, D. & IJSSELMUIDEN, C. 2013. Where there is no lawyer: Guidance for fairer contract negotiation in collaborative research

partnerships. *In:* DEVELOPMENT, C. I. H. R. F. (ed.). Geneva & Pietermaritzburg: Council in Health Research for Development.

MARCHETTI, E., MAZARIN-DIOP, V., CHAUMONT, J., MARTELLET, L., MAKADI, M. F., VIVIANI, S., KULKARNI, P. S. & PREZIOSI, M. P. 2012. Conducting vaccine clinical trials in sub-Saharan Africa: operational challenges and lessons learned from the Meningitis Vaccine Project. *Vaccine,* 30**,** 6859-63.

MARJANOVIC, S., HANLIN, R., DIEPEVEEN, S. & CHATAWAY, J. 2012. RESEARCH CAPACITY-BUILDING IN AFRICA: NETWORKS, INSTITUTIONS AND LOCAL OWNERSHIP. *Journal of International Development***,** n/a-n/a.

MARSHALL-LUCETTE, S., CORBETT, K., LARTEY, N., OPIO, D. & BIKAITWOHA, M. E. 2007. Developing locally based research capacity in Uganda. *Int Nurs Rev,* 54**,** 227-33.

MARTINS, N. & HAWKINS, Z. 2012. Striving for better health through health research in post-conflict Timor-Leste. *Health Res Policy Syst,* 10**,** 13.

MATEE, M. I., MANYANDO, C., NDUMBE, P. M., CORRAH, T., JAOKO, W. G., KITUA, A. Y., AMBENE, H. P., NDOUNGA, M., ZIJENAH, L., OFORI-ADJEI, D., AGWALE, S., SHONGWE, S., NYIRENDA, T. & MAKANGA, M. 2009. European and Developing Countries Clinical Trials Partnership (EDCTP): the path towards a true partnership. *BMC Public Health,* 9**,** 249.

MAYHEW, S. H., DOHERTY, J. & PITAYARANGSARIT, S. 2008. Developing health systems research capacities through north-south partnership: an evaluation of collaboration with South Africa and Thailand. *Health Res Policy Syst,* 6**,** 8.

MAZIAK, W. 2001. Global health research. Science aid programme could be set up to help researchers in developing countries. *BMJ,* 322**,** 173.

MBUAGBAW, L., ONGOLO-ZOGO, P. & THABANE, L. 2013. Investigating community ownership of a text message programme to improve adherence to antiretroviral therapy and provider-client communication: a mixed methods research protocol. *BMJ Open,* 3.

MBUAGBAW, L., THABANE, L., ONGOLO-ZOGO, P. & LANG, T. 2011. The challenges and opportunities of conducting a clinical trial in a low resource setting: the case of the Cameroon mobile phone SMS (CAMPS) trial, an investigator initiated trial. *Trials,* 12**,** 145.

MCKEE, M. 2008. Global research for health. *British Medical Journal,* 337.

MCKEE, M., STUCKLER, D. & BASU, S. 2012. Where there is no health research: what can be done to fill the global gaps in health research? *PLoS Med,* 9**,** e1001209.

MEDAGLINI, D. & HOEVELER, A. 2003. The European research effort for HIV/AIDS, malaria and tuberculosis. *Vaccine,* 21 Suppl 2**,** S116-20.

MELIS, T., ASHCROFT, K., MACFARLANE, I., RAYNER, P., SEMELA, T. & YIZENGAW, T. 2008. Human capacity building needs analysis of Ethiopian new public universities (NPUs). *In:* CENTRE FOR INTERNATIONAL COOPERATION, V. U. A. (ed.). Development Assistance Group, Ethiopia.

MGONE, C., VOLMINK, J., COLES, D., MAKANGA, M., JAFFAR, S. & SEWANKAMBO, N. 2010. Linking research and development to strengthen health systems in Africa. *Trop Med Int Health,* 15**,** 1404-6.

MGONE, C. S. 2010. Strengthening of the clinical research capacity for malaria: a shared responsibility. *Malar J,* 9 Suppl 3**,** S5.

MGONE, S. & MOCUMBI, P. 2008. Collaborative approach to clinical trials. *In:* MAITLIN, S., DE FRANCISCO, A., SUNDARAM, L., FAICH, H. & GEHNER, M. (eds.) *Health Partnerships Review.* Geneva: Global Forum for Health Research.

MIIRO, G. M., OUKEM-BOYER, O. O., SARR, O., RAHMANI, M., NTOUMI, F., DHEDA, K., PYM, A., MBOUP, S. & KALEEBU, P. 2013. EDCTP regional networks of excellence: initial merits for planned clinical trials in Africa. *BMC Public Health,* 13**,** 258.

MINJA, H., NSANZABANA, C., MAURE, C., HOFFMANN, A., RUMISHA, S., OGUNDAHUNSI, O., ZICKER, F., TANNER, M. & LAUNOIS, P. 2011. Impact of Health Research Capacity Strengthening in Low- and Middle-Income Countries: The Case of WHO/TDR Programmes. *Plos Neglected Tropical Diseases,* 5.

MONY, P. K., KURPAD, A. & VAZ, M. 2005. Capacity building in collaborative research is essential. *BMJ,* 331**,** 843-4.

MORAN, M., GUZMAN, J., ROPARS, A., JORGENSEN, M., POTTER, S., MCDONALD, A. & HAILE-SELASSIE, H. 2008. Clinical trial site capacity for malaria product development. *In:* MAITLIN, S., DE FRANCISCO, A., SUNDARAM, L., FAICH, H. & GEHNER, M. (eds.) *Health Partnerships Review.* Geneva: Global Forum for Health Research, Geneva.

MORENO-BORCHART, A. 2004. One problem at a time. Building research capacities in developing countries is necessary for economic success in the long term. But the numerous problems in doing so have to be solved for each country individually. *EMBO Rep,* 5**,** 127-30.

MULDOON, K. A., BIRUNGI, J., BERRY, N. S., NGOLOBE, M. H., MWESIGWA, R., SHANNON, K. & MOORE, D. M. 2012. Supporting southern-led research: implications for North-South research partnerships. *Can J Public Health,* 103**,** 128-31.

MULLAN, F., FREHYWOT, S., OMASWA, F., BUCH, E., CHEN, C., GREYSEN, S. R., WASSERMANN, T., ABUBAKR, D. E., AWASES, M., BOELEN, C., DIOMANDE, M. J., DOVLO, D., FERRO, J., HAILEAMLAK, A., IPUTO, J., JACOBS, M., KOUMARE, A. K., MIPANDO, M., MONEKOSSO, G. L., OLAPADE-OLAOPA, E. O., RUGARABAMU, P., SEWANKAMBO, N. K., ROSS, H., AYAS, H., CHALE, S. B., CYPRIEN, S., COHEN, J., HAILE-MARIAM, T., HAMBURGER, E., JOLLEY, L., KOLARS, J. C., KOMBE, G. & NEUSY, A. J. 2011. Medical schools in sub-Saharan Africa. *Lancet,* 377**,** 1113-21.

MUULA, A. S. 2007. What drives health research in a developing country? *Croat Med J,* 48**,** 261-7.

MWABA, P., BATES, M., GREEN, C., KAPATA, N. & ZUMLA, A. 2010. Research capacity strengthening in African countries. *Lancet,* 375**,** 1874.

MWANGOKA, G., OGUTU, B., MSAMBICHAKA, B., MZEE, T., SALIM, N., KAFURUKI, S., MPINA, M., SHEKALAGHE, S., TANNER, M. & ABDULLA, S. 2013. Experience and challenges from clinical trials with malaria vaccines in Africa. *Malar J,* 12**,** 86.

NACHEGA, J. B., UTHMAN, O. A., HO, Y. S., LO, M., ANUDE, C., KAYEMBE, P., WABWIRE-MANGEN, F., GOMO, E., SOW, P. S., OBIKE, U., KUSIAKU, T., MILLS, E. J., MAYOSI, B. M. & IJSSELMUIDEN, C. 2012. Current status and

future prospects of epidemiology and public health training and research in the WHO African region. *Int J Epidemiol,* 41**,** 1829-46.

NANTULYA, F. N., KENGEYA-KAYONDO, J. F. & OGUNDAHUNSI, O. A. 2007. Research themes and advances in malaria research capacity made by the Multilateral Initiative on Malaria. *Am J Trop Med Hyg,* 77**,** 303-13.

NCHINDA, T. C. 2002. Research capacity strengthening in the South. *Soc Sci Med,* 54**,** 1699-711.

NJIE-CARR, V., KALENGE, S., KELLEY, J., WILSON, A., MULIIRA, J. K., NABIRYE, R. C., GLASS, N., BOLLINGER, R., ALAMO-TALISUNA, S. & CHANG, L. W. 2012. Research capacity-building program for clinicians and staff at a community-based HIV clinic in Uganda: A pre/post evaluation. *J Assoc Nurses AIDS Care,* 23**,** 431-41.

NTOUMI, F. 2010. Networking and capacity building for health research in Central Africa. *Wien Klin Wochenschr,* 122 Suppl 1**,** 23-6.

NUYENS, Y. 2005. No Development Without Research. Geneva: Global Forum for Health Research.

OGUTU, B. R., BAIDEN, R., DIALLO, D., SMITH, P. G. & BINKA, F. N. 2010. Sustainable development of a GCP-compliant clinical trials platform in Africa: the malaria clinical trials alliance perspective. *Malar J,* 9**,** 103.

OLVEDA, R., LEONARDO, L., ZHENG, F., SRIPA, B., BERGQUIST, R. & ZHOU, X. N. 2010. Coordinating research on neglected parasitic diseases in Southeast Asia through networking. *Adv Parasitol,* 72**,** 55-77.

PANG, T., SADANA, R., HANNEY, S., BHUTTA, Z., HYDER, A. & SIMON, J. 2003. Knowledge for better health — a conceptual framework and foundation for

health research systems. *Bulletin of the World Health Organization,* 81**,** 815-820.

PARLIMENTARY OFFICE OF SCIENCE AND TECHNOLOGY 2004. Scientific Capacity In Developing Countries. *In:* TECHNOLOGY, P. O. O. S. A. (ed.). London: Parlimentary Office of Science and Technology.

PARRY, C., MOROJELE, N., MYERS, B. & PLUDDEMANN, A. 2013. Addiction research centres and the nurturing of creativity: The Alcohol & Drug Abuse Research Unit at the South African Medical Research Council - strengthening substance abuse research and policy in South Africa. *Addiction,* 108**,** 14-9.

PERKOVIC, V., PATIL, V., WEI, L., LV, J., PETERSEN, M. & PATEL, A. 2012. Global randomized trials: the promise of India and China. *J Bone Joint Surg Am,* 94 Suppl 1**,** 92-6.

PETERSEN, P. E. 2009. Global policy for improvement of oral health in the 21st century--implications to oral health research of World Health Assembly 2007, World Health Organization. *Community Dent Oral Epidemiol,* 37**,** 1-8.

PITAYARANGSARIT, S. & TANGCHAROENSATHIEN, V. 2009. Sustaining capacity in health policy and systems research in Thailand. *Bull World Health Organ,* 87**,** 72-4.

PITISUTTITHUM, P., CHOOPANYA, K. & RERK-NGNAM, S. 2010. HIV-vaccine research and development in Thailand: evolution and challenges. *Vaccine,* 28 Suppl 2**,** B45-9.

PURTY, A. J. 2008. Reflections for research capacity development in India. *Natl Med J India,* 21**,** 263.

RAB, M. A. 2003. Setting global health research priorities: investments for health research for developing countries must be increased. *BMJ,* 326**,** 1399.

RABIU, T. B. & BALOGUN, J. A. 2009. Repositioning health research in developing countries. *Arch Med Res,* 40**,** 223.

RAMJEE, G. 2008. Issues surrounding the implementation of multiple product development partnership clinical trials in developing countries. *In:* RESEARCH, G. F. F. H. (ed.). Geneva: Global Forum for Health Research.

REDMAN-MACLAREN, M., MACLAREN, D. J., HARRINGTON, H., ASUGENI, R., TIMOTHY-HARRINGTON, R., KEKEUBATA, E. & SPEARE, R. 2012. Mutual research capacity strengthening: a qualitative study of two-way partnerships in public health research. *Int J Equity Health,* 11**,** 79.

RERKS-NGARM, S., PITISUTTITHUM, P., GANGULY, N., ZHANG, L., TAMASHIRO, H., COOPER, D. A., VUN, M. C., BELA, B., DITANGCO, R., VAN KINH, N., BERNSTEIN, A., OSMANOV, S., MATHIESON, B., KENT, S. J. & SHAO, Y. 2010. Defining the objectives of the AIDS vaccine for Asia network: report of the WHO-UNAIDS/Global HIV vaccine enterprise regional consultation on expanding AIDS vaccine research and development capacity in Asia. *Curr Opin HIV AIDS,* 5**,** 435-52.

RESNIK, D. B. 2004. The distribution of biomedical research resources and international justice. *Dev World Bioeth,* 4**,** 42-57.

SABZWARI, S., KAUSER, S. & KHUWAJA, A. K. 2009. Experiences, attitudes and barriers towards research amongst junior faculty of Pakistani medical universities. *BMC Med Educ,* 9**,** 68.

SADANA, R., D'SOUZA, C., HYDER, A. A. & CHOWDHURY, A. M. 2004. Importance of health research in South Asia. *BMJ,* 328**,** 826-30.

SAWYERR 2004. African Universities and the Challenge of Research Capacity Development. *JHEA/RESA Vol. 2, No. 1, 2004, pp. 211–240*.

SAYED, S. I., DUTTA, S., MATEEN, S., KAZI, R. & JAGADE, M. 2011. Clinical health research in India: is there a way forward? *J Indian Med Assoc,* 109**,** 270-1.

SCHLUGER, N., KARUNAKARA, U., LIENHARDT, C., NYIRENDA, T. & CHAISSON, R. 2007. Building Clinical Trials Capacity for Tuberculosis Drugs in High-Burden Countries. *PLoS Med,* 4**,** e302.

SEN, F. & MUTHUSWAMY, V. 2006. Capacity building for clinical trials in India. *Indian J Med Res,* 124**,** 605-7.

SHAFIQ, N., PANDHI, P. & MALHOTRA, S. 2009. Investigator-initiated pragmatic trials in developing countries--much needed but much ignored. *Br J Clin Pharmacol,* 67**,** 141-2.

SHANKAR, P. R. 2007. Mentoring a medical student towards applied research in a developing country. *Med Teach,* 29**,** 253-4.

SHANKAR, P. R., CHANDRASEKHAR, T. S., MISHRA, P. & SUBISH, P. 2006. Initiating and strengthening medical student research: time to take up the gauntlet. *Kathmandu Univ Med J (KUMJ),* 4**,** 135-8.

SHANN, F. 2002. Research in developing countries. *N Engl J Med,* 346**,** 627-8.

SHIRAHATTI, R. V., SURA, S., SUMANTHPRASAD, G. R. & KHURANA, L. 2010. Dental students research inventory: a questionnaire to assess research challenges and opportunities. *J Dent Educ,* 74**,** 1308-18.

SIEGFRIED, N. L. & HUGHES, G. 2012. Herbal medicine, randomised controlled trials and global core competencies. *S Afr Med J,* 102**,** 912-3.

SILKAVUTE, P., TUNG, D. X. & JONGUDOMSUK, P. 2013. Sustaining a regional emerging infectious disease research network: a trust-based approach. *Emerg Health Threats J,* 6.

SILOVE, D., REES, S., TAM, N., LIDDELL, B. & ZWI, A. 2011. Staff management and capacity building under conditions of insecurity: lessons from developing mental health service and research programs in post-conflict Timor-Leste. *Australas Psychiatry,* 19 Suppl 1**,** S90-4.

SIRIWARDHANA, C., SUMATHIPALA, A., SIRIBADDANA, S., SAMARAWEERA, S., ABEYSINGHE, N., PRINCE, M. & HOTOPF, M. 2011. Reducing the scarcity in mental health research from low and middle income countries: a success story from Sri Lanka. *Int Rev Psychiatry,* 23**,** 77-83.

SITTHI-AMORN, C., PONGPANICH, S., SOMRONGTHONG, R., LIKITKIRIRAT, T. & LIKITKIRIRAT, P. 2002. The Asian Voice in building equity in health for development - from the Asian Forum for Health Research, Manila, February 2000. *Health Policy Plan,* 17**,** 213-7.

SITTHI-AMORN, C. & SOMRONGTHONG, R. 2000. Strengthening health research capacity in developing countries: a critical element for achieving health equity. *BMJ,* 321**,** 813-7.

SMITH, R. 2002. Publishing research from developing countries. *Stat Med,* 21**,** 2869-77.

SPARKS, B. L. & GUPTA, S. K. 2004. Research in family medicine in developing countries. *Ann Fam Med,* 2 Suppl 2**,** S55-9.

STEPHEN, C. & DAIBES, I. 2010. Defining features of the practice of global health research: an examination of 14 global health research teams. *Glob Health Action,* 3.

SUAALII-SAUNI, T., AIAVAO, F., FAAFEU-HOPE, E., SOPOAGA, T., PAUL, C., RIGHARTS, A., MCCOOL, J., KIRIFI-ALAI, T. N., HILL, P. & FUATAI, F. L. 2011. Strengthening health research capacity from within Samoa. *Asia Pac J Public Health,* 23**,** 100-9.

SUMATHIPALA, A., SIRIBADDANA, S., SAMARAWEERA, S. & DAYARATNE, D. A. 2003. Capacity building through multi-disciplinary research: a report from Sri Lanka. *Br J Psychiatry,* 183**,** 457-8.

THAMARANGSI, T. 2013. Addiction research centres and the nurturing of creativity: Center for Alcohol Studies (CAS), Thailand. *Addiction,* 108**,** 1201-6.

THATTE, U. M. & BAVDEKAR, S. B. 2008. Clinical research in India: great expectations? *J Postgrad Med,* 54**,** 318-23.

THORNICROFT, G., COOPER, S., BORTEL, T. V., KAKUMA, R. & LUND, C. 2012. Capacity building in global mental health research. *Harv Rev Psychiatry,* 20**,** 13-24.

TIERNEY, W. M., NYANDIKO, W. N., SIIKA, A. M., WOOLS-KALOUSTIAN, K., SIDLE, J. E., KIPLAGAT, J., BELL, A. & INUI, T. S. 2013. "These are Good Problems to Have...": Establishing a Collaborative Research Partnership in East Africa. *J Gen Intern Med*.

TSAI, S. L. 2000. Nurses' participation and utilization of research in the Republic of China. *Int J Nurs Stud,* 37**,** 435-44.

TUGWELL, P., SITTHI-AMORN, C., HATCHER-ROBERTS, J., NEUFELD, V., MAKARA, P., MUNOZ, F., CZERNY, P., ROBINSON, V., NUYENS, Y. & OKELLO, D. 2006. Health Research Profile to assess the capacity of low and middle income countries for equity-oriented research. *BMC Public Health,* 6**,** 151.

UTHMAN, O. A. 2008. Performance, priorities, and future of biomedical research publications in Africa: Need for networks between scientists in developed and developing countries. *Pan Afr Med J,* 1**,** 5.

VAMADEVAN, A. S., SHAH, B. R., CALIFF, R. M. & PRABHAKARAN, D. 2011. Cardiovascular research in India: a perspective. *Am Heart J,* 161**,** 431-8.

VAN HELDEN, P. 2012. The cost of research in developing countries. *EMBO Rep,* 13**,** 395.

VAN ROYEN, K., LACHAT, C., HOLDSWORTH, M., SMIT, K., KINABO, J., ROBERFROID, D., NAGO, E., GARIMOI ORACH, C. & KOLSTEREN, P. 2013. How can the operating environment for nutrition research be improved in sub-saharan Africa? The views of african researchers. *PLoS One,* 8**,** e66355.

VARKEVISSER, C. M., MWALUKO, G. M. & LE GRAND, A. 2001. Research in action: the training approach of the Joint Health Systems Research Project for the Southern African Region. *Health Policy Plan,* 16**,** 281-91.

VASQUEZ, E., HIRSCH, J., GIANG, L. & PARKER, R. 2013. Rethinking health research capacity strengthening. *Global Public Health*.

VOGEL, I. 2011. Research Capacity Strengthening: Learning from Experience. *In:* (UKCDS), U. C. O. D. S. (ed.). UK Collaborative on Development Sciences (UKCDS).

VOLMINK, J. & DARE, L. 2005. Addressing inequalities in research capacity in Africa. *BMJ,* 331**,** 705-6.

WERTHEIM, H. F., PUTHAVATHANA, P., NGHIEM, N. M., VAN DOORN, H. R., NGUYEN, T. V., PHAM, H. V., SUBEKTI, D., HARUN, S., MALIK, S., ROBINSON, J., RAHMAN, M., TAYLOR, W., LINDEGARDH, N., WIGNALL, S., FARRAR, J. J. & DE JONG, M. D. 2010. Laboratory capacity building in Asia for infectious disease research: experiences from the South East Asia Infectious Disease Clinical Research Network (SEAICRN). *PLoS Med,* 7**,** e1000231.

WHITE, F. 2002. Capacity-building for health research in developing countries: a manager's approach. *Rev Panam Salud Publica,* 12**,** 165-72.

WHITE, M. T. 2007. A right to benefit from international research: a new approach to capacity building in less-developed countries. *Account Res,* 14**,** 73-92.

WHITE, N. W. 2004. Capacity building for research: report on a UNION Strategic Planning Workshop. Report of a workshop held during the International Union Against Tuberculosis and Lung Disease World Conference on Lung Health, Montreal, Canada, 7 October 2002. *Int J Tuberc Lung Dis,* 8**,** 910-4.

WHITWORTH, J., SEWANKAMBO, N. K. & SNEWIN, V. A. 2010. Improving implementation: building research capacity in maternal, neonatal, and child health in Africa. *PLoS Med,* 7**,** e1000299.

WILLCOX, M., SIEGFRIED, N. & JOHNSON, Q. 2012. Capacity for clinical research on herbal medicines in Africa. *J Altern Complement Med,* 18**,** 622-8.

WILLIAMS, J. R., SCHATZ, E. J., CLARK, B. D., COLLINSON, M. A., CLARK, S. J., MENKEN, J., KAHN, K. & TOLLMAN, S. M. 2010. Improving public health

training and research capacity in Africa: a replicable model for linking training to health and socio-demographic surveillance data. *Glob Health Action,* 3.

WORLD HEALTH ORGANISATION 2002. National Health Research Systems. Report of an international workshop, Cha-am, Thailand, 12–15 March 2001. Geneva: World Health Organisation.

WORLD HEALTH ORGANISATION 2004. World report on knowledge for better health: strengthening health systems. Geneva: World Health Organisation.

WORLD HEALTH ORGANISATION 2005. Ministerial Summit on Health Research (2004: Mexico City, Mexico). *In:* REPORT FROM THE MINISTERIAL SUMMIT ON HEALTH RESEARCH: IDENTIFY CHALLENGES, I. A., CORRECT INEQUITIES. (ed.). Geneva: World Health Organisation.

WORLD HEALTH ORGANISATION 2009. Scaling up research and learning for health systems: now is the time. *In:* REPORT OF A HIGH LEVEL TASK FORCE, P. A. E. A. T. G. M. F. O. R. F. H., BAMAKO, MALI (ed.). Geneva: World Health Organisation.

WORLD HEALTH ORGANISATION 2012. The WHO strategy on research for health. Geneva: World Health Organisation.

WRIGHT MDA, G., CAUFIELD, C., GRAY, G. & OLSON, J. 2005. International Research Capacity-Building Programs for Nurses to Study the Drug Phenomenon in Latin America: challenges and perspectives. *Rev Lat Am Enfermagem,* 13 Spec No**,** 1095-101.

YUSUF, S. 2002. Clinical research and trials in developing countries. *Stat Med,* 21**,** 2859-67.

ZACHARIAH, R., HARRIES, A. D., ISHIKAWA, N., RIEDER, H. L., BISSELL, K., LASERSON, K., MASSAQUOI, M., VAN HERP, M. & REID, T. 2009. Operational research in low-income countries: what, why, and how? *Lancet Infect Dis,* 9**,** 711-7.

ZACHARIAH, R., REID, T., SRINATH, S., CHAKAYA, J., LEGINS, K., KARUNAKARA, U. & HARRIES, A. D. 2011. Building leadership capacity and future leaders in operational research in low-income countries: why and how? *Int J Tuberc Lung Dis,* 15**,** 1426-35, i.

ZAIN, R. B., GHANI, W. M., RAZAK, I. A., LATIFAH, R. J., SAMSUDDIN, A. R., CHEONG, S. C., ABDULLAH, N., ISMAIL, A. R., HUSSAINI, H. B., TALIB, N. A. & JALLALUDIN, A. 2009. Building partnership in oral cancer research in a developing country: processes and barriers. *Asian Pac J Cancer Prev,* 10**,** 513-8.

ZHOU, X. N., WAYLING, S. & BERGQUIST, R. 2010. Concepts in research capabilities strengthening positive experiences of network approaches by TDR in the People's Republic of China and Eastern Asia. *Adv Parasitol,* 73**,** 1-19.

ZICKER, F. 2001. Strengthening capability for malaria research in Africa. *Emerg Infect Dis,* 7**,** 529-30.

ZUMLA, A., HUGGETT, J., DHEDA, K., GREEN, C., KAPATA, N. & MWABA, P. 2010. Trials and tribulations of an African-led research and capacity development programme: the case for EDCTP investments. *Trop Med Int Health,* 15**,** 489-94.

Supplementary file S2: Key terminology and definitions used in this synthesis

Term	Definition adopted	Examples	Comments and caveats
Health research capacity development (HRCD)	"Capacity development is defined as the ability of individuals, organisations or systems to perform appropriate functions effectively, efficiently and in a sustainable manner. When applied to health research, this translates to enabling both individuals and institutions to define health problems, set objectives and priorities, build sustainable institutions and organisations and identify solutions to key national health problems". [1]	Conducted by a large numbers of actors including: private foundations, multi and bi-lateral funders, international organisations, consortia, research councils, universities, NGOs and Industry. Examples include Rockefeller Foundation, The Swedish International Development Agency and WHO TDR. Usually involves knowledge or resource transfer at individual, institutional or macro levels.	This definition by Magwaza et al. [1] was found to be the most straightforward and encompassing definition of health research capacity development. Although the term "capacity development" has some pejorative connotations (assumption that there is little extant capacity), in its broadest sense capacity development could involve both building new capacity and strengthening existing capacity. It also semantically links capacity development to the international development agenda.
Research system	Concept representing a system designed to coordinate and manage health research at all stages of the knowledge cycle with the goal of improving health and health equity. The research system can be conceptualised as the environment or ecosystem that research takes place in [2].	Research systems encompass health research structures, regulations, governance, ethics, infrastructure, priority setting, financial and resource planning, acquisition and allocation at national, regional or global levels [3]. They include and connect all other levels, including the supra-national level.	Research system is not to be confused with "System Level". "System Level" is sometimes used to describe the "Macro Level".
Development modality	Modality refers to the methods or organisational setup used to deliver development interventions	May include basket funding to institutions, vertical support to projects, or horizontal capacity development, collaboration or partnerships [4].	Similar to research model. Modality is distinct from "strategy" which more specifically describes the development intervention.
Development strategy	Strategy refers to the selection and deployment of interventions aimed at resolving specific development barriers	Strategies can focussed at the individual, institutional, or macro level. Examples include training fellowships, building laboratories, or creating knowledge development platforms.	Modality is distinct from "strategy" which more specifically describes the development intervention.
Macro level capacity	The highest level of the national research system. Capacities at this level may be agenda setting, policies, national budgetary allocations, demand creation and strategic planning [5].	Government ministries such as Ministry of Health, Research or Education. Also includes regulatory and ethics bodies, funding bodies, top level administrative structures, professional associations and national registries.	Often used interchangeably with "System Level" [5]. However, this is confusing because the system encompasses individual, institutional, macro and supra-national levels.

Institutional level capacity	Refers to the ability of institutions to fund, manage and sustain themselves to perform all tasks required to deliver their services or goals. Common institutions include: universities, hospitals, and ministerial departments.	Elements of institutions include: human resources, material resources (computers and machinery), infrastructure (libraries and laboratories), service connections (internet, water, and power), service delivery and finance and management systems.	Based on the working definitions used by The Global Forum for Health Research and the World Health Organisation as they encompass the most common conceptualisations of the term [2, 5-7].
Organisational level capacity	The capacities of individual units within and governed by "institutions".	Usually include departments or research units within universities or research divisions within ministries of health	The term "institution" is often used interchangeably with "organisation". However, differentiating between these terms is useful because it distinguishes between the wider governing institution and organisational units within institutions [8].
Individual level capacity	Individual capacity development attempts to increase the capacities of individuals to perform their work effectively	Traditionally focused on producers of research. More recently extended to other stakeholders and includes "soft" skills training such as leadership.	Based on commonly accepted definitions used by The Global Forum for Health Research and the World Health Organisation [2, 5-7].

References

1. Magwaza S, Mathambo V, Magongo B, Mvo E, Makhanya N. Health research Capacity Building in South Africa: Current knowledge and practices. Durban: Health Systems Trust; 2003.

2. World Health Organisation. World report on knowledge for better health: strengthening health systems. Geneva: World Health Organisation; 2004.

3. Chanda-Kapata P, Campbell S, Zarowsky C. Developing a national health research system: participatory approaches to legislative, institutional and networking dimensions in Zambia. Health Res Policy Syst. 2012;10:17. Epub 2012/06/08. doi: 10.1186/1478-4505-10-17. PubMed PMID: 22672331; PubMed Central PMCID: PMC3463500.

4. Jones N, Bailey M, Lyytikainen M. Research capacity strengthening in Africa: Trends, gaps and opportunities. In: Institute OD, editor. London: Overseas Development Institute; 2007.

5. Nuyens Y. No Development Without Research. Geneva: Global Forum for Health Research; 2005.

6. Global Forum for Health Research. The 10/90 report on health research 2000. In: Research GFfH, editor. Geneva: Global Forum for Health Research; 2000.

7. World Health Organisation. National Health Research Systems. Report of an international workshop, Cha-am, Thailand, 12–15 March 2001. Geneva: World Health Organisation; 2002.

8. DFID. Capacity Building in Research. In: Development DfI, editor. 2010.

Supplementary file S3: Typology of capacity development actors

Actor	Examples	History	Roles	Development strategies	Research focus
Private foundations or charities	Wellcome Trust, Gates Foundation, Rockefeller Foundation	Most are relatively new to HRCD but some well-established	Funding	Mostly individual-level development to undertake specific projects. Little investment in local institutions.	Mostly support research generation but recent moves to translation
Multi-lateral agencies	World Health Organisation, World Bank, African Development Bank, Global Fund	WHO TDR & HRP are some of the oldest actors in HRCD. Most relatively new to HRCD.	Governance, stewardship, agenda setting, advocacy & funding	Usually channel funds through independent or subsidiary organisations. WHO offers individual-level development. Traditionally did not support institutions & had little system interest. However, now taking the lead in system approaches & may channel funds though local institutions.	Typically support research generation but increasing emphasis on translation, & dissemination
Bilateral agencies	Swedish International Development Agency, Department for International Development	Generally the longest running financial supporters of HRCD, but some are newer.	Varied	Usually support individual & institutional development. Little system development until very recently.	Historical focus on knowledge generation but progressively more emphasis on knowledge utilisation & dissemination
Global organisations	Global Forum for Health Research, European & Developing Countries Clinical Trial Partnership	Mostly since mid-1990s but some older. Often formed by, or as, a subsidiary of multi-laterals.	Stewardship roles set & promote global agendas. Also have multi-lateral funding brokerage roles.	Act as a catalyst to support & direct diverse actors to common goals. Usually fund & work with networks & consortia. Organise forums. Historically supported individual & institutional development but now support HRCD at most levels & modes. Provide advice & strong advocacy roles.	Originally interested in knowledge generation & translation but now tackle all stages of knowledge cycle
Consortia & networks	Alliance for Health Policy & Systems Research, International Network for Clinical Epidemiology, Central African Network on TB HIV/AIDS & Malaria	Largely a recent phenomenon forming mid-late 1990s onwards	Development, advocacy or funding brokerage roles Global, regional or local reach.	Individual & institutional support for specific projects or organisations that are thematically focussed. Not traditionally institution-wide or system development but recently more attention to those areas. Mixture of horizontal & vertical initiatives.	Collectively they cover the entire knowledge cycle but most have specific focus.
Public private partnerships & product development partnerships	Medicines for Malaria Venture, International AIDS Vaccine Initiative, Global Alliance for TB Drug Development	Largely a recent phenomenon forming mid-late 1990s onwards. Over 70 formed between 1995 & 2003.	Thematically based on disease or intervention of interest. Product development "upstream" R&D research.	Development approaches usually concentrated on building capacity to run specific studies through vertical interventions. Recently a little more attention to individual level & infrastructure development.	Knowledge generation & strong emphasis on translation

LMIC research councils & institutes of health	South African Medical Research Council, The National Research Council of Sri Lanka	Much less common than in HICs but increasing & some well-established.	Varies widely but usually in accordance with national priorities & focus on specific conditions or projects.	Funding is often limited but appears to be increasing. Formation of research sites, particularly centres of excellence. Individual & institutional development. Often in collaboration with international networks. Early moves towards system development. May also carry out own research.	Mostly knowledge generation
LMIC Governments	South Africa, Brazil, Zambia	Highly variable often according to GDP but also economic policies. Some investing a lot, others not at all. Typically only recent investments in HRCD.	Variable but usually in accordance with national priorities. May be linked to infrastructure development.	Some ministries have their own research centres & develop capacity "in house". Others provide project grants or individual development. Governments may upgrade or create research institutions. Investment value typically small due to resource constraints or low priority of research. However, some countries investing heavily. More recent attention to macro level capacities.	Varied. Knowledge generation common but recently agenda setting, stewardship, demand creation & knowledge utilisation
LMIC academic & healthcare institutions	University of KwaZulu-Natal, Makerere University, Fundação Oswaldo Cruz	Varied history. Some very well established in research but most new to HRCD. May be public or private.	Variable. Research may be in accordance with national or global priorities, or investigator interest.	Mainly undergraduate & some graduate training. Provide institutional resources for research. Development of institutions usually reliant on governmental funds, unless private. Normally training & education takes precedence over research.	Knowledge generation
HIC research councils & institutes of health	Medical Research Council (UK), NIH (USA), Canadian Institutes for Health Research, Royal Society	Institutions with a long history but only recently (around 2000) expanding their role in HRCD	Varied. But no specific remit to conduct capacity development.	Provide various funding & scholarships for individuals to undertake post graduate training. Also fund specific research projects which may include institutional development. Normally work in collaboration with institutions from donor country. Usually not system level. Some encourage scientific excellence by forming links with other LMIC societies, but do not conduct HRCD directly.	May conduct research themselves. Mostly support knowledge generation but may have smaller investments in knowledge utilisation.
HIC academic & healthcare institutions	University of Oxford, Institut Pasteur, Johns Hopkins University	A long history of research in LMICs. Some project specific HRCD but only recently taking on more explicit capacity development.	Project focused around research goals. Mostly investigator-led but may follow national priorities.	Development is usually to facilitate a specific project. May involve developing research sites & staff. Often focus on centres of excellence. Individual development either in-country or at HIC universities. System development not common. Normally in partnership with local groups which increases knowledge transfer.	Mostly knowledge generation. Specific projects may target knowledge utilisation & sometimes dissemination but much rarer.

Industry	GlaxoSmithKline, IBM, local industries	Pharmaceutical companies important but IT companies increasingly involved. International & national industry involved.	Product development & innovation technologies. Mostly in Asia. Currently less reach to Africa.	Develop capacity through technology or "know how" transfer. Infrastructure strengthening, particularly IT. May fund individual training or institutional development. May also provide services at favourable rate or free. Usually work in partnership with other actors.	Knowledge generation & translation but also knowledge management. May work in other areas depending on company.
Non-governmental organisations (NGO)	Medicine Sans Frontiers, Drugs for Neglected Diseases Initiative, One World Health, local NGOS	Recent involvement in research & HRCD (post 2005)	Either highly applied research or product development R&D. Some work in partnerships with other actors.	Strengthen research within networks or embedded in health delivery. Usually individual or specialised institutional support. As part of civil society, have strong advocacy & moderation roles. Can mobilise resources towards non-profit activities.	All stages of knowledge cycle.
Academic journals	International Committee of Medical Journal Editors, Lancet, PLOS, Tanzanian Journal of Health Research	Long history of discussion on HRCD but becoming increasingly prominent in last 5 years.	Advocacy & opinion leaders. Role as moderators & amplifiers. Provide access to information & publishing.	Improve access to information & enable individuals to publish by changing publication & subscription policies. Promoting best practice & improving quality & reliability of publications. Encourage debate & advocate.	Knowledge dissemination

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Page 1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	Pages 2-3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	Pages 5-6
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	Page 6 (end)
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	No formal protocol exists
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Section 2.1, page 7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	Section 2.2., pages 7
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Box 1, page 8
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	Sections 2.2 & 2.3, pages 7. Also figure 1.
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	Section 2.4, pages 9
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Section 2.4, pages 9.
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	Section 2.3. Page 8
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	Section 2.4,

PRISMA 2009 Checklist

			pages 9
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	Section 2.4, pages 9

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	Section 4.4., pages 27, and section 3.6, pages 22
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	NA
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Section 2.2., Pages 7. Figure 1.
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Section 3.2, pages 11. Table 2.
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	NA – See section 2.3, page 8.
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	NA
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Sections 3.3. and 3.4, pages

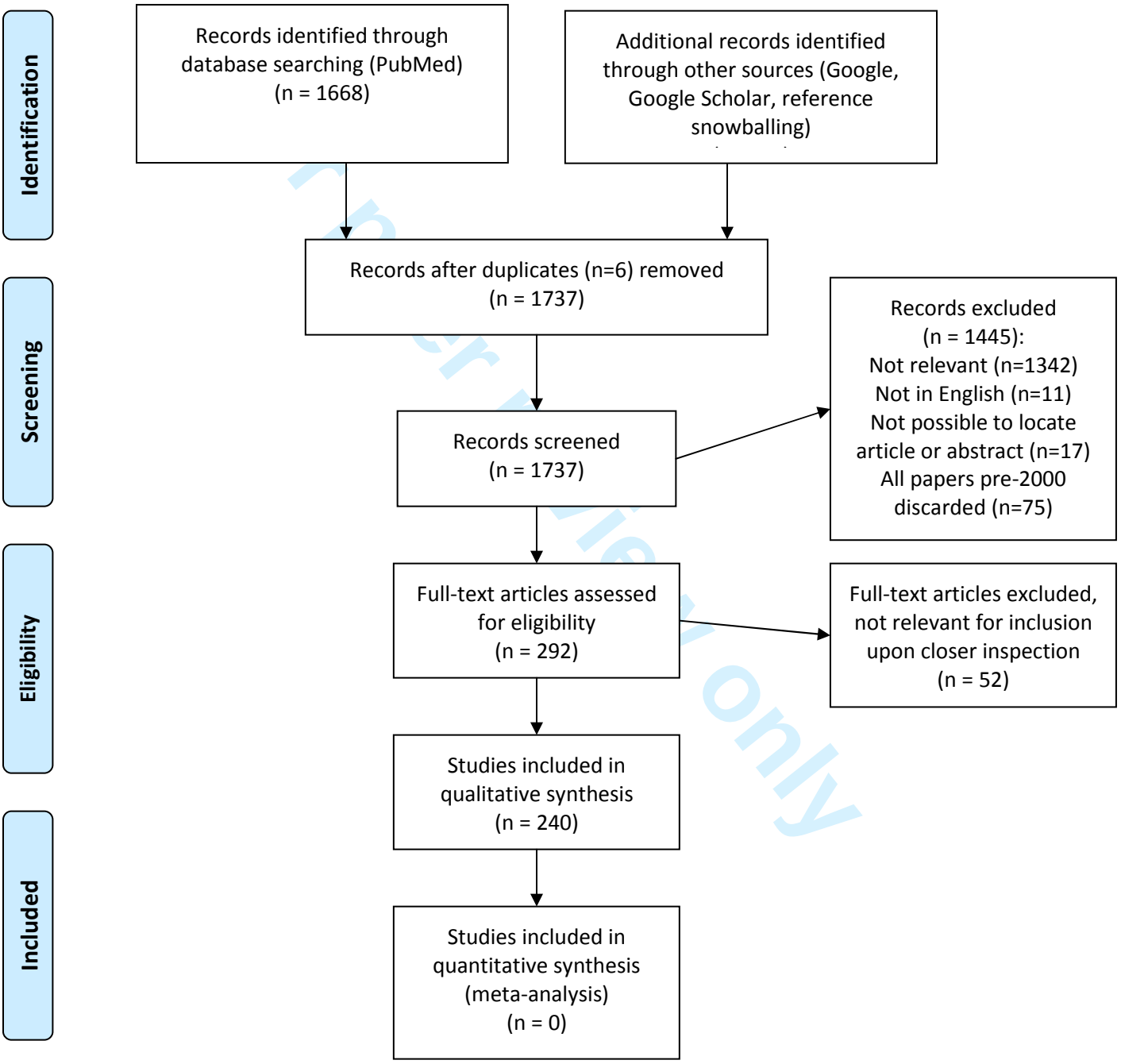
PRISMA 2009 Checklist

			12-22
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	NA – See section 2.3, page 8.
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	NA
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	Section 4.1, page 25, and 4.3 pages 27
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	Section 4.4, pages 28-29
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	Sections 4.2 pages 27 & 4.5 page 28
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	Funding statement, page 29

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

PRISMA 2009 Flow Diagram: Health research capacity development in Low and Middle Income Countries: reality or rhetoric? A systematic meta-narrative review of the qualitative literature



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit www.prisma-statement.org.

BMJ Open

Health research capacity development in Low and Middle Income Countries: reality or rhetoric? A systematic meta-narrative review of the qualitative literature

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2016-012332.R2
Article Type:	Research
Date Submitted by the Author:	11-Nov-2016
Complete List of Authors:	Franzen, Samuel; Oxford Policy Management; University of Oxford, The Global Health Network, Centre for Tropical Medicine and Global Health Chandler, Clare; London School of Hygiene & Tropical Medicine, Global Health and Development Lang, Trudie; University of Oxford, The Global Health Network, Centre for Tropical Medicine and Global Health
Primary Subject Heading:	Global health
Secondary Subject Heading:	Evidence based practice, Qualitative research, Research methods
Keywords:	QUALITATIVE RESEARCH, TROPICAL MEDICINE, EDUCATION & TRAINING (see Medical Education & Training)

Title

Health research capacity development in Low and Middle Income Countries: reality or rhetoric? A systematic meta-narrative review of the qualitative literature

Authors

Dr Samuel R P Franzen[1,2], Dr Clare Chandler[3], Prof Trudie Lang[1]

Corresponding author's address

Samuel R P Franzen, Oxford Policy Management, The Clarendon Centre, 52 Cornmarket Street, Oxford, OX1 3HJ, United Kingdom; Email: sam.franzen@opml.co.uk; Telephone: +44 (0)1865 410 846

Affiliations

1 The Global Health Network, Centre for Tropical Medicine and Global Health, University of Oxford, Oxford, UK.

2 Oxford Policy Management, Oxford, UK.

3 Department of Global Health and Development, London School of Hygiene & Tropical Medicine, London W, UK.

Key words

Health Research, Capacity Development, Low and Middle Income Countries, Research Systems, Clinical Trials

Word count

5653

Abstract

Objectives: Locally-led health research in Low and Middle Income Countries (LMIC) is critical for overcoming global health challenges. Yet, despite over 25 years of international efforts, health research capacity in LMICs remains insufficient and development attempts continue to be fragmented. The aim of this systematic review is to identify and critically examine the main approaches and trends in health research capacity development and consolidate key thinking to identify a more coherent approach.

Methods: This review includes academic and grey literature published between Jan 2000 and July 2013. Using a predetermined search strategy, we systematically searched PubMed, hand-searched Google Scholar, and checked reference lists. This process yielded 1668 papers. 240 papers were selected based on a priori criteria. A modified version of meta-narrative synthesis was used to analyse the papers.

Results: Three key narratives were identified: the effect of power relations on capacity development; demand for stronger links between research, policy, and practice; and the importance of a systems approach. Capacity development was delivered through 4 main modalities: vertical research projects, centres of excellence, North-South partnerships, and networks; all were controversial and each had their strengths and weaknesses. A plurality of development strategies was employed to address specific barriers to health research. However, lack of empirical research and monitoring and evaluation meant that their effectiveness was unclear and learning was weak.

Conclusions: There has been steady progress in LMIC health research capacity but major barriers to research persist and more empirical evidence on development strategies is required. Despite an evolution in development thinking, international actors continue to use outdated development models that are recognised as ineffective. To realise newer development thinking, research capacity outcomes need to be equally valued as research

outputs. While some development actors are now adopting this dedicated capacity development approach, they are in the minority.

Strengths and limitations of this study

- This systematic review goes beyond previous attempts that lacked reflexivity, to provide a nuanced, in-depth, and enquiring critique of health research capacity development approaches.

- This review integrates diverse qualitative literature that largely lacked formal reporting procedures or empirical base, allowing the inclusion of voices that are traditionally excluded in other styles of systematic analyses.

- Some academic articles may have been missed because PubMed was the only formal database used, and there was limited inclusion of evaluation and programme-level data due to poor grey literature indexing in Google and Google Scholar.

- However, the meta-narrative method aims to develop overarching narratives through saturation of themes, rather than include every eligible article, so inclusion of additional papers would be unlikely to change the findings of the study.

1 Introduction

Locally-led health research is critical for overcoming global health challenges in Low and Middle Income Countries (LMICs) [1]. This research is needed to "propose culturally apt and cost-effective individual and collective interventions, to investigate their implementation, and to explore the obstacles that prevent recommended strategies from being implemented" [2]. Such research is now the focus of key capacity development efforts, such as the regional educational centres supported by the Special Programme for Research and Training in Tropical Diseases (TDR) [3].

However, these arguments are not new; the importance of LMIC research capacity has been recognised for well over two decades. The 1990 Commission on Health Research for Development stated that strengthening research capacity in LMICs is "one of the most powerful, cost-effective, and sustainable means of advancing health and development" [4]. This marked the beginning of a "revolution" in health research [5] where there was a surge of investment and concerted effort to conduct health research aimed at solving health problems in LMICs [6].

Nevertheless, at the turn of the millennium LMICs accounted for 85% of the world's population, 92% of the global disease burden, but only 10% of global funding for health research was devoted to addressing these persistent health challenges [6]. Recognition of this "10/90" gap led to renewed calls for health research capacity development in LMICs and further investment [5].

Yet nearly 15 years later, many LMICs still lack sufficient health research capacity to build a local evidence-base with which to inform policy and improve population health. This was recently and profoundly described in The 2013 World Health Report which argued that "all nations should be producers and users of research as well as consumers", noting that this was not yet the case [1].

Therefore, despite years of international collaborations and investment, development of LMIC nation's capacity to address their own health problems appears enduringly problematic. Where there has been progress, such gains often do not appear sustainable without continued strong foreign support [7, 8], which is itself questionable in light of recent austerity and bilateral aid agency restructuring [1, 9, 10].

Although there is a large and diverse body of literature on health research capacity development, it remains confusing, controversial, and poorly defined, with various contradictory understandings [11] and conceptualisations [1]. Since capacity development is now something that most research actors are expected to participate in, or at least be knowledgeable on [5, 12], this is problematic. To increase the likelihood of future capacity development efforts being effective, there is a need to take stock of past experiences and learn from successes and failures. Such an exercise would not only provide a unifying picture to appraise previous capacity development efforts, but also encourage discussion and reflection that could lead to fresh thinking.

The aim of this systematic review is to identify and critically examine the main approaches, strategies, and trends in health research capacity development and consolidate key thinking in order to identify a more coherent approach. This review should prove useful to all stakeholders interested in learning how to undertake the complex business of capacity development, and will be of particular interest to actors working to make locally-led and sustainable health research capacity in LMICs a reality.

2 Methods

Our systematic review followed the 6 stages of the meta-narrative methodology developed by Greenhalgh *et al* [13]. The meta-narrative method is a "systematic, theory-driven interpretative technique, which [was] developed to help make sense of heterogeneous evidence about complex interventions applied in diverse contexts in a way that informs policy" [14]. Since the Health Research Capacity Development (HRCD) literature shares these characteristics, the meta-narrative method was highly suited to the purposes of this study.

2.1 Inclusion criteria

This review considers the perspectives of all actors involved in HRCD that have published within academic and grey literature from the year 2000 onwards. We included any papers that broadly discussed HRCD or its more specific components. Papers that mentioned HRCD but did not discuss the issue further were not included. Non-English language publications were excluded due to lack of resources for translation. Papers published before the year 2000 were initially included, but after screening it became clear that paradigm shifts in global health at the turn of the millennium [5, 6] meant that much of their content was not relevant to current day. Furthermore, many papers published post 2000 effectively summarised historically important issues. Therefore, all papers published pre-2000 were excluded.

2.2 Search strategy and study selection

The search and study selection process is presented in Figure 1. We searched PubMed using the search terms presented in Box 1 for all papers published up to 20 June 2013. This search yielded 1668 potentially relevant papers. The titles and abstracts of these papers were then screened for eligibility, resulting in 1376 papers being excluded

based on pre-screening, with an additional 75 papers excluded after it was decided that papers published before 1 January 2000 should not be included.

Fig 1: Search and study selection process

Box 1: Search terms used in PubMed search

((((((((((((((((capacity building[MeSH Terms]) OR ((("developing"[Title/Abstract]) OR "develop"[Title/Abstract]) OR "capacity"[Title/Abstract]))))) OR "strengthen"[Title/Abstract]) OR "strengthening"[Title/Abstract])) AND ((((developing country[MeSH Terms]) OR Africa) OR Asia) OR Latin America))) AND ((("trial"[Title]) OR "trials"[Title]) OR "research"[Title])))) NOT clinical trial[Publication Type]) NOT informed consent[MeSH Terms]) NOT waste management[MeSH Terms]) NOT air pollution[MeSH Terms]) NOT agriculture[MeSH Terms]) NOT ("Na6(H2O)8(ZnAsO4)6" [Supplementary Concept] OR "K3Zn4O(AsO4)3" [Supplementary Concept])

The PubMed search was complemented by a search of Google and Google Scholar using the terms “Health AND research AND capacity AND strengthening OR Building OR Development”. All literature added from Google were found in the first 10 pages (n=30). After the first 10 pages, no search results were relevant to the study. Literature collections of the authors and other experts were also hand searched and references snowballed (n=45). A total of 292 papers were read in full and considered for eligibility. Based on this screening, the final synthesis involved 240 papers. The full list of papers included in this review can be found in supplementary file S1.

Relevant papers published between June 20 2013 and December 14 2014 were scanned and read to determine if the synthesis findings were still valid post-search. Although there were some pertinent new articles, their content would not have changed the findings of this synthesis.

2.3 Quality assessment

No papers were excluded based on assessment of quality because the majority of papers lacked an empirical or explicit study design, and all stakeholders' views regardless of their perceived validity were considered important. Furthermore, capacity development discussion is inherently political and most contributions are based on personal opinion informed by theoretical, ethical, or experiential standpoint. Accordingly much of it is biased. Rather than attempt to remove the bias, assumptions and motivations were explicitly studied to undercover authors' implicit logic, so that readers can make their own informed opinion.

Instead of using quality criteria, similarity of arguments within the literature was used as an indicator of current agreement on a topic or popularity of an idea. This allowed a comprehensive analysis of all the HRCD narratives, while still highlighting and giving emphasis to the most widely accepted opinions.

2.4 Data extraction and synthesis

To synthesise the literature, papers need to be framed within a "storyline" that recognises where the contribution came from [13]. *Greenhalgh et al.'s* method explicitly catalogues these storylines as "meta-narratives" [13]. Developing meta-narratives provides context to contributions whose underlying assumptions and interests would otherwise be opaque. Although less prescribed than a quantitative systematic review, this approach pragmatically allows a plurality of ideas, recognising there may be no single correct answer.

To ensure that source content was interpreted alongside its context, even when broken into themes and narratives, a tagging system was used instead of a traditional extraction form. All sources were organised in EndNote X7 (Thomson Reuters) and associated citations, metadata and PDF copies of the documents were attached. These

data were then imported into Nvivo 9 qualitative analysis software (QSR International) where the sources were given tags using deductive codes for key characteristics.

Meta-narratives were then identified inductively by reading each paper and coding for meta-narratives where several authors in the literature discussed and presented topics similarly. This is an interpretive approach similar to that used in thematic coding analysis, where reoccurring themes that are conceptually related are grouped into concepts. Once the meta-narratives had been finalised they were systematically applied to all relevant papers. No prior theory beyond the guidance presented by Greenhalgh *et al.* [13] was explicitly used to help identify and categorise the meta-narratives. Instead, iterative rounds of open data-driven inductive coding were used.

2.5 Role and position of the authors

This systematic review was undertaken, in part, to inform the design of a larger body of empirical research on health research capacity development in LMICs. All authors have backgrounds in social science and global health. Initial coding was conducted by Samuel Franzen, and then refined based on face-to-face discussions with other authors around the coding framework and preliminary findings. The authors of this paper do not include individuals from LMICs, but this paper was reviewed and commented on by individuals from LMICs who collaborated on and participated in the parallel empirical research, and discussed with other relevant experts at meetings and conferences. These team processes represent a deviation from the meta-narrative method presented by Greenhalgh *et al.* [13] because the authors did not constitute a multi-disciplinary team and input from external peers was largely ad hoc, rather than through regular planned inputs. These methodological deviations were required to enable the systematic review to feed into the evolving parallel empirical research.

3 Results

3.1 Definitions and actors

The concept of capacity development can be confusing because there are multiple and conflicting terminologies for development activities and actors. To assist the reader, typologies of key definitions and development actors were produced. Supplementary file S2 presents these definitions alongside reasons for adopting them, and supplementary file S3 categorises and provides background to development actors' activities.

3.2 Characteristics of included papers

Table 1 summarises the main characteristics of the papers included in the review. Based on first author characteristics, the greatest number of articles came from LMIC academic and healthcare institutions (31.3%), closely followed by HIC academic and healthcare institutions (29.6%). Contributions from funders were very low (0.8%), and industry and civil society were absent, potentially reflecting the sampling from academic databases. Europe was the greatest contributing region (32.9%) followed by Sub-Saharan Africa at 23.8% and North America at 13.8%. Contributions from Latin America (2.5%), Middle East (1.7%) and North Africa (0.8%) were low. Although most articles were concerned with capacity development across all LMICs (42.1%), Sub-Saharan Africa dominated the regional specific discussions (34.6%). The main basis for viewpoints were opinion, debate or personal perspectives (34.2%); sharing experiences represented 21.7%, and empirical work 20.8%.

Table 1: Characteristics of papers included in this review

Category* of development actor (for first author)	%	Location of first author's institution	%	Region of interest	%	Main topic of development interest	%	Main disease of interest	%	Basis for viewpoint	%
LMIC Academic and Healthcare Institutions	31.3	Europe	32.9	All LMIC countries	42.1	Multiple broad issues discussed	24.6	Not disease specific or address multiple	72.5	Opinion, debate, perspective	34.2
HIC Academic and Healthcare Institutions	29.6	Sub Saharan Africa	23.8	Sub Saharan Africa	34.6	Individual level development	15.8	HIV	6.3	Experience report	21.7
Multi-laterals	10.4	North America	13.8	South Asia	10	Partnerships networking, consortia	15.8	Malaria	5.8	Empirical research	20.8
Consortia & Networks, NGOs and Public-Private Partnerships	8.8	South Asia	10	East Asia	6.7	Operational challenges & opportunities	11.3	Other	4.6	Literature review, summary or synthesis	7.9
Academic Journals	5.4	East Asia	9.2	All Asia	2.9	System approaches and macro level development	9.2	Mental Health and Addiction	2.5	Proceedings or conference report	7.5
LMIC Governmental	4.6	Australia	2.9	Latin America	1.7	Agenda and priority setting	6.3	Maternal Child Health and Paediatrics	2.5	Organisation document	4.6
LMIC Funders, Research Councils and Institutes of Health	4.6	Latin America	2.5	Pacific	0.8	Institution level development	5.4	Tuberculosis	2.1	News report	3.3
Bi-lateral aid agencies	2.1	Not specific	2.1	Middle East	0.8	Monitoring and evaluation	2.9	Non-communicable diseases	2.1		
HIC Research Councils and Institutes of Health	2.1	Middle East	1.7	Central Asia	0.4	Research and development	2.1	Dental or oral health	1.7		
Private Foundations or Charity Funders	0.8	North Africa	0.8			Ethics and regulations	1.7				
Industry	0	Pacific	0.4			Knowledge cycle	0.8				
Civil Society and Media	0										

* Some categories have been merged because they could not be separated

3.3 Meta-narratives in health research capacity development

Three key narratives ran though the literature: the effect of power relations on capacity development; demand for stronger links between research, policy, and practice; and the importance of a systems approach to HRCD. Each narrative is described below with reference to the key papers that discussed these narratives in detail.

3.3.1 Effect of power relations on capacity development

The effect of power relations on capacity development was the most common narrative running through the literature (present in 29% of papers). The main concerns of this topic are that research agendas in LMICs are set more by international funders than by LMIC institutions, and research conducted in LMICs is predominantly led by HIC researchers with little involvement of LMIC individuals or institutions. This is argued to erode national sovereignty [15], prevent capacity development [16, 17], and create research priorities that more closely match funder agendas than countries' needs [18-20] leading to a situation of "he who pays the piper calls the tune" [20, 21]. Examples include "spotlight issues", which receive funding regardless of relative need [22], and "parachute" research where data is collected in LMICs but all other work is conducted in HIC institutions.

"North-South" collaborations between HIC and LMIC research institutions are considered to be better mechanisms for developing research capacity [8], but many authors still thought that they comparatively disadvantage the LMIC partner [9, 12, 15]. The perceived situation of "treating Africa as a repository of raw materials for expatriate-driven research" [9] led to the development of guidelines for research collaboration. To reflect the change in approach, there was a rhetorical shift to using the term "partnership" to describe collaborations that were equitable [17]. These partnerships should be built on mutual trust and shared decision making, national ownership, early planning for translation of research findings and development of national research capacity [17]. Importantly, it is

now expected that all partnerships should have capacity development at their forefront [12]. However, despite discussion for well over a decade, a good proportion of the international community still feels that partnerships are not yet equal [12, 23, 24], and they cannot be until the power divide is addressed [15] because LMICs are unable to negotiate for a fairer deal [15, 25, 26].

In an effort to adjust the power balance there have been conscious efforts towards recognising local research capacity in LMICs [12, 20]. This change is again reflected in rhetoric through the evolution of the term “capacity development” which gradually places stronger emphasis on extant capacity; changing from “capacity building” to “capacity strengthening” [20] to “capacity utilisation” [27], “unleashing” and “releasing” [20]. Many authors now propose that research and capacity development in LMICs should be locally owned and led [17, 20, 28, 29]. This is because LMIC researchers have the best understanding of evidence gaps [17] and can present research to policy makers with an understanding of the political and cultural context which increases the chance of evidence uptake [30, 31]. Locally-led studies are also thought to be better aligned with national agendas [32] and address more applied implementation topics than foreign-led research [17].

Most stakeholders now agree that research and capacity development should, at a minimum, include the local research community in the design and conduct of research studies [33]. Development actors are also advised to be more sensitive to the power dynamics they create and ensure they strengthen, not weaken, the role of national governments by responding specifically to their priorities [20, 29, 34] and including the “recipients” in any agenda setting [35]. However, others argue that this situation will inevitably continue so long as foreign countries are the majority financers of research in LMICs [36]; only through greater national investment and commitment will LMICs have a stronger voice to make relations more equitable [7, 9, 37]. Nevertheless, the vast majority

of development efforts reportedly still focus on international collaborative research meaning local investigator-led studies are largely ignored [38]. This is evidenced by only 3 papers in this review being focussed on supporting locally-led clinical trials, compared to 33 papers aimed at developing international clinical trials.

3.3.2 Demand for stronger links between research, policy and practice

Arguments for stronger links between research, policy and practice were present in 16% of sources. These emerged due to concerns that much research was failing to be translated into policy [25, 39], and was too narrowly conceived and disease-specific to have impact [40].

Accordingly, applied fields now deemed to be highly relevant to decision makers and those that promote sustainable adoption and implementation of evidence based medicine have been called for [30, 41, 42]. These include health policy and systems research [43], health services research [44], implementation research, and operations research [45-47]. These arguments formed the backbone of the WHO strategy on "research for health" which "gives priority to research and innovation that has the greatest potential to improve global health security, accelerate health-related development, redress health inequities and help to attain the Millennium Development Goals" [48] .

Despite these discussions, much research is still regarded as uncoordinated and concentrating on a few high profile diseases [49] such as the "big 3": HIV/AIDS, Malaria and Tuberculosis. Furthermore, the majority of research is critiqued as largely technology development focused, even though many argue that the impact of this research is low [44] and more lives could be saved by improving service delivery of existing interventions [25, 43, 50].

3.3.3 The importance of a systems approach to capacity development

The importance of taking a systems approach to HRCD was discussed in 24% of sources. Conceived in the 1990s and popularized after the Ministerial Summit on Health Research in Mexico in 2004 [25], systems approaches to HRCD emerged in response to perceived failings of capacity development targeted at only one level. Particular weaknesses cited included: lack of provision for trained individuals to use their skills [6] leading to "brain drain" of LMIC researchers to HICs [51, 52]; exclusively focusing on high performing individuals [53] rather than strengthening local institutions to develop researchers [54]; absence of national bodies to coordinate priorities, develop policy, and translate evidence into action [55]; and the fragmentation of capacity development activities [56, 57].

Proponents of systems approaches argue that for capacity development to be effective and sustainable [8, 58], new approaches to addressing all three levels of the national research system are needed; macro, institutional and individual [58] (for definitions of these levels, please see supplementary file 2). Macro-level capacity development should include: priority setting, planning and coordinating research, governance and regulation, and knowledge translation and dissemination [48, 57, 59]. Individual development should include a broader range of stakeholders than just research producers (e.g. policy makers, administrators, medical personnel and ethics board members) and teach a wider variety of skills and disciplines, particularly "soft skills" such as organisation, management and leadership [55]. Institutional development should focus on the ability to generate, retain and utilise individual capacity through improving curricula, training support, mentorship, and research resources [60-62].

Although presented as a complex task with long time frames [63], taking a systems approach is said to result in more dynamic capacity development that produces endogenous change, greater local ownership, and removal of perennial system barriers

[20] which helps countries to effectively target their own health needs [19]. This is in stark contrast to previous approaches that established parallel structures to deliberately bypass local systems because they were deemed to be chronically ineffective [24]. However, despite the accepted importance of research systems development, little is known about how health research systems can be formed [19], there are few successful examples of research system strengthening, and little guidance is available [64].

3.4 A summary of modern health research capacity development modalities

After attempts at aligning human, material and technical capacities failed in the 1980s, research models that directed funds and technology through HIC institutions became the preferred HRCD mechanism [5]. These mechanisms are now the most common approach to HRCD. The justification for requiring LMICs to collaborate with HICs is that knowledge transfer and HIC expertise are required to achieve capacity development [65, 66]. However, others argue that such development models propagate inequities in research and development [17, 36]. Discussions on development modalities are therefore contentious. The following sections summarise the justifications, benefits, drawbacks and controversies of the main development modalities.

3.4.1 Vertical research projects

One of the earliest and most persistent research models arising from the HIC fund channelling mechanism was vertical research projects [5]. This involves a HIC research collaborator working in a LMIC to conduct applied, normally short-term research projects with narrow objectives [54]. The theoretical advantage of a vertical strategy is that it maintains focus on a specific scientific mission [67]. This allows the necessary capacity to be developed more rapidly and can quickly produce research outputs [5] even where major expansion of R&D is required [35]. These approaches now account for the biggest

share of health research funding [58]. Examples include product development partnerships such as The Global Alliance for TB Drug Development, and many commercial or non-commercial clinical trials [68].

HRCD is often included in these programmes, but development of capacity is usually not the primary objective [59]. Rather it is designed to develop capacities that will benefit the successful completion of the project [60] and result in high quality research outputs [54]. Vertical projects often have strong expatriate leadership and are frequently managed by external institutions [54], which is argued to result in parallel structures that bypass local research institutions [69]. Where individual-level development is provided, it is typically short term and project specific [70].

Critics of vertical projects argue that local researchers often only have support roles [16], samples may be shipped abroad for analysis [23] and there can be little investment in local institutions because they are bypassed [15, 69]. Therefore when these short-term projects finish, research sites and individuals are rarely left with the skills or resources to run their own studies [41, 68]. Another criticism is that vertical approaches force the research community to work separately on overlapping issues [71] leading to fragmentation of national research systems [55].

Proponents of vertical interventions are however mindful that there is a trade-off between the speed and quality of research, and capacity development [72]. They argue that in the case of health emergencies, investment should be made in excellent research, not excellent capacity development.

3.4.2 Centres of excellence

A common modality for developing long-term capacity to conduct advanced research in LMICs is “centres of excellence”. These have taken various forms, but the approach generally concentrates investment within a few institutions that show potential to excel and

become high quality self-sustaining sites. These models are reportedly useful because they increase the likelihood of high quality research and renewed investment in an otherwise challenging environment [52, 55, 73].

Early forms of this concept were criticised as being “annexed” research sites, effectively led and managed by expatriate staff [74]. Others argue that they create parallel research structures outside of the national system that further depletes the local resource pool by diverting investment and human resources towards these better funded sites [17, 24, 44]. More recent forms of “centres of excellence”, such as those championed by the European and Developing Countries Clinical Trials Partnership, strive for greater Southern leadership and better integration with local research systems [75].

3.4.3 North-South partnership

Another common development model is North-South partnerships. They are distinct forms of collaboration between HIC and LMIC researchers because unlike “centres of excellence”, they are usually project specific rather than institution building, and they put more emphasis on sustainable research, shared leadership and mutual benefit than vertical research projects. However, depending on the nature of the partnership, these demarcations can become blurred.

Since the millennium, North-South partnerships and have been heavily promoted by organisations such as The Global Forum for Health Research [6] and The European and Developing Countries Clinical Trial Partnership (EDCTP) [75]. Such partnerships are said to be responsible for increasing resource flows to LMICs [31] and have been advocated for: increasing scientific productivity [76], training of graduates, staff exchange and knowledge sharing, exposure to cutting edge technology [52], strengthening local education programmes and moderate levels of institutional strengthening [6, 77, 78]. This is argued to result in more sustainable development [54], greater cost-efficiency and a

broader research scope than exclusively expatriate-led or locally-led research could achieve alone [17, 20].

Despite their popularity, a greater proportion of the literature is dedicated to discussing problems with North-South partnerships than their benefits. Many authors still feel that despite much guidance for entering into partnerships [12, 17, 53, 79, 80], too few benefits are accrued by the Southern partner [9, 12, 23, 24, 81] because they are forced to collaborate with HIC institutions to meet funding requirements [82]. Accordingly, LMIC partners are reported to sometimes receive little financial benefit, go unrecognised in publications, and release intellectual property rights [9, 12]. Proposed amendments to this model have involved adapting partnerships to be driven by LMIC demand [60], led by the Southern partner [20] or supporting more South-South partnerships [28, 83].

3.4.4 Networks and consortia

Networks and consortia development models emerged in the mid-1990s. By the mid-2000s they were used to tackle whole programmes of research [60] and are now very popular with funders [60]. Actors adopting network models are highly diverse and can sometimes be hard to separate from partnership models or vertical programmes. However, they all involve linking multiple research departments, groups or institutions.

Networks are considered advantageous because they encourage less-hierarchical leadership and competitive and individualistic attitudes. They are therefore reportedly useful for working cooperatively on shared problems at regional or global levels [84, 85]. Because networks facilitate information exchange and pooling of resources to achieve a critical mass [86], they are seen as particularly important where groups may be isolated [87] or when one group alone would have insufficient capacity to address an issue [88]. Networks are also thought to: help focus on common research priorities [60, 89]; increase knowledge exchange and speed diffusion of innovations [57, 64]; and help forge long term

relationships [5, 87], and sustainability [37, 86, 90, 91]. However, some authors point out that most networks focus on highly thematic research projects [60] and only develop capacity of individual research groups, not research systems [87].

3.5 Specific development strategies

The reviewed literature contained a multitude of development strategies targeted at all levels of the health research system; macro, institutional and individual. These are presented in Table 2 and grouped according to the barrier that they address. The research barrier groupings were identified by the authors through thematic coding of the literature content. The popularity of the development strategies are indicated as a percentage of the reviewed sources that proposed them as a solution to a health research barrier.

Table 2: Summary of capacity development strategies designed to address specific barriers to health research

Barrier to research	Strategies designed to address barriers to research	Popularity (% of sources)
Fragmented research systems	• Undertake a situational analysis & build on existing assets [28, 29, 57, 92] • Collaboratively develop research agendas with LMIC stakeholders [55, 70, 75] • Create a research coordinating body or scientific councils [29, 64, 93]	Recently gaining popularity (12%)
Insufficient research funding	• Establish a research finance system using innovative revenue generation [52, 94, 95] • Provide long-term funding & flexible grants [8, 63, 96] • Advocate for funding through shared causes & engaging with the media [68, 97]	Growing popularity (21%)
Limited use of research evidence	• Build capacities of policy makers to demand & scrutinise research [25, 84, 98] • Develop evidence repositories & use Research-to-Action-Groups as knowledge brokers to package findings appropriately [39, 99] • Create knowledge translation platforms to support evidence dissemination & dialogue between research producers and users [30, 39, 64, 100]	Consistent popularity (11%)
Limited governance & regulatory capacity	• Work research into a legislative framework [64, 101, 102] • Clarify guidelines, map review capacity, & streamline procedures [74, 103] • Strengthen regulatory & ethical review capacity [42, 64]	Growing popularity (21%)
Insufficient networking	• Develop and share a database of researchers and their expertise [31] • Utilise or develop professional networks, especially web-based communities [42, 104] • Organise conferences & working groups on locally important topics [2, 105]	Very popular (26%)
Inefficient admin & research management	• Train management & research support staff [29, 106] • Set up a research support office to help with grant management, reporting & contracts, & develop information and finance systems [20, 28, 72] • Develop transparent & accountable policies & procedures [69, 107]	Unpopular but increasing (8%)

Inadequate material capacity	• Upgrade libraries & journal availability and invest in laboratories [28, 91, 108] • Improve Information Technology, particularly internet [6, 78] • Ensure stable power & water supplies [108]	Widely recognised (20%)
Insufficient human capacity with research knowledge & skills	• Develop LMIC university research training capacity using "train the trainer" programmes, LMIC-HIC "sandwich" courses, or visiting research fellowships [20, 70, 92, 96, 109-111] • Make research principles & skills key components of undergraduate & continuing professional medical education [37, 70, 112] • Develop a variety of research roles: nurses, data managers, statisticians, laboratory personnel, managers, data collectors [9, 63, 70, 109, 113-115] • Increase distance learning via e-technologies or e-learning resources [26, 41, 70, 116, 117] • Training in major skills gaps: data collection, data management, data analysis & statistics, GCP, laboratory skills, computer literacy & ethics [46, 51, 54, 109, 118] • Training in core capabilities: protocol development, writing for grant applications & publication, grant management & budgeting, & policy dialogue [29, 45, 55, 63, 119]	Extremely popular (41%). Training in core capabilities less popular (15%)
Insufficient practical research experience	• Supplement didactic training with research "learning by doing" opportunities [40, 47, 55] • Involve more LMIC institutional staff in research projects [54] • Exchange visits to advanced research sites to update skills [120] • Pilot or small grants for early stage researchers to gain experience [53, 121]	Fairly accepted (11%)
Too few research leaders	• Develop leadership, project and human resource management skills [8, 72] • Opportunities for junior staff to take responsibility within a supportive environment [20] • In collaborative projects, local staff must be involved in the entire research process [122]	Gaining popularity (13%)
Too few mentors & role models	• Support mentors with long term funded positions & recognition [73, 78] • Where mentoring is not available locally, institutional partnerships/exchanges or peer mentorship can be used [9, 11, 55]	Popular (15%)
Lack of research culture	• Promote academic departmental leaders based on research experience [112] • Set up a departmental committee to promote research [123] • Journal clubs & seminars to develop interest in research & critical thinking [70, 120]	Not popular (6%)
Low motivation to conduct research	• Protected research time & longer term contracts [54, 76] • Re-entry grants or guaranteed jobs to encourage "brain drain" diaspora to return home [109, 110] • Higher salaries or funded research time to off-set private-practice incentives [76, 124]	Popular (18%)

3.6 Reported success and effectiveness of development efforts

Broadly, authors consider capacity to conduct health research in Africa to have increased considerably since the millennium [12] with potential to leverage further gains from current efforts [59]. This is best exemplified by increases in the number of clinical trials conducted in LMICs [103, 125] with reports of enhanced trial capacity [68],

particularly laboratories [126] and quality standards [38, 117, 127], and greater LMIC inclusion [106, 128]. Such institutional strengthening is also thought to have helped reduce brain drain in specific cases [109]. Although some countries still lag behind in regulatory and ethical review capacity, several publications indicate that LMICs have made good progress [108, 129].

The increase in research capacity is thought to have been driven by recognition of the importance of health research over the last 20 years [5], a revised strategic focus [30], and the expansion of networks and partnerships for addressing research needs [60, 67, 91]. However, it is not possible to attribute success to these development approaches due to lack of monitoring and evaluation data; in Africa, positive outcomes in the quality and quantity of published research have been recorded [60, 109, 130], but their connection to development inputs and outputs is not established [131]. Operational research and sharing of on-the-ground experiences is thought to be a useful learning resource, but with the exception of a few examples [42, 132], little published material on operations is thought to exist [133]. This is argued to make it hard to learn from previous efforts and experience [60] and determine why and how successes were achieved [28].

The paucity of monitoring and evaluation data is a recognised problem [5, 58, 60], with authors attributing it to long time-lags to achieve objectives [11], outcomes such as organisational culture being difficult to measure [11], lack of commonly agreed and conceptually robust indicators [59, 60, 102], and most evaluation data not being published [131]. To remedy this situation, guidance on planning and implementing monitoring and evaluation for health research has been developed [29], and one research group provides online resources to help record and share operational guidance [41].

It was also clear from the literature that significant capacity gaps remain in many LMICs. Following the example of clinical trials, authors point out that early phase studies are still lacking [134] and there are too few quality research sites to meet demand [103].

Despite increases in some capacities, translation of findings into policy is considered an enduringly difficult outcome [60, 135] and LMIC leadership and authorship in studies is still thought to be too low [43]. Reportedly insufficient political buy-in for strengthening investment in health research has also raised concerns over the sustainability of capacity development achievements [7, 8]. Some authors argue that longer term projects and planning for sustainability of research staff and services is needed [103], but little literature explores this [63].

4 Discussion

4.1 An evolution in health research capacity development thinking

This literature synthesis has objectively presented the main HRCD modalities and strategies, and shows that some development actors continue to operate research models that are contrary to widely accepted views of best practice e.g. ex-patriate led parallel research units. Nevertheless, the literature reveals that there has been steady progress in health research capacity in LMICs. Development actors have continuously reassessed their approaches and have become much more reflexive of their actions. National stakeholders have taken on a stronger voice and greater ownership, and are generally in a more self-sufficient position.

Overall, development actors now agree that there is no panacea or one-size-fits-all model to HRCD. Instead a plurality of solutions exists, the choice of which should be determined by the specific capacities constraints and research goals of LMIC institutions. However, despite progress, major barriers to health research persist, there is little evidence to support decision-making, and the sustainability of HRCD achievements is questionable.

4.2 Health research capacity development, reality or just rhetoric?

The evolution in HRCD thinking appears promising, but the literature demonstrates that good HRCD practices are not always enacted. While the requirement for short term projects is recognised [5], the vertical model has been the dominant model for almost 20 years [58]. This would indicate that vertical approaches have been used in situations that would be better served by longer term systems strengthening strategies [5]. However, there are far fewer programmes dedicated to implementing systems approaches to capacity development. Other examples include: focusing on a few high profile diseases,

donor-led research agendas, compulsory requirements for collaboration with HICs, setting up parallel structures, and fragmentary competitive research. To make the HRCD rhetoric a reality, there is a need to understand why research models that do not enhance or potentially inhibit locally-led research remain the *modus operandi*, even though there is clear agreement that they are bad practice.

The literature findings clearly and frequently show that the persistence of flawed development strategies is driven by approaching capacity development within the context of a dedicated research model. This creates a trade-off between doing good research and doing good capacity development. Projects prioritising good research place research outputs as the primary goal and assume capacity will be developed through limited LMIC involvement in research activities. This means that specific development strategies designed to improve capacity are not used. This "implicit" capacity development is known to be largely ineffective [63, 72], yet is it regularly used. As a result, local research systems may fail to develop or deteriorate [22], and development efforts are likely to become multiplicative and fragmented [60, 92], despite overlapping interests and generic requirements [104].

The other main alternative is "explicit" capacity development. This refers to research projects that place more priority on capacity development and use specific strategies designed to address capacity gaps. There is wide recognition that this is a superior approach and is more likely to improve capacity sustainably [11, 63]. However, because the research component is usually more valued by the research community, capacity development receives less attention and often focusses on developing project-specific capacities, not addressing systemic deficiencies. Accordingly, the capacity development component often becomes "bolted-on" and *ad hoc* [11, 28]; thus making it "implicit" in disguise.

Instead, the review findings suggest that conducting research to improve health in LMICs, and developing health research capacity in LMICs, must be considered two, sometimes diverging objectives. Recognising this leads to a third way; “dedicated” capacity development. This implies that developing local capacity is as equally valued as the research outputs and should be considered as carefully as the research designs. Due to the additional resources this requires, previous efforts have been limited to individual capacity development or centres of excellence [91]. However, some capacity development actors are now attempting to do this at a more systemic level. Examples include: The Special Programme for Research and Training in Tropical Disease’s (TDR) implementation research programmes [3], ESSENCE on Health Research [136], and The Global Health Network [137].

4.3 Implications for policy and practice

This systematic literature review provides an important synthesis of HRCD that should prove useful for policy makers and practitioners alike. It identifies the strengths, limitations and, controversies of the main development approaches and summarises strategies that can be used to overcome specific research system barriers.

Dedicated capacity development appears to offer the best approach for achieving the WHO’s vision of all nations becoming producers and users of research [1]. However, a key barrier to designing development strategies based on this thinking is the lack of empirical evidence. Without operational and implementation research and quality evaluation data, it is not possible to know the relative effectiveness of different development strategies and difficult to predict if they will be appropriate for a given context. The current experience of sharing data is a good start, but more systematic empirical research is required. This should be done with the same rigorous attention to

methodological design, analysis, and reporting standards as any other research endeavour.

4.4 Study strengths and limitations

Previous reviews of capacity development have lacked sufficient reflexivity and questioning of assumptions implicit in many strategies [40]. This systematic review produced a nuanced and enquiring critique of HRCD approaches in LMICs and has identified dedicated capacity development as a promising strategy for future HRCD efforts. It also integrated diverse qualitative literature that largely lacked formal reporting procedures or empirical base, allowing the inclusion of voices that are traditionally excluded in other styles of systematic analyses.

Some academic articles may have been missed because PubMed was the only formal database used and non-English language articles were excluded. However, the meta-narrative method aims to develop overarching narratives through saturation of themes, rather than include every eligible article, so using additional databases would add little to the study. More problematic was the limited availability and inclusion of programme evaluations and evidence supporting operational learning. While expert opinion and the popularity of development strategies was presented, it was apparent that this is not a reliable indicator of good development practice. Searching Google and Google Scholar, hand searching literature collections, and snowballing references did identify the most seminal papers, but some useful organisational documents will have been missed due to poor grey literature indexing. Furthermore, most articles had a general focus or related only to sub-Saharan Africa, meaning that context and research specific differences could not be examined in detail. The focus of the literature on sub-Saharan Africa is likely due to the high publishing rates of African authors and many papers' disease specific-focus on high burden diseases of sub-Saharan Africa (HIV and Malaria). However, it may also be

possible that the English-language search restriction excluded papers from authors publishing about their region in non-English languages. Regardless, the HRCD evidence gap in other developing regions is notable.

It is also important to note that the literature search was carried out on June 20 2013, so only articles published prior to this date were included in the analysis. A literature scan was carried out on December 14 2014 which found that the findings were still valid up to this date. It is possible that due to the delay in publication of this article further papers may have been published that could contribute to the findings of this study. While this means that this systematic review may not contain the most up-to-date literature, it is the opinion of the authors' and peer reviewers' that the study findings continue to be valid and of important relevance to the global capacity development community. These assertions are supported by the fact that major health research capacity development agencies such as WHO-TDR and multi-agency collaborations such as ESSENCE on Health Research continue to view the issues raised in this paper as problematic. Indeed the 2016 revised version of ESSENCE's Framework for Research Capacity Strengthening [138] reiterates the importance of the guiding principles it set out in 2011, while a contemporary WHO-TDR report on Key Enabling Factors in Effective and Sustainable Research Networks [139] would suggest that these principles have not yet been achieved.

The limited number of authors working on this review reduced the breadth of perspectives involved during analysis which could have biased interpretation towards the authors' particular knowledge paradigms and world views. However, this was mitigated to some extent by drawing on perspectives and experiences from concurrent research collaborators and participants, and seeking feedback from relevant experts at meetings and conferences. While some context-specific differences in experiences were inevitably raised, all individuals who were consulted considered the findings of this study to be

relevant and consistent with their broad view of health research capacity development in LMICs. Although it may have been desirable to have a second coder, this would not have necessarily improved the validity of findings through inter-coder reliability comparisons because regardless of the number of coders, the emerging coding scheme and findings would always be subjective. Ensuring quality of interpretation relies, rather, on being transparent in offering explanations of meanings rather than presenting definitive causations, and explicitly acknowledging the subjective nature of the analysis and the bias this creates. These principles were adhered to in the research process and the publication.

4.5 Conclusion

Despite gains in health research capacity and progress in development thinking, further work is needed to develop sustainable health research systems in LMICs. One promising option is dedicated capacity development in which capacity outcomes are as equally valued as research outputs. However, more empirical research is needed to identify the most effective strategies. If these issues are successfully addressed, health research in all nations could become a reality, rather than just rhetoric.

Funding Statement

This work was supported by a grant from The Bill and Melinda Gates Foundation to Prof Trudie Lang (grant reference: OPP1053843), and in part by a Nuffield Department of Medicine Doctoral Prize Studentship to Dr Samuel Franzen (http://www.ndm.ox.ac.uk/ndm-prize-studentships). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Contributors

SF, CC, and TL conceived and designed the study. SF collected and analysed the data and drafted the manuscript with intellectual input and assistance from CC and TL. All authors approved the final version of the manuscript.

Acknowledgments

The authors would like to thank Professor Sisira Siribaddana and Dr Julius Atashili for their technical advice and intellectual input.

Competing interests

The authors declare that they have no competing interests.

Data sharing statement

No additional data are available.

References

1. Dye C, Boerma T, Evans D, Harries AD, Lienhardt C, McManus J, et al. The World Health Report 2013: Research for universal health coverage. In: Organisation WH, editor. Geneva: World Health Organisation; 2013.
2. Thornicroft G, Cooper S, Bortel TV, Kakuma R, Lund C. Capacity building in global mental health research. Harv Rev Psychiatry. 2012;20(1):13-24. Epub 2012/02/18. doi: 10.3109/10673229.2012.649117. PubMed PMID: 22335179; PubMed Central PMCID: PMC3335140.
3. TDR Special Programme for Research and Training in Tropical Diseases. Seven universities selected to host international postgraduate training scheme. Geneva: World Health Organisation; 2015.
4. The Commission on Health Research for Development. Health Research: Essential Link to Equity in Development. In: Development TCoHRf, editor. New York: Oxford University Press; 1990.
5. Davey S. The 10/90 Report on Health Research 2003-2004. In: Global Forum for Health Research, editor. Geneva, Switzerland: Global Forum for Health Research; 2004.
6. Global Forum for Health Research. The 10/90 report on health research 2000. In: Research GFfH, editor. Geneva: Global Forum for Health Research; 2000.
7. Gulland A. Plan to stimulate research in developing countries is put on hold. BMJ. 2012;344:e3771. Epub 2012/05/30. PubMed PMID: 22641833.
8. Annerstedt J, Liyanage S. Challenges when Shaping Capabilities for Research: Swedish Support to Bilateral Research Cooperation with Sri Lanka and Vietnam, 1976–2006, and a Look Ahead. In: Cooperation DfR, editor. Stockholm: SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY; 2008.
9. Laabes EP, Desai R, Zawedde SM, Glew RH. How much longer will Africa have to depend on western nations for support of its capacity-building efforts for biomedical research? Trop Med Int Health. 2011;16(3):258-62. Epub 2011/03/05. doi: 10.1111/j.1365-3156.2010.02709.x. PubMed PMID: 21371216.
10. Davies R. Dismantling AusAID: taking a leaf out of the Canadian book? DevPolicyBlog: Development Policy Centre; 2013.
11. Bates I, Akoto AY, Ansong D, Karikari P, Bedu-Addo G, Critchley J, et al. Evaluating health research capacity building: an evidence-based tool. PLoS Med. 2006;3(8):e299. Epub 2006/09/01. doi: 10.1371/journal.pmed.0030299. PubMed PMID: 16942394; PubMed Central PMCID: PMC1502158.
12. Marais D, Toohey J, Edwards D, IJsselmuiden C. Where there is no lawyer: Guidance for fairer contract negotiation in collaborative research partnerships. In: Development CiHRf, editor. Geneva & Pietermaritzburg: Council in Health Research for Development; 2013.
13. Greenhalgh T, Robert G, Macfarlane F, Bate P, Kyriakidou O, Peacock R. Storylines of research in diffusion of innovation: a meta-narrative approach to systematic review. Soc Sci Med. 2005;61(2):417-30. doi: http://dx.doi.org/10.1016/j.socscimed.2004.12.001.
14. Greenhalgh T, Wong G, Westhorp G, Pawson R. Protocol - realist and meta-narrative evidence synthesis: Evolving Standards (RAMESES). BMC Medical Research Methodology. 2011;11(1):115. doi: info:pmid/21843376.
15. White MT. A right to benefit from international research: a new approach to capacity building in less-developed countries. Account Res. 2007;14(2):73-92. Epub 2007/09/12. doi: 10.1080/08989620701290341. PubMed PMID: 17844784.

16. Mony PK, Kurpad A, Vaz M. Capacity building in collaborative research is essential. BMJ. 2005;331(7520):843-4. Epub 2005/10/08. doi: 10.1136/bmj.331.7520.843-b. PubMed PMID: 16210297; PubMed Central PMCID: PMC1246129.
17. Costello A, Zumla A. Moving to research partnerships in developing countries. BMJ. 2000;321(7264):827-9. Epub 2000/09/29. PubMed PMID: 11009530; PubMed Central PMCID: PMC1118627.
18. Sitthi-Amorn C, Somrongthong R. Strengthening health research capacity in developing countries: a critical element for achieving health equity. BMJ. 2000;321(7264):813-7. Epub 2000/09/29. PubMed PMID: 11009525; PubMed Central PMCID: PMC1118622.
19. Kok MO, Rodrigues A, Silva AP, de Haan S. The emergence and current performance of a health research system: lessons from Guinea Bissau. Health Res Policy Syst. 2012;10:5. Epub 2012/02/11. doi: 10.1186/1478-4505-10-5. PubMed PMID: 22321566; PubMed Central PMCID: PMC3295730.
20. Green A, Bennett S, editors. Sound Choices: Enhancing Capacity for Evidence-Informed Health Policy. Geneva: World Health Organisation; 2007.
21. Jentsch B, Pilley C. Research relationships between the South and the North: Cinderella and the ugly sisters? Soc Sci Med. 2003;57(10):1957-67. Epub 2003/09/23. PubMed PMID: 14499518.
22. Coloma J, Harris E. From construction workers to architects: developing scientific research capacity in low-income countries. PLoS Biol. 2009;7(7):e1000156. Epub 2009/07/22. doi: 10.1371/journal.pbio.1000156. PubMed PMID: 19621063; PubMed Central PMCID: PMC2704958.
23. Gonzalez-Block MA, Vargas-Riano EM, Sonela N, Idrovo AJ, Ouwe-Missi-Oukem-Boyer O, Monot JJ. Research capacity for institutional collaboration in implementation research on diseases of poverty. Trop Med Int Health. 2011;16(10):1285-90. Epub 2011/07/19. doi: 10.1111/j.1365-3156.2011.02834.x. PubMed PMID: 21762393.
24. Crane J. Scrambling for Africa? Universities and global health. The Lancet. 2011;377(9775):1388-90.
25. World Health Organisation. Ministerial Summit on Health Research (2004: Mexico City, Mexico). In: Report from the Ministerial Summit on Health Research: identify challenges ia, correct inequities., editor. Geneva: World Health Organisation; 2005.
26. Lansang M., Dennis R. The need to develop research capacity. Global Forum Update on Research for Health Volume 4. 4. London: Pro-Brook Publishing Ltd; 2007. p. 123-7.
27. Silove D, Rees S, Tam N, Liddell B, Zwi A. Staff management and capacity building under conditions of insecurity: lessons from developing mental health service and research programs in post-conflict Timor-Leste. Australas Psychiatry. 2011;19 Suppl 1:S90-4. Epub 2011/09/09. doi: 10.3109/10398562.2011.583076. PubMed PMID: 21878030.
28. DFID. Capacity Building in Research. In: Development DfI, editor. 2010.
29. ESSENCE on Health Research. Planning Monitoring and Evaluation; Framework for Capacity Strengthening in Health Research. In: ESSENCE Good Practice Document Series, editor. Geneva: Copytrend; 2011.
30. Aksoy S. Solutions to neglected tropical diseases require vibrant local scientific communities. PLoS Negl Trop Dis. 2010;4(3):e662. Epub 2010/04/03. doi: 10.1371/journal.pntd.0000662. PubMed PMID: 20361026; PubMed Central PMCID: PMC2846929.
31. Chandiwana S, Ornbjerg N. Review of North-South and South-South cooperation and conditions necessary to sustain research capability in developing countries. J Health Popul Nutr. 2003;21(3):288-97. Epub 2004/01/14. PubMed PMID: 14717574.

32. Devasenapathy N, Singh K, Prabhakaran D. Conduct of clinical trials in developing countries: a perspective. Curr Opin Cardiol. 2009;24(4):295-300. doi: Doi 10.1097/Hco.0b013e32832af21b. PubMed PMID: ISI:000267279500004.

33. Ali R, Finlayson A, Network ICR. Building capacity for clinical research in developing countries: the INDOX cancer research network experience. Global Health Action. 2012;5:1-6. doi: DOI 10.3402/gha.v5i0.17288. PubMed PMID: ISI:000304003100001.

34. Editorial. The Bamako call to action: research for health. Lancet. 2008;372(9653):1855-. PubMed PMID: WOS:000261388700001.

35. Lexchin J. One step forward, one step sideways? Expanding research capacity for neglected diseases. BMC Int Health Hum Rights. 2010;10:20. Epub 2010/07/16. doi: 1472-698X-10-20 [pii]
10.1186/1472-698X-10-20. PubMed PMID: 20630063; PubMed Central PMCID: PMC2922093.

36. Khanna R, Hota P, Lahariya C. Health research strengthening and operational research needs for improving child survival in India. Indian J Pediatr. 2010;77(3):291-9. Epub 2010/05/01. doi: 10.1007/s12098-010-0037-x. PubMed PMID: 20431966.

37. Mgone CS. Strengthening of the clinical research capacity for malaria: a shared responsibility. Malar J. 2010;9 Suppl 3:S5. Epub 2010/12/22. doi: 10.1186/1475-2875-9-s3-s5. PubMed PMID: 21144085; PubMed Central PMCID: PMC3002146.

38. Shafiq N, Pandhi P, Malhotra S. Investigator-initiated pragmatic trials in developing countries--much needed but much ignored. Br J Clin Pharmacol. 2009;67(1):141-2. Epub 2008/11/14. doi: BCP3291 [pii]10.1111/j.1365-2125.2008.03291.x. PubMed PMID: 19006544; PubMed Central PMCID: PMC2668099.

39. Kasonde JM, Campbell S. Creating a Knowledge Translation Platform: nine lessons from the Zambia Forum for Health Research. Health Res Policy Syst. 2012;10:31. Epub 2012/10/05. doi: 10.1186/1478-4505-10-31. PubMed PMID: 23034056; PubMed Central PMCID: PMC3491024.

40. vasquez E, Hirsch J, Giang L, Parker R. Rethinking health research capacity strengthening. Global Public Health. 2013.

41. Lang TA, White NJ, Hien TT, Farrar JJ, Day NPJ, Fitzpatrick R, et al. Clinical Research in Resource-Limited Settings: Enhancing Research Capacity and Working Together to Make Trials Less Complicated. PLoS Negl Trop Dis. 2010;4(6):e619.

42. Mbuagbaw L, Thabane L, Ongolo-Zogo P, Lang T. The challenges and opportunities of conducting a clinical trial in a low resource setting: the case of the Cameroon mobile phone SMS (CAMPS) trial, an investigator initiated trial. Trials. 2011;12:145. Epub 2011/06/11. doi: 1745-6215-12-145 PubMed PMID: 21658262; PubMed Central PMCID: PMC3138444.

43. Adam T, Ahmad S, Bigdeli M, Ghaffar A, Rottingen JA. Trends in health policy and systems research over the past decade: still too little capacity in low-income countries. PLoS One. 2011;6(11):e27263. Epub 2011/12/02. doi: 10.1371/journal.pone.0027263. PubMed PMID: 22132094; PubMed Central PMCID: PMC3222652.

44. Mgone C, Volmink J, Coles D, Makanga M, Jaffar S, Sewankambo N. Linking research and development to strengthen health systems in Africa. Trop Med Int Health. 2010;15(12):1404-6. Epub 2010/10/20. doi: 10.1111/j.1365-3156.2010.02661.x. PubMed PMID: 20955373.

45. Courtright P, Faal HB. How can we strengthen ophthalmic research in Africa? Can J Ophthalmol. 2006;41(4):424-5. Epub 2006/08/03. doi: 10.1016/s0008-4182(06)80003-7. PubMed PMID: 16883358.

46. Garcia PJ, Cotrina A, Gotuzzo E, Gonzalez E, Buffardi AL. Research training needs in Peruvian national TB/HIV programs. BMC Med Educ. 2010;10(1). doi: 10.1186/1472-6920-10-63.

47. Harries AD, Rusen ID, Reid T, Detjen AK, Berger SD, Bissell K, et al. The Union and Medecins Sans Frontieres approach to operational research. Int J Tuberc Lung Dis. 2011;15(2):144-54, i. Epub 2011/01/12. PubMed PMID: 21219672.
48. World Health Organisation. The WHO strategy on research for health. Geneva: World Health Organisation; 2012.
49. Garrett L. The Challenge of Global Health. (cover story). Foreign Affairs. 2007;86(1):14-38.
50. Whitworth J, Sewankambo NK, Snewin VA. Improving implementation: building research capacity in maternal, neonatal, and child health in Africa. PLoS Med. 2010;7(7):e1000299. Epub 2010/07/14. doi: 10.1371/journal.pmed.1000299. PubMed PMID: 20625547; PubMed Central PMCID: PMC2897765.
51. Goto A, Nguyen TN, Nguyen TM, Hughes J. Building postgraduate capacity in medical and public health research in Vietnam: an in-service training model. Public Health. 2005;119(3):174-83. Epub 2005/01/22. doi: 10.1016/j.puhe.2004.05.005. PubMed PMID: 15661126.
52. Lansang MA, Dennis R. Building capacity in health research in the developing world. Bull World Health Organ. 2004;82(10):764-70. Epub 2005/01/13. PubMed PMID: 15643798; PubMed Central PMCID: PMC2623028.
53. Nchinda TC. Research capacity strengthening in the South. Soc Sci Med. 2002;54(11):1699-711. Epub 2002/07/13. PubMed PMID: 12113452.
54. Magwaza S, Mathambo V, Magongo B, Mvo E, Makhanya N. Health research Capacity Building in South Africa: Current knowledge and practices. Durban: Health Systems Trust; 2003.
55. Nuyens Y. No Development Without Research. Geneva: Global Forum for Health Research; 2005.
56. Pang T, Sadana R, Hanney S, Bhutta Z, Hyder A, Simon J. Knowledge for better health — a conceptual framework and foundation for health research systems. Bulletin of the World Health Organization. 2003;81(11):815-20.
57. World Health Organisation. National Health Research Systems. Report of an international workshop, Cha-am, Thailand, 12–15 March 2001. Geneva: World Health Organisation; 2002.
58. Bennett S, Adam T, Zarowsky C, Tangcharoensathien V, Ranson K, Evans T, et al. From Mexico to Mali: progress in health policy and systems research. Lancet. 2008;372(9649):1571-8. Epub 2008/11/06. doi: 10.1016/s0140-6736(08)61658-x. PubMed PMID: 18984191.
59. Ijsselmuiden C, Marais DL, Becerra-Posada F, Ghannem H. Africa's neglected area of human resources for health research - the way forward. S Afr Med J. 2012;102(4):228-33. Epub 2012/04/03. PubMed PMID: 22464504.
60. Jones N, Bailey M, Lyytikainen M. Research capacity strengthening in Africa: Trends, gaps and opportunities. In: Institute OD, editor. London: Overseas Development Institute; 2007.
61. Kariuki T, Phillips R, Njenga S, Olesen OF, Klatser PR, Porro R, et al. Research and capacity building for control of neglected tropical diseases: the need for a different approach. PLoS Negl Trop Dis. 2011;5(5):e1020. Epub 2011/06/10. doi: 10.1371/journal.pntd.0001020. PubMed PMID: 21655352; PubMed Central PMCID: PMC3104960.
62. Minja H, Nsanzabana C, Maure C, Hoffmann A, Rumisha S, Ogundahunsi O, et al. Impact of health research capacity strengthening in low- and middle-income countries: the case of WHO/TDR programmes. PLoS Negl Trop Dis. 2011;5(10):e1351. Epub 2011/10/25. doi: 10.1371/journal.pntd.0001351. PubMed PMID: 22022630; PubMed Central PMCID: PMC3191138.

63. Vogel I. Research Capacity Strengthening: Learning from Experience. In: (UKCDS) UCoDS, editor.: UK Collaborative on Development Sciences (UKCDS); 2011.
64. Chanda-Kapata P, Campbell S, Zarowsky C. Developing a national health research system: participatory approaches to legislative, institutional and networking dimensions in Zambia. Health Res Policy Syst. 2012;10:17. Epub 2012/06/08. doi: 10.1186/1478-4505-10-17. PubMed PMID: 22672331; PubMed Central PMCID: PMC3463500.
65. Cooke J. A framework to evaluate research capacity building in health care. BMC Family Practice. 2005;6(1):1-11. doi: 10.1186/1471-2296-6-44.
66. Iaccarino M. Mastering science in the South. To develop much-needed research capacity, developing countries cannot rely on the industrialized world, but have to find their own specific solutions. EMBO Rep. 2004;5(5):437-41. Epub 2004/06/09. doi: 10.1038/sj.embor.7400159. PubMed PMID: 15184971; PubMed Central PMCID: PMC1299062.
67. Higgs ES. The Southeast Asian Influenza Clinical Research Network: development and challenges for a new multilateral research endeavor. Antiviral Res. 2008;78(1):64.
68. Ogutu BR, Baiden R, Diallo D, Smith PG, Binka FN. Sustainable development of a GCP-compliant clinical trials platform in Africa: the malaria clinical trials alliance perspective. Malar J. 2010;9:103. Epub 2010/04/22. doi: 10.1186/1475-2875-9-103. PubMed PMID: 20406478; PubMed Central PMCID: PMC2873521.
69. Sawyerr. African Universities and the Challenge of Research Capacity Development. JHEA/RESA Vol 2, No 1, 2004, pp 211–240. 2004.
70. Gezmu M, DeGruttola V, Dixon D, Essex M, Halloran E, Hogan J, et al. Strengthening biostatistics resources in sub-Saharan Africa: research collaborations through U.S. partnerships. Stat Med. 2011;30(7):695-708. Epub 2011/03/12. doi: 10.1002/sim.4144. PubMed PMID: 21394746.
71. Lang T. Advancing global health research through digital technology and sharing data. Science. 2011;331(6018):714-7. Epub 2011/02/12. doi: 10.1126/science.1199349. PubMed PMID: 21311011.
72. Marjanovic S, Hanlin R, Diepeveen S, Chataway J. RESEARCH CAPACITY-BUILDING IN AFRICA: NETWORKS, INSTITUTIONS AND LOCAL OWNERSHIP. Journal of International Development. 2012:n/a-n/a. doi: 10.1002/jid.2870.
73. Whitworth JA, Kokwaro G, Kinyanjui S, Snewin VA, Tanner M, Walport M, et al. Strengthening capacity for health research in Africa. Lancet. 2008;372(9649):1590-3. Epub 2008/11/06. doi: S0140-6736(08)61660-8 [pii]
10.1016/S0140-6736(08)61660-8. PubMed PMID: 18984193; PubMed Central PMCID: PMC2607030.
74. Andronikou S, Mngomezulu V. Paediatric radiology seen from Africa. Part II: recognising research advantages in a developing country. Pediatr Radiol. 2011;41(7):826-31. Epub 2011/05/10. doi: 10.1007/s00247-011-2080-9. PubMed PMID: 21553039.
75. Matee MI, Manyando C, Ndumbe PM, Corrah T, Jaoko WG, Kitua AY, et al. European and Developing Countries Clinical Trials Partnership (EDCTP): the path towards a true partnership. BMC Public Health. 2009;9:249. Epub 2009/07/22. doi: 1471-2458-9-249 [pii]
10.1186/1471-2458-9-249. PubMed PMID: 19619283; PubMed Central PMCID: PMC2719636.
76. Dakik HA, Kaidbey H, Sabra R. Research productivity of the medical faculty at the American University of Beirut. Postgrad Med J. 2006;82(969):462-4. Epub 2006/07/11. doi: 10.1136/pgmj.2005.042713. PubMed PMID: 16822923; PubMed Central PMCID: PMC2563770.
77. Mayhew SH, Doherty J, Pitayarangsarit S. Developing health systems research capacities through north-south partnership: an evaluation of collaboration with South Africa

and Thailand. Health Res Policy Syst. 2008;6:8. Epub 2008/08/05. doi: 10.1186/1478-4505-6-8. PubMed PMID: 18673541; PubMed Central PMCID: PMC2559830.
78. Andruchow JE, Soskolne CL, Racioppi F, Bertollini R. Capacity building for epidemiologic research: a case study in the newly independent state of Azerbaijan. Ann Epidemiol. 2005;15(3):228-31. Epub 2005/02/23. doi: 10.1016/j.annepidem.2004.06.004. PubMed PMID: 15723769.
79. de-Graft Aikins A, Arhinful DK, Pitchforth E, Ogedegbe G, Allotey P, Agyemang C. Establishing and sustaining research partnerships in Africa: a case study of the UK-Africa Academic Partnership on Chronic Disease. Global Health. 2012;8:29. Epub 2012/08/18. doi: 10.1186/1744-8603-8-29. PubMed PMID: 22897937; PubMed Central PMCID: PMC3475042.
80. Gadsby EW. Research capacity strengthening: donor approaches to improving and assessing its impact in low- and middle-income countries. Int J Health Plann Manage. 2011;26(1):89-106. Epub 2010/04/28. doi: 10.1002/hpm.1031. PubMed PMID: 20422620.
81. Jones AC, Geneau R. Assessing research activity on priority interventions for non-communicable disease prevention in low- and middle-income countries: a bibliometric analysis. Glob Health Action. 2012;5:1-13. Epub 2012/09/05. PubMed PMID: 22944364; PubMed Central PMCID: PMC3427597.
82. Muula AS. What drives health research in a developing country? Croat Med J. 2007;48(2):261-7. Epub 2007/04/17. PubMed PMID: 17436392; PubMed Central PMCID: PMC2080513.
83. Siriwardhana C, Sumathipala A, Siribaddana S, Samaraweera S, Abeysinghe N, Prince M, et al. Reducing the scarcity in mental health research from low and middle income countries: a success story from Sri Lanka. Int Rev Psychiatry. 2011;23(1):77-83. Epub 2011/02/23. doi: 10.3109/09540261.2010.545991. PubMed PMID: 21338302.
84. Sadana R, D'Souza C, Hyder AA, Chowdhury AM. Importance of health research in South Asia. BMJ. 2004;328(7443):826-30. doi: 10.1136/bmj.328.7443.826. PubMed PMID: 15070643; PubMed Central PMCID: PMC383385.
85. Choi HY, Ko JW. Facilitating large-scale clinical trials: in Asia. Urol Oncol. 2010;28(6):691-2. Epub 2010/11/11. doi: 10.1016/j.urolonc.2009.12.016. PubMed PMID: 21062654.
86. Editorial. Strengthening research capacity in Africa. Lancet. 2009;374(9683):1. Epub 2009/07/07. doi: 10.1016/s0140-6736(09)61213-7. PubMed PMID: 19577676.
87. Bennett S, Agyepong IA, Sheikh K, Hanson K, Ssengooba F, Gilson L. Building the Field of Health Policy and Systems Research: An Agenda for Action. PLoS Med. 2011;8(8). doi: ARTN e1001081
DOI 10.1371/journal.pmed.1001081. PubMed PMID: ISI:000294477300015.
88. Lee PP, Lau YL. Improving care, education, and research: the Asian primary immunodeficiency network. Ann N Y Acad Sci. 2011;1238:33-41. Epub 2011/12/02. doi: 10.1111/j.1749-6632.2011.06225.x. PubMed PMID: 22129051.
89. Excler JL, Pitisuttithum P, Rerks-Ngarm S, Shao Y, Zhang L, Tamashiro H, et al. Expanding research capacity and accelerating AIDS vaccine development in Asia. Southeast Asian J Trop Med Public Health. 2008;39(4):766-84. PubMed PMID: 19058617.
90. Kilama WL, Chilengi R, Wanga CL. Towards an African-driven malaria vaccine development program: history and activities of the African Malaria Network Trust (AMANET). Am J Trop Med Hyg. 2007;77(6 Suppl):282-8. Epub 2008/01/31. doi: 77/6_Suppl/282 [pii]. PubMed PMID: 18165504.
91. Miiro GM, Oukem-Boyer OO, Sarr O, Rahmani M, Ntoumi F, Dheda K, et al. EDCTP regional networks of excellence: initial merits for planned clinical trials in Africa. BMC Public Health. 2013;13:258. Epub 2013/03/23. doi: 10.1186/1471-2458-13-258. PubMed PMID: 23517572; PubMed Central PMCID: PMCPmc3623728.

92. Editorial. Bringing health research forward. Tanzan J Health Res. 2009;11(4):iii-iv. Epub 2010/08/26. PubMed PMID: 20734693.
93. Kamunyori S, Al-Bader S, Sewankambo N, Singer PA, Daar AS. Science-based health innovation in Uganda: creative strategies for applying research to development. BMC Int Health Hum Rights. 2010;10 Suppl 1:S5. Epub 2010/12/15. doi: 1472-698X-10-S1-S5 [pii] 10.1186/1472-698X-10-S1-S5. PubMed PMID: 21144076; PubMed Central PMCID: PMC3001613.
94. Barreto ML. Health research in developing countries. BMJ. 2009;339:b4846. Epub 2009/11/26. doi: 10.1136/bmj.b4846. PubMed PMID: 19933304.
95. Zachariah R, Reid T, Srinath S, Chakaya J, Legins K, Karunakara U, et al. Building leadership capacity and future leaders in operational research in low-income countries: why and how? Int J Tuberc Lung Dis. 2011;15(11):1426-35, i. Epub 2011/10/20. doi: 10.5588/ijtld.11.0316. PubMed PMID: 22008755.
96. Lang TA, Kokwaro GO. Malaria drug and vaccine trials in Africa: obstacles and opportunities. Trans R Soc Trop Med Hyg. 2008;102(1):7-10. Epub 2007/10/05. doi: S0035-9203(07)00279-9 [pii] 10.1016/j.trstmh.2007.08.008. PubMed PMID: 17915267.
97. Ntoumi F. Networking and capacity building for health research in Central Africa. Wien Klin Wochenschr. 2010;122 Suppl 1:23-6. Epub 2010/04/14. doi: 10.1007/s00508-010-1331-3. PubMed PMID: 20376720.
98. Sitthi-Amorn C, Pongpanich S, Somrongthong R, Likitkirirat T, Likitkirirat P. The Asian Voice in building equity in health for development - from the Asian Forum for Health Research, Manila, February 2000. Health Policy Plan. 2002;17(2):213-7. Epub 2002/05/10. PubMed PMID: 12000783.
99. World Health Organisation. Scaling up research and learning for health systems: now is the time. In: Report of a High Level Task Force paeatGMFoRfH, Bamako, Mali, editor. Geneva: World Health Organisation; 2009.
100. Van Royen K, Lachat C, Holdsworth M, Smit K, Kinabo J, Roberfroid D, et al. How can the operating environment for nutrition research be improved in sub-saharan Africa? The views of african researchers. PLoS One. 2013;8(6):e66355. Epub 2013/06/19. doi: 10.1371/journal.pone.0066355. PubMed PMID: 23776663; PubMed Central PMCID: PMC3680459.
101. Kirigia JM, Wambebe C. Status of national health research systems in ten countries of the WHO African Region. BMC Health Serv Res. 2006;6:135. Epub 2006/10/21. doi: 10.1186/1472-6963-6-135. PubMed PMID: 17052326; PubMed Central PMCID: PMC1622748.
102. McKee M, Stuckler D, Basu S. Where there is no health research: what can be done to fill the global gaps in health research? PLoS Med. 2012;9(4):e1001209. Epub 2012/05/01. doi: 10.1371/journal.pmed.1001209. PubMed PMID: 22545025; PubMed Central PMCID: PMC3335864.
103. Mwangoka G, Ogutu B, Msambichaka B, Mzee T, Salim N, Kafuruki S, et al. Experience and challenges from clinical trials with malaria vaccines in Africa. Malar J. 2013;12:86. Epub 2013/03/19. doi: 10.1186/1475-2875-12-86. PubMed PMID: 23496910; PubMed Central PMCID: PMCPmc3599886.
104. Lang T. Advancing Global Health Research Through Digital Technology and Data Sharing. Science. 2011;In Press.
105. Thamarangsi T. Addiction research centres and the nurturing of creativity: Center for Alcohol Studies (CAS), Thailand. Addiction. 2013;108(7):1201-6. Epub 2012/03/27. doi: 10.1111/j.1360-0443.2012.03795.x. PubMed PMID: 22443475.
106. Ali R, Finlayson A, Indox Cancer Research N. Building capacity for clinical research in developing countries: the INDOX Cancer Research Network experience. Glob Health

Action. 2012;5. Epub 2012/05/09. doi: 10.3402/gha.v5i0.17288. PubMed PMID: 22566788; PubMed Central PMCID: PMC3343878.
107. White F. Capacity-building for health research in developing countries: a manager's approach. Rev Panam Salud Publica. 2002;12(3):165-72. Epub 2002/10/25. PubMed PMID: 12396634.
108. Excler JL, Pitisuttithum P, Rerks-Ngarm S, Shao Y, Zhang L, Tamashiro H, et al. Expanding research capacity and accelerating AIDS vaccine development in Asia. Southeast Asian J Trop Med Public Health. 2008;39(4):766-84. Epub 2008/12/09. PubMed PMID: 19058617.
109. Kellerman R, Klipstein-Grobusch K, Weiner R, Wayling S, Fonn S. Investing in African research training institutions creates sustainable capacity for Africa: the case of the University of the Witwatersrand School of Public Health masters programme in epidemiology and biostatistics. Health Res Policy Syst. 2012;10(1):11. Epub 2012/04/06. doi: 10.1186/1478-4505-10-11. PubMed PMID: 22475629; PubMed Central PMCID: PMC3378446.
110. Greenwood B, Bhasin A, Targett G. The Gates Malaria Partnership: a consortium approach to malaria research and capacity development. Trop Med Int Health. 2012;17(5):558-63. Epub 2012/03/17. doi: 10.1111/j.1365-3156.2012.02970.x. PubMed PMID: 22420422.
111. Kabiru CW, Izugbara CO, Wambugu SW, Ezeh AC. Capacity development for health research in Africa: experiences managing the African Doctoral Dissertation Research Fellowship Program. Health Res Policy Syst. 2010;8:21. Epub 2010/07/01. doi: 10.1186/1478-4505-8-21. PubMed PMID: 20587016; PubMed Central PMCID: PMC2907373.
112. Baum BJ, Scott J, Bickel M, Gombos G, Greenspan JS, Guo W, et al. Global challenges in research and strategic planning. Eur J Dent Educ. 2002;6 Suppl 3:179-84. Epub 2002/10/23. PubMed PMID: 12390276.
113. Halabi-Nassif H, Hatem M. [Evidence-based practice and the development of a nursing research culture]. Perspect Infirm. 2008;5(7):36-42. Epub 2009/03/10. PubMed PMID: 19266791.
114. Edwards N, Webber J, Mill J, Kahwa E, Roelofs S. Building capacity for nurse-led research. Int Nurs Rev. 2009;56(1):88-94. Epub 2009/02/26. doi: 10.1111/j.1466-7657.2008.00683.x. PubMed PMID: 19239521.
115. Gaym A. Health research in Ethiopia--past, present and suggestions on the way forward. Ethiop Med J. 2008;46(3):287-308. Epub 2009/03/11. PubMed PMID: 19271395.
116. Dodani S, Songer T, Ahmed Z, Laporte RE. Building research capacity in developing countries: cost-effectiveness of an epidemiology course taught by traditional and video-teleconferencing methods in Pakistan. Telemed J E Health. 2012;18(8):621-8. Epub 2012/10/16. doi: 10.1089/tmj.2011.0262. PubMed PMID: 23061643.
117. Gotch F, Gilmour J. Science, medicine and research in the developing world: a perspective. Nat Immunol. 2007;8(12):1273-6. Epub 2007/10/24. doi: 10.1038/ni1531. PubMed PMID: 17952077.
118. Manabe YC, Katabira E, Brough RL, Coutinho AG, Sewankambo N, Merry C. Developing independent investigators for clinical research relevant for Africa. Health Res Policy Syst. 2011;9:44. Epub 2011/12/31. doi: 10.1186/1478-4505-9-44. PubMed PMID: 22206247; PubMed Central PMCID: PMC3283488.
119. Siegfried NL, Hughes G. Herbal medicine, randomised controlled trials and global core competencies. S Afr Med J. 2012;102(12):912-3. Epub 2013/03/19. PubMed PMID: 23498035.
120. Abu-Zidan FM, Rizk DE. Research in developing countries: problems and solutions. Int Urogynecol J Pelvic Floor Dysfunct. 2005;16(3):174-5. Epub 2005/02/09. doi: 10.1007/s00192-004-1278-x. PubMed PMID: 15700105.

121. Tierney WM, Nyandiko WN, Siika AM, Wools-Kaloustian K, Sidle JE, Kiplagat J, et al. "These are Good Problems to Have...": Establishing a Collaborative Research Partnership in East Africa. J Gen Intern Med. 2013. Epub 2013/06/26. doi: 10.1007/s11606-013-2459-4. PubMed PMID: 23797916.

122. Muldoon KA, Birungi J, Berry NS, Ngolobe MH, Mwesigwa R, Shannon K, et al. Supporting southern-led research: implications for North-South research partnerships. Can J Public Health. 2012;103(2):128-31. Epub 2012/04/26. PubMed PMID: 22530536.

123. Akhtar W, Arain MA, Ali A, Sajjad Z. Interventions for improving research productivity in clinical radiology. J Coll Physicians Surg Pak. 2012;22(7):478-9. Epub 2012/07/04. doi: 07.2012/jcpsp.478479. PubMed PMID: 22747876.

124. Mullan F, Frehywot S, Omaswa F, Buch E, Chen C, Greysen SR, et al. Medical schools in sub-Saharan Africa. Lancet. 2011;377(9771):1113-21. Epub 2010/11/16. doi: S0140-6736(10)61961-7. PubMed PMID: 21074256.

125. Excler JL. AIDS vaccine efficacy trials: expand capacity and prioritize. 'Throughout Africa, Asia and Latin America state-of-the-art clinics and laboratories...exist where, 4 years ago, there were none'. Expert Rev Vaccines. 2006;5(2):167-70. Epub 2006/04/13. doi: 10.1586/14760584.5.2.167. PubMed PMID: 16608417.

126. Gilmour JW, Stevens WS, Gray C, de Souza M. Laboratory expansion to large-scale international HIV preventive vaccine trials. Curr Opin HIV AIDS. 2007;2(3):201-6. Epub 2007/05/01. doi: 10.1097/COH.0b013e3280eec77a. PubMed PMID: 19372887.

127. Guindo MA, Shott JP, Saye R, Diakite ML, Sanogo S, Dembele MB, et al. Promoting good clinical laboratory practices and laboratory accreditation to support clinical trials in sub-Saharan Africa. Am J Trop Med Hyg. 2012;86(4):573-9. Epub 2012/04/12. doi: 10.4269/ajtmh.2012.11-0691. PubMed PMID: 22492138; PubMed Central PMCID: PMC3403781.

128. Kilama WL. The 10/90 gap in sub-Saharan Africa: resolving inequities in health research. Acta Trop. 2009;112 Suppl 1:S8-S15. Epub 2009/08/22. doi: S0001-706X(09)00244-7 [pii]
10.1016/j.actatropica.2009.08.015. PubMed PMID: 19695211.

129. Rerks-Ngarm S, Pitisuttithum P, Ganguly N, Zhang L, Tamashiro H, Cooper DA, et al. Defining the objectives of the AIDS vaccine for Asia network: report of the WHO-UNAIDS/Global HIV vaccine enterprise regional consultation on expanding AIDS vaccine research and development capacity in Asia. Curr Opin HIV AIDS. 2010;5(5):435-52. Epub 2010/10/28. doi: 10.1097/COH.0b013e32833c95c1. PubMed PMID: 20978386; PubMed Central PMCID: PMC3125721.

130. Nachega JB, Uthman OA, Ho YS, Lo M, Anude C, Kayembe P, et al. Current status and future prospects of epidemiology and public health training and research in the WHO African region. Int J Epidemiol. 2012;41(6):1829-46. Epub 2013/01/04. doi: 10.1093/ije/dys189. PubMed PMID: 23283719; PubMed Central PMCID: PMC3535755.

131. Bates I, Taegtmeyer M, Squire SB, Ansong D, Nhlema-Simwaka B, Baba A, et al. Indicators of sustainable capacity building for health research: analysis of four African case studies. Health Res Policy Syst. 2011;9:14. Epub 2011/03/30. doi: 10.1186/1478-4505-9-14. PubMed PMID: 21443780; PubMed Central PMCID: PMC3078899.

132. Marchetti E, Mazarin-Diop V, Chaumont J, Martellet L, Makadi MF, Viviani S, et al. Conducting vaccine clinical trials in sub-Saharan Africa: operational challenges and lessons learned from the Meningitis Vaccine Project. Vaccine. 2012;30(48):6859-63. Epub 2012/09/20. doi: 10.1016/j.vaccine.2012.09.008. PubMed PMID: 22989686.

133. Casale M, Lane T, Sello L, Kuo C, Cluver L. Conducting health survey research in a deep rural South African community: challenges and adaptive strategies. Health Res Policy Syst. 2013;11:14. Epub 2013/04/27. doi: 10.1186/1478-4505-11-14. PubMed PMID: 23618363; PubMed Central PMCID: PMCPmc3640973.

134. Louisa M, Takeuchi M, Setiabudy R, Nafrialdi. Current status of phase I clinical trials in Asia: an academic perspectives. Acta Med Indones. 2012;44(1):71-7. Epub 2012/03/28. PubMed PMID: 22451190.
135. Tugwell P, Sitthi-Amorn C, Hatcher-Roberts J, Neufeld V, Makara P, Munoz F, et al. Health Research Profile to assess the capacity of low and middle income countries for equity-oriented research. BMC Public Health. 2006;6:151. Epub 2006/06/14. doi: 10.1186/1471-2458-6-151. PubMed PMID: 16768792; PubMed Central PMCID: PMC1539005.
136. TDR. ESSENCE on Health Research (Enhancing Support for Strengthening the Effectiveness of National Capacity Efforts) Geneva: World Health Organisation; 2014 [cited 2014 04/06/2014]. Available from: http://www.who.int/tdr/partnerships/initiatives/essence/en/.
137. The Global Health Network. The Global Health Network: The Global Health Network; 2014 [cited 2014 04/06/2014]. Available from: www.tghn.org.
138. ESSENCE on Health Research. Planning, Monitoring and Evaluation Framework for Research Capacity Strengthening; Revision 2016. ESSENCE Good practice document series. Geneva: World Health Organisation; 2016.
139. WHO-TDR. Key enabling factors in effective and sustainable research networks; Findings from a qualitative research study. Geneva: World Health Organisation; 2016.

Supplementary file captions

S1: Full list of papers included in the systematic review

S2: Key terminology and definitions used in this synthesis

S3: Typology of capacity development actors

Figure 1: Search and study selection process

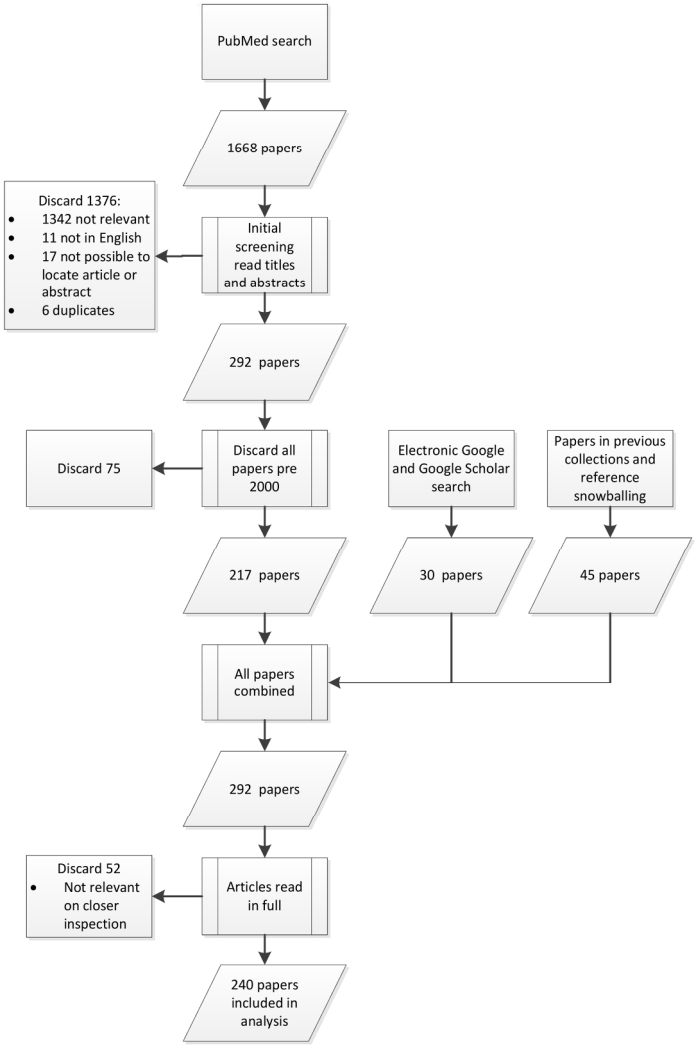


Figure 1: Search and study selection process
Figure 1
149x230mm (300 x 300 DPI)

Supplementary file S1: All papers included in the systematic review

ABBOOD, S. A. 2002. Medical research in developing countries still in Cinderella status. *Saudi Med J,* 23**,** 1554-6.

ABU-ZIDAN, F. M. & RIZK, D. E. 2005. Research in developing countries: problems and solutions. *Int Urogynecol J Pelvic Floor Dysfunct,* 16**,** 174-5.

ADAM, T., AHMAD, S., BIGDELI, M., GHAFFAR, A. & ROTTINGEN, J. A. 2011. Trends in health policy and systems research over the past decade: still too little capacity in low-income countries. *PLoS One,* 6**,** e27263.

ADDAE-MENSAH, I., FAKOREDE, F., HOLTEL, A. & NWAKA, S. 2011. Traditional medicines as a mechanism for driving research innovation in Africa. *Malar J,* 10 Suppl 1**,** S9.

AIRHIHENBUWA, C. O., SHISANA, O., ZUNGU, N., BELUE, R., MAKOFANI, D. M., SHEFER, T., SMITH, E. & SIMBAYI, L. 2011. Research capacity building: a US-South African partnership. *Glob Health Promot,* 18**,** 27-35.

AKHTAR, W., ARAIN, M. A., ALI, A. & SAJJAD, Z. 2012. Interventions for improving research productivity in clinical radiology. *J Coll Physicians Surg Pak,* 22**,** 478-9.

AKSOY, S. 2010. Solutions to neglected tropical diseases require vibrant local scientific communities. *PLoS Negl Trop Dis,* 4**,** e662.

ALEM, A. & KEBEDE, D. 2003. Conducting psychiatric research in the developing world: challenges and rewards. *Br J Psychiatry,* 182**,** 185-7.

ALI, R., FINLAYSON, A. & NETWORK, I. C. R. 2012. Building capacity for clinical research in developing countries: the INDOX cancer research network experience. *Global Health Action,* 5**,** 1-6.

ALI, R. & RAINA, V. 2008. Developing innovative models for North-South cooperation in clinical research--experience from the INDOX Cancer Research Network. *Ann Oncol,* 19**,** 831-3.

AMEH, E. A., DAUDA, M. M. & NMADU, P. T. 2008. Paediatric surgical research and publications in a developing country setting. *Afr J Paediatr Surg,* 5**,** 3-7.

ANDRONIKOU, S. & MNGOMEZULU, V. 2011. Paediatric radiology seen from Africa. Part II: recognising research advantages in a developing country. *Pediatr Radiol,* 41**,** 826-31.

ANDRUCHOW, J. E., SOSKOLNE, C. L., RACIOPPI, F. & BERTOLLINI, R. 2005. Capacity building for epidemiologic research: a case study in the newly independent state of Azerbaijan. *Ann Epidemiol,* 15**,** 228-31.

ANNERSTEDT, J. & LIYANAGE, S. 2008. Challenges when Shaping Capabilities for Research: Swedish Support to Bilateral Research Cooperation with Sri Lanka and Vietnam, 1976–2006, and a Look Ahead. *In:* COOPERATION, D. F. R. (ed.). Stockholm: SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY.

ARAI, R. J., MANO, M. S., DE CASTRO, G., DIZ, M. D. E. & HOFF, P. M. G. 2010. Building research capacity and clinical trials in developing countries. *Lancet Oncology,* 11**,** 712-713.

ARENAS-LOPEZ, S., FAJARDO, C., VALLS I SOLER, A., GARCIA-CORZO, J. R., LIMA-ROGEL, M. V., CALLE, G., LEITE, R., LOBOS, E., HUME-WRIGHT, Q.

& MACLEOD, S. 2011. Pediatric clinical trials in Latin America and Guyana: present views of local practitioners and ways to embrace the future. *Paediatr Drugs,* 13**,** 257-65.

ATUKORALA, K. R., SUMANASEKARA, D. R., WICKRAMASINGHE, K. H., RATNAYAKE, G. M., JAYASENA, G. M., WEERATUNGA, P. N., WICKRAMASINGHE, S. I. & JAYASINGHE, S. 2012. Medical student research output in a developing country: where has all the research gone? *Med Teach,* 34**,** 998.

BARBOUR, V., COHEN, B. & YAMEY, G. 2004. A new vision for clinical trials in Africa. *PLoS Med,* 1**,** e71.

BARRETO, M. L. 2009. Health research in developing countries. *BMJ,* 339**,** b4846.

BATES, I., AKOTO, A. Y., ANSONG, D., KARIKARI, P., BEDU-ADDO, G., CRITCHLEY, J., AGBENYEGA, T. & NSIAH-ASARE, A. 2006. Evaluating health research capacity building: an evidence-based tool. *PLoS Med,* 3**,** e299.

BATES, I., ANSONG, D., BEDU-ADDO, G., AGBENYEGA, T., AKOTO, A. Y., NSIAH-ASARE, A. & KARIKARI, P. 2007. Evaluation of a learner-designed course for teaching health research skills in Ghana. *BMC Med Educ,* 7**,** 18.

BATES, I., TAEGTMEYER, M., SQUIRE, S. B., ANSONG, D., NHLEMA-SIMWAKA, B., BABA, A. & THEOBALD, S. 2011. Indicators of sustainable capacity building for health research: analysis of four African case studies. *Health Res Policy Syst,* 9**,** 14.

BAUM, B. J., SCOTT, J., BICKEL, M., GOMBOS, G., GREENSPAN, J. S., GUO, W., PARK, N. H., PURDELL-LEWIS, D., RANNEY, R., SCHWARZ, E., SEYMOUR,

G. & UOSHIMA, K. 2002. Global challenges in research and strategic planning. *Eur J Dent Educ,* 6 Suppl 3**,** 179-84.

BENNETT, S., ADAM, T., ZAROWSKY, C., TANGCHAROENSATHIEN, V., RANSON, K., EVANS, T. & MILLS, A. 2008. From Mexico to Mali: progress in health policy and systems research. *Lancet,* 372**,** 1571-8.

BENNETT, S., AGYEPONG, I. A., SHEIKH, K., HANSON, K., SSENGOOBA, F. & GILSON, L. 2011. Building the Field of Health Policy and Systems Research: An Agenda for Action. *PLoS medicine,* 8.

BODEKER, G. & WILLCOX, M. 2000. The first international meeting of the Research Initiative on Traditional Antimalarial Methods (RITAM). *J Altern Complement Med,* 6**,** 195-207.

BOSCH, X. 2004. Clinical trials partnership seeks to boost research in developing countries. *JAMA,* 292**,** 1290.

BROWN, K. H., MCLACHLAN, M., CARDOSA, P., TCHIBINDAT, F. & BAKER, S. K. 2010. Strengthening public health nutrition research and training capacities in West Africa: Report of a planning workshop convened in Dakar, Senegal, 26-28 March 2009. *Glob Public Health,* 5 Suppl 1**,** S1-19.

BURGESS, L. J. & SULZER, N. U. 2010. Clinical trials in South Africa: Need for capacity building and training. *S Afr Med J,* 100**,** 402.

CASALE, M., LANE, T., SELLO, L., KUO, C. & CLUVER, L. 2013. Conducting health survey research in a deep rural South African community: challenges and adaptive strategies. *Health Res Policy Syst,* 11**,** 14.

CHANDA-KAPATA, P., CAMPBELL, S. & ZAROWSKY, C. 2012. Developing a national health research system: participatory approaches to legislative,

institutional and networking dimensions in Zambia. *Health Res Policy Syst,* 10**,** 17.

CHANDIWANA, S. & ORNBJERG, N. 2003. Review of North-South and South-South cooperation and conditions necessary to sustain research capability in developing countries. *J Health Popul Nutr,* 21**,** 288-97.

CHATAWAY, J. & HANLIN, R. 2008. Sustainable (vaccine) development: the International AIDS Vaccine Initiative (IAVI) and capacity building. *In:* MATLIN, S., DE FRANCISCO, A., SUNDARAM, L., FALCH, H. & GEHNER, M. (eds.) *Health Partnerships Review.* Geneva: Global Forum for Health Research.

CHEN, C., GREYSEN, R., MIPANDO, M. & RUGARABAMU, P. 2009. SAMSS Site Visit Report: Faculty of Helath Sciences, School of Medicine, Jimma University, Ethiopia. SAMMS.

CHOI, H. Y. & KO, J. W. 2010. Facilitating large-scale clinical trials: in Asia. *Urol Oncol,* 28**,** 691-2.

COLLINS, F., BEAUDET, A., DRAGHIA-AKLI, R., GRUSS, P., SAVILL, J., SYROTA, A., DAUTRY, A., ULFENDAHL, M., WALPORT, M., ONKEN, J. & GLASS, R. I. 2013. A database on global health research in Africa. *The Lancet,* 1**,** e64-e65.

COLOMA, J. & HARRIS, E. 2009. From construction workers to architects: developing scientific research capacity in low-income countries. *PLoS Biol,* 7**,** e1000156.

COOKE, J. 2005. A framework to evaluate research capacity building in health care. *BMC Family Practice,* 6**,** 1-11.

COSTELLO, A. & ZUMLA, A. 2000. Moving to research partnerships in developing countries. *BMJ,* 321**,** 827-9.

COURTRIGHT, P. & FAAL, H. B. 2006. How can we strengthen ophthalmic research in Africa? *Can J Ophthalmol,* 41**,** 424-5.

CRANE, J. 2011. Scrambling for Africa? Universities and global health. *The Lancet,* 377**,** 1388-1390.

D'SOUZA, C. & SADANA, R. 2006. Why do case studies on national health research systems matter?: identifying common challenges in low- and middle-income countries. *Soc Sci Med,* 62**,** 2072-8.

DAKIK, H. A., KAIDBEY, H. & SABRA, R. 2006. Research productivity of the medical faculty at the American University of Beirut. *Postgrad Med J,* 82**,** 462-4.

DAVEY, S. 2004. The 10/90 Report on Health Research 2003-2004. *In:* GLOBAL FORUM FOR HEALTH RESEARCH (ed.). Geneva: Global Forum for Health Research.

DE OLIVEIRA, N. A., LUZ, M. R., SARAIVA, R. M. & ALVES, L. A. 2011. Student views of research training programmes in medical schools. *Med Educ,* 45**,** 748-55.

DE THE, G. & ZETTERSTROM, R. 2005. Mother-child health research (IRN-MCH): achievements and prospects of an international network. *Acta Paediatr,* 94**,** 964-7.

DE-GRAFT AIKINS, A., ARHINFUL, D. K., PITCHFORTH, E., OGEDEGBE, G., ALLOTEY, P. & AGYEMANG, C. 2012. Establishing and sustaining research partnerships in Africa: a case study of the UK-Africa Academic Partnership on Chronic Disease. *Global Health,* 8**,** 29.

DECKELBAUM, R. J., NTAMBI, J. M. & WOLGEMUTH, D. J. 2011. Basic science research and education: a priority for training and capacity building in developing countries. *Infect Dis Clin North Am,* 25**,** 669-76, x.

DELISLE, H., ROBERTS, J. H., MUNRO, M., JONES, L. & GYORKOS, T. W. 2005. The role of NGOs in global health research for development. *Health Res Policy Syst,* 3**,** 3.

DEVASENAPATHY, N., SINGH, K. & PRABHAKARAN, D. 2009. Conduct of clinical trials in developing countries: a perspective. *Current Opinion in Cardiology,* 24**,** 295-300.

DEVI, V., ABRAHAM, R. R., ADIGA, A., RAMNARAYAN, K. & KAMATH, A. 2010. Fostering research skills in undergraduate medical students through mentored students projects: example from an Indian medical school. *Kathmandu Univ Med J (KUMJ),* 8**,** 294-8.

DFID 2010. Capacity Building in Research. *In:* DEVELOPMENT, D. F. I. (ed.).

DODANI, S. & LAPORTE, R. E. 2008. Ways to strengthen research capacity in developing countries: effectiveness of a research training workshop in Pakistan. *Public Health,* 122**,** 578-87.

DODANI, S., SONGER, T., AHMED, Z. & LAPORTE, R. E. 2012. Building research capacity in developing countries: cost-effectiveness of an epidemiology course taught by traditional and video-teleconferencing methods in Pakistan. *Telemed J E Health,* 18**,** 621-8.

EDITORIAL 2000. Enabling research in developing countries. *Lancet,* 356**,** 1043.

EDITORIAL 2001. Strengthening research capacity's weakest link. *Lancet,* 358**,** 1381.

EDITORIAL 2008. The Bamako call to action: research for health. *Lancet,* 372**,** 1855-1855.

EDITORIAL 2009a. Bringing health research forward. *Tanzan J Health Res,* 11**,** iii-iv.

EDITORIAL 2009b. Strengthening research capacity in Africa. *Lancet,* 374**,** 1.

EDWARDS, N., WEBBER, J., MILL, J., KAHWA, E. & ROELOFS, S. 2009. Building capacity for nurse-led research. *Int Nurs Rev,* 56**,** 88-94.

ENOCH, S. 2005. The Mexico Summit on Health Research 2004: medical community in developing countries has duty to promote healthcare research. *BMJ,* 330**,** 421.

ESSENCE ON HEALTH RESEARCH 2011. Planning Monitoring and Evaluation; Framework for Capacity Strengthening in Health Research. *In:* ESSENCE GOOD PRACTICE DOCUMENT SERIES (ed.). Geneva: Copytrend.

EXCLER, J. L. 2006. AIDS vaccine efficacy trials: expand capacity and prioritize. 'Throughout Africa, Asia and Latin America state-of-the-art clinics and laboratories...exist where, 4 years ago, there were none'. *Expert Rev Vaccines,* 5**,** 167-70.

EXCLER, J. L., PITISUTTITHUM, P., RERKS-NGARM, S., SHAO, Y., ZHANG, L., TAMASHIRO, H., OSMANOV, S. & CONSULTATION, W.-U. R. 2008. Expanding research capacity and accelerating AIDS vaccine development in Asia. *Southeast Asian J Trop Med Public Health,* 39**,** 766-84.

EZEH, A. C., IZUGBARA, C. O., KABIRU, C. W., FONN, S., KAHN, K., MANDERSON, L., UNDIEH, A. S., OMIGBODUN, A. & THOROGOOD, M. 2010. Building capacity for public and population health research in Africa: the consortium for advanced research training in Africa (CARTA) model. *Glob Health Action,* 3.

FATHALLA, M. F. 2004. Tapping the potential for health research in developing countries. *Bull World Health Organ,* 82**,** 722.

GADSBY, E. W. 2011. Research capacity strengthening: donor approaches to improving and assessing its impact in low- and middle-income countries. *Int J Health Plann Manage,* 26**,** 89-106.

GARCIA, P. J., COTRINA, A., GOTUZZO, E., GONZALEZ, E. & BUFFARDI, A. L. 2010. Research training needs in Peruvian national TB/HIV programs. *BMC Medical Education,* 10.

GARRETT, L. 2007. The Challenge of Global Health. (cover story). *Foreign Affairs,* 86**,** 14-38.

GAYM, A. 2008. Health research in Ethiopia--past, present and suggestions on the way forward. *Ethiop Med J,* 46**,** 287-308.

GELDENHUYS, H., VELDSMAN, A., TAMERIS, M., LUABEYA, A., HANEKOM, W., MAHOMED, H. & HATHERILL, M. 2013. Analysis of time to regulatory and ethical approval of SATVI TB vaccine trials in South Africa. *S Afr Med J,* 103**,** 85-9.

GELDENHUYS, H., WAGGIE, Z., JACKS, M., GELDENHUYS, M., TRAUT, L., TAMERIS, M., HATHERILL, M., HANEKOM, W. A., SUTTER, R., HUSSEY, G. & MAHOMED, H. 2012. Vaccine trials in the developing world: operational lessons learnt from a phase IV poliomyelitis vaccine trial in South Africa. *Vaccine,* 30**,** 5839-43.

GEZMU, M., DEGRUTTOLA, V., DIXON, D., ESSEX, M., HALLORAN, E., HOGAN, J., GROBLER, A., KIM, S., MCDERMOTT, J., MCKAIG, R. & NEATON, J. D. 2011. Strengthening biostatistics resources in sub-Saharan Africa: research collaborations through U.S. partnerships. *Stat Med,* 30**,** 695-708.

GILMOUR, J. W., STEVENS, W. S., GRAY, C. & DE SOUZA, M. 2007. Laboratory expansion to large-scale international HIV preventive vaccine trials. *Curr Opin HIV AIDS,* 2**,** 201-6.

GLOBAL FORUM FOR HEALTH RESEARCH 2000. The 10/90 report on health research 2000. *In:* RESEARCH, G. F. F. H. (ed.). Geneva: Global Forum for Health Research.

GONZALEZ-BLOCK, M. A., VARGAS-RIANO, E. M., SONELA, N., IDROVO, A. J., OUWE-MISSI-OUKEM-BOYER, O. & MONOT, J. J. 2011. Research capacity for institutional collaboration in implementation research on diseases of poverty. *Trop Med Int Health,* 16**,** 1285-90.

GOTCH, F. & GILMOUR, J. 2007. Science, medicine and research in the developing world: a perspective. *Nat Immunol,* 8**,** 1273-6.

GOTO, A., NGUYEN, T. N., NGUYEN, T. M. & HUGHES, J. 2005. Building postgraduate capacity in medical and public health research in Vietnam: an in-service training model. *Public Health,* 119**,** 174-83.

GRAY, G. E., DE BRUYN, G., SLACK, C., STEEL, G. & WILLIAMSON, C. 2006. Preparing developing countries for efficacy trials. *Curr Opin HIV AIDS,* 1**,** 330-5.

GREEN, A. & BENNETT, S. (eds.) 2007. *Sound Choices: Enhancing Capacity for Evidence-Informed Health Policy,* Geneva: World Health Organisation.

GREENWOOD, B., BHASIN, A. & TARGETT, G. 2012. The Gates Malaria Partnership: a consortium approach to malaria research and capacity development. *Trop Med Int Health,* 17**,** 558-63.

GREENWOOD, B. M., BHASIN, A., BOWLER, C. H., NAYLOR, H. & TARGETT, G. A. 2006. Capacity strengthening in malaria research: the Gates Malaria Partnership. *Trends Parasitol,* 22**,** 278-84.

GUINDO, M. A., SHOTT, J. P., SAYE, R., DIAKITE, M. L., SANOGO, S., DEMBELE, M. B., KEITA, S., NAGEL, M. C., ELLIS, R. D., AEBIG, J. A., DIALLO, D. A. & DOUMBO, O. K. 2012. Promoting good clinical laboratory practices and laboratory accreditation to support clinical trials in sub-Saharan Africa. *Am J Trop Med Hyg,* 86**,** 573-9.

GULLAND, A. 2012. Plan to stimulate research in developing countries is put on hold. *BMJ,* 344**,** e3771.

GYAPONG, J. & OFORI-ADJEI, D. 2011. Capacity building for relevant health research in developing countries. *In:* UNIT, H. R. (ed.). University of Ghana Medical School.

HALABI-NASSIF, H. & HATEM, M. 2008. [Evidence-based practice and the development of a nursing research culture]. *Perspect Infirm,* 5**,** 36-42.

HARGREAVES, S. 2002. Wellcome Trust promotes ethical research in developing world. *BMJ,* 325**,** 986.

HARRIES, A. D. 2003. Integration of operational research into National Tuberculosis Control Programmes. *Tuberculosis (Edinb),* 83**,** 143-7.

HARRIES, A. D., RUSEN, I. D., REID, T., DETJEN, A. K., BERGER, S. D., BISSELL, K., HINDERAKER, S. G., EDGINTON, M., FUSSELL, M., FUJIWARA, P. I. & ZACHARIAH, R. 2011. The Union and Medecins Sans Frontieres approach to operational research. *Int J Tuberc Lung Dis,* 15**,** 144-54, i.

HARUN AR, R. 2004. Promoting road traffic injuries research in South Asia: capacity strengthening in health research. *J Coll Physicians Surg Pak,* 14**,** 736-8.

HIGGS, E. S., HAYDEN, F. G., CHOTPITAYASUNONDH, T., WHITWORTH, J. & FARRAR, J. 2008. The Southeast Asian Influenza Clinical Research Network: development and challenges for a new multilateral research endeavor. *Antiviral Res,* 78**,** 64-8.

HOYT, P. 2006. Problem Solving for Better Health Nursing: a working approach to the development and dissemination of applied research in developing countries. *Appl Nurs Res,* 19**,** 110-2; discussion 112.

HUSSEY, G. & HAWKRIDGE, A. 2012. The state and future of research at the University of Cape Town's Faculty of Health Sciences. *S Afr Med J,* 102**,** 412-4.

HYDER, A. A., AKHTER, T. & QAYYUM, A. 2003. Capacity development for health research in Pakistan: the effects of doctoral training. *Health Policy Plan,* 18**,** 338-43.

IACCARINO, M. 2004. Mastering science in the South. To develop much-needed research capacity, developing countries cannot rely on the industrialized world, but have to find their own specific solutions. *EMBO Rep,* 5**,** 437-41.

IJSSELMUIDEN, C., MARAIS, D. L., BECERRA-POSADA, F. & GHANNEM, H. 2012. Africa's neglected area of human resources for health research - the way forward. *S Afr Med J,* 102**,** 228-33.

JAFFAR, S., LAZARUS, J. V., ONYEBUJOH, P., CHAKAYA, J., GARRIB, A., MWABA, P., MBOUP, S., BELLIS, K., EGWAGA, S., CORRAH, T. & COUTINHO, A.

2010. Health services strengthening in Africa--research is a key component. *Trop Med Int Health,* 15**,** 1270-3.

JENTSCH, B. & PILLEY, C. 2003. Research relationships between the South and the North: Cinderella and the ugly sisters? *Soc Sci Med,* 57**,** 1957-67.

JOHNSON, K., KENNEDY, S. B., HARRIS, A. O., LINCOLN, A., NEACE, W. & COLLINS, D. 2005. Strengthening the HIV/AIDS service delivery system in Liberia: an international research capacity-building strategy. *J Eval Clin Pract,* 11**,** 257-73.

JONES, N., BAILEY, M. & LYYTIKAINEN, M. 2007. Research capacity strengthening in Africa: Trends, gaps and opportunities. *In:* INSTITUTE, O. D. (ed.). London: Overseas Development Institute.

KABIRU, C. W., IZUGBARA, C. O., WAMBUGU, S. W. & EZEH, A. C. 2010. Capacity development for health research in Africa: experiences managing the African Doctoral Dissertation Research Fellowship Program. *Health Res Policy Syst,* 8**,** 21.

KAMUNYORI, S., AL-BADER, S., SEWANKAMBO, N., SINGER, P. A. & DAAR, A. S. 2010. Science-based health innovation in Uganda: creative strategies for applying research to development. *BMC Int Health Hum Rights,* 10 Suppl 1**,** S5.

KARIUKI, T., PHILLIPS, R., NJENGA, S., OLESEN, O. F., KLATSER, P. R., PORRO, R., LOCK, S., CABRAL, M. H., GLIBER, M. & HANNE, D. 2011. Research and capacity building for control of neglected tropical diseases: the need for a different approach. *PLoS Negl Trop Dis,* 5**,** e1020.

KASONDE, J. M. & CAMPBELL, S. 2012. Creating a Knowledge Translation Platform: nine lessons from the Zambia Forum for Health Research. *Health Res Policy Syst,* 10**,** 31.

KELLERMAN, R., KLIPSTEIN-GROBUSCH, K., WEINER, R., WAYLING, S. & FONN, S. 2012. Investing in African research training institutions creates sustainable capacity for Africa: the case of the University of the Witwatersrand School of Public Health masters programme in epidemiology and biostatistics. *Health Res Policy Syst,* 10**,** 11.

KENT, S. J., COOPER, D. A., CHHI VUN, M., SHAO, Y., ZHANG, L., GANGULY, N., BELA, B., TAMASHIRO, H., DITANGCO, R., RERKS-NGARM, S., PITISUTTITHUM, P., VAN KINH, N., BERNSTEIN, A., OSMANOV, S., INVESTIGATORS, A. V. F. A. N. & SUPPORTERS 2010. AIDS vaccine for Asia Network (AVAN): expanding the regional role in developing HIV vaccines. *PLoS Med,* 7**,** e1000331.

KHAN, F. A. 2010. Challenges of anaesthesia research in developing countries. *J Coll Physicians Surg Pak,* 20**,** 563-4.

KHAN, H., KHAN, S. & IQBAL, A. 2009. Knowledge, attitudes and practices around health research: the perspective of physicians-in-training in Pakistan. *BMC Med Educ,* 9**,** 46.

KHANNA, R., HOTA, P. & LAHARIYA, C. 2010. Health research strengthening and operational research needs for improving child survival in India. *Indian J Pediatr,* 77**,** 291-9.

KILAMA, W. L. 2001. The malaria burden and the need for research and capacity strengthening in Africa. *Am J Trop Med Hyg,* 64**,** iii.

KILAMA, W. L. 2009. The 10/90 gap in sub-Saharan Africa: resolving inequities in health research. *Acta Trop,* 112 Suppl 1**,** S8-S15.

KILAMA, W. L., CHILENGI, R. & WANGA, C. L. 2007. Towards an African-driven malaria vaccine development program: history and activities of the African Malaria Network Trust (AMANET). *Am J Trop Med Hyg,* 77**,** 282-8.

KIRIGIA, J. M. & WAMBEBE, C. 2006. Status of national health research systems in ten countries of the WHO African Region. *BMC Health Serv Res,* 6**,** 135.

KITUA, A. Y. 2007. Health research agenda for East Africa in the new millennium: looking ahead. *Tanzan Health Res Bull,* 9**,** 147-53.

KITUA, A. Y., CORRAH, T., HERBST, K., NYIRENDA, T., AGWALE, S., MAKANGA, M. & MGONE, C. S. 2009. Strengthening capacity, collaboration and quality of clinical research in Africa: EDCTP Networks of Excellence. *Tanzan J Health Res,* 11**,** 51-4.

KOK, M. O., RODRIGUES, A., SILVA, A. P. & DE HAAN, S. 2012. The emergence and current performance of a health research system: lessons from Guinea Bissau. *Health Res Policy Syst,* 10**,** 5.

KWONG, J. S. & YU, C. M. 2013. The need for multicentre cardiovascular clinical trials in Asia. *Nat Rev Cardiol,* 10**,** 355-62.

LAABES, E. P., DESAI, R., ZAWEDDE, S. M. & GLEW, R. H. 2011. How much longer will Africa have to depend on western nations for support of its capacity-building efforts for biomedical research? *Trop Med Int Health,* 16**,** 258-62.

LANG, T. 2011. Advancing global health research through digital technology and sharing data. *Science,* 331**,** 714-7.

LANG, T. & SIRIBADDANA, S. 2012. Clinical trials have gone global: is this a good thing? *PLoS Med,* 9**,** e1001228.

LANG, T. A. & KOKWARO, G. O. 2008. Malaria drug and vaccine trials in Africa: obstacles and opportunities. *Trans R Soc Trop Med Hyg,* 102**,** 7-10.

LANG, T. A., WHITE, N. J., TRAN, H. T., FARRAR, J. J., DAY, N. P., FITZPATRICK, R., ANGUS, B. J., DENIS, E., MERSON, L., CHEAH, P. Y., CHILENGI, R., KIMUTAI, R. & MARSH, K. 2010. Clinical research in resource-limited settings: enhancing research capacity and working together to make trials less complicated. *PLoS Negl Trop Dis,* 4**,** e619.

LANGER, A., DIAZ-OLAVARRIETA, C., BERDICHEVSKY, K. & VILLAR, J. 2004. Why is research from developing countries underrepresented in international health literature, and what can be done about it? *Bull World Health Organ,* 82**,** 802-3.

LANSANG M. & DENNIS R. 2007. The need to develop research capacity. *Global Forum Update on Research for Health Volume 4.* London: Pro-Brook Publishing Ltd.

LANSANG, M. A. & DENNIS, R. 2004. Building capacity in health research in the developing world. *Bull World Health Organ,* 82**,** 764-70.

LAZARUS, J. V., WALLACE, S. A. & LILJESTRAND, J. 2010. Improving African health research capacity. *Scand J Public Health,* 38**,** 670-1.

LEE, P. P. & LAU, Y. L. 2011. Improving care, education, and research: the Asian primary immunodeficiency network. *Ann N Y Acad Sci,* 1238**,** 33-41.

LEHNER, T., HOELSCHER, M., CLERICI, M., GOTCH, F., PEDNEAULT, L., TARTAGLIA, J., GRAY, C., MESTECKY, J., SATTENTAU, Q., VAN DE WIJGERT, J., TOURE, C., OSMANOV, S., SCHMIDT, R. E., DEBRE, P.,

ROMARIS, M., HOEVELER, A. & DI FABIO, S. 2005. European Union and EDCTP strategy in the global context: recommendations for preventive HIV/AIDS vaccines research. *Vaccine,* 23**,** 5551-6.

LESI, O. A., ORENUGA, O. O., ROBERTS, A. & ABUDU, O. O. 2009. Research productivity of junior academic staff at a tertiary medical college in south west, Nigeria. *Nig Q J Hosp Med,* 19**,** 119-24.

LEXCHIN, J. 2010. One step forward, one step sideways? Expanding research capacity for neglected diseases. *BMC Int Health Hum Rights,* 10**,** 20.

LI, M., WEI, L., LIU, H. & TANG, L. 2009. Integrative review of international nursing research in Mainland China. *Int Nurs Rev,* 56**,** 28-33.

LOUISA, M., TAKEUCHI, M., SETIABUDY, R. & NAFRIALDI 2012. Current status of phase I clinical trials in Asia: an academic perspectives. *Acta Med Indones,* 44**,** 71-7.

LUTUMBA, P., KANDE, V., BOELAERT, M., KAYEMBE, J. M. & MAMPUNZA, S. 2010. Research capacity strengthening in the DRC. *Lancet,* 375**,** 1080.

MAGWAZA, S., MATHAMBO, V., MAGONGO, B., MVO, E. & MAKHANYA, N. 2003. Health research Capacity Building in South Africa: Current knowledge and practices. Durban: Health Systems Trust.

MANABE, Y. C., KATABIRA, E., BROUGH, R. L., COUTINHO, A. G., SEWANKAMBO, N. & MERRY, C. 2011. Developing independent investigators for clinical research relevant for Africa. *Health Res Policy Syst,* 9**,** 44.

MARAIS, D., TOOHEY, J., EDWARDS, D. & IJSSELMUIDEN, C. 2013. Where there is no lawyer: Guidance for fairer contract negotiation in collaborative research

partnerships. *In:* DEVELOPMENT, C. I. H. R. F. (ed.). Geneva & Pietermaritzburg: Council in Health Research for Development.

MARCHETTI, E., MAZARIN-DIOP, V., CHAUMONT, J., MARTELLET, L., MAKADI, M. F., VIVIANI, S., KULKARNI, P. S. & PREZIOSI, M. P. 2012. Conducting vaccine clinical trials in sub-Saharan Africa: operational challenges and lessons learned from the Meningitis Vaccine Project. *Vaccine,* 30**,** 6859-63.

MARJANOVIC, S., HANLIN, R., DIEPEVEEN, S. & CHATAWAY, J. 2012. RESEARCH CAPACITY-BUILDING IN AFRICA: NETWORKS, INSTITUTIONS AND LOCAL OWNERSHIP. *Journal of International Development***,** n/a-n/a.

MARSHALL-LUCETTE, S., CORBETT, K., LARTEY, N., OPIO, D. & BIKAITWOHA, M. E. 2007. Developing locally based research capacity in Uganda. *Int Nurs Rev,* 54**,** 227-33.

MARTINS, N. & HAWKINS, Z. 2012. Striving for better health through health research in post-conflict Timor-Leste. *Health Res Policy Syst,* 10**,** 13.

MATEE, M. I., MANYANDO, C., NDUMBE, P. M., CORRAH, T., JAOKO, W. G., KITUA, A. Y., AMBENE, H. P., NDOUNGA, M., ZIJENAH, L., OFORI-ADJEI, D., AGWALE, S., SHONGWE, S., NYIRENDA, T. & MAKANGA, M. 2009. European and Developing Countries Clinical Trials Partnership (EDCTP): the path towards a true partnership. *BMC Public Health,* 9**,** 249.

MAYHEW, S. H., DOHERTY, J. & PITAYARANGSARIT, S. 2008. Developing health systems research capacities through north-south partnership: an evaluation of collaboration with South Africa and Thailand. *Health Res Policy Syst,* 6**,** 8.

MAZIAK, W. 2001. Global health research. Science aid programme could be set up to help researchers in developing countries. *BMJ,* 322**,** 173.

MBUAGBAW, L., ONGOLO-ZOGO, P. & THABANE, L. 2013. Investigating community ownership of a text message programme to improve adherence to antiretroviral therapy and provider-client communication: a mixed methods research protocol. *BMJ Open,* 3.

MBUAGBAW, L., THABANE, L., ONGOLO-ZOGO, P. & LANG, T. 2011. The challenges and opportunities of conducting a clinical trial in a low resource setting: the case of the Cameroon mobile phone SMS (CAMPS) trial, an investigator initiated trial. *Trials,* 12**,** 145.

MCKEE, M. 2008. Global research for health. *British Medical Journal,* 337.

MCKEE, M., STUCKLER, D. & BASU, S. 2012. Where there is no health research: what can be done to fill the global gaps in health research? *PLoS Med,* 9**,** e1001209.

MEDAGLINI, D. & HOEVELER, A. 2003. The European research effort for HIV/AIDS, malaria and tuberculosis. *Vaccine,* 21 Suppl 2**,** S116-20.

MELIS, T., ASHCROFT, K., MACFARLANE, I., RAYNER, P., SEMELA, T. & YIZENGAW, T. 2008. Human capacity building needs analysis of Ethiopian new public universities (NPUs). *In:* CENTRE FOR INTERNATIONAL COOPERATION, V. U. A. (ed.). Development Assistance Group, Ethiopia.

MGONE, C., VOLMINK, J., COLES, D., MAKANGA, M., JAFFAR, S. & SEWANKAMBO, N. 2010. Linking research and development to strengthen health systems in Africa. *Trop Med Int Health,* 15**,** 1404-6.

MGONE, C. S. 2010. Strengthening of the clinical research capacity for malaria: a shared responsibility. *Malar J,* 9 Suppl 3**,** S5.

MGONE, S. & MOCUMBI, P. 2008. Collaborative approach to clinical trials. *In:* MAITLIN, S., DE FRANCISCO, A., SUNDARAM, L., FAICH, H. & GEHNER, M. (eds.) *Health Partnerships Review.* Geneva: Global Forum for Health Research.

MIIRO, G. M., OUKEM-BOYER, O. O., SARR, O., RAHMANI, M., NTOUMI, F., DHEDA, K., PYM, A., MBOUP, S. & KALEEBU, P. 2013. EDCTP regional networks of excellence: initial merits for planned clinical trials in Africa. *BMC Public Health,* 13**,** 258.

MINJA, H., NSANZABANA, C., MAURE, C., HOFFMANN, A., RUMISHA, S., OGUNDAHUNSI, O., ZICKER, F., TANNER, M. & LAUNOIS, P. 2011. Impact of Health Research Capacity Strengthening in Low- and Middle-Income Countries: The Case of WHO/TDR Programmes. *Plos Neglected Tropical Diseases,* 5.

MONY, P. K., KURPAD, A. & VAZ, M. 2005. Capacity building in collaborative research is essential. *BMJ,* 331**,** 843-4.

MORAN, M., GUZMAN, J., ROPARS, A., JORGENSEN, M., POTTER, S., MCDONALD, A. & HAILE-SELASSIE, H. 2008. Clinical trial site capacity for malaria product development. *In:* MAITLIN, S., DE FRANCISCO, A., SUNDARAM, L., FAICH, H. & GEHNER, M. (eds.) *Health Partnerships Review.* Geneva: Global Forum for Health Research, Geneva.

MORENO-BORCHART, A. 2004. One problem at a time. Building research capacities in developing countries is necessary for economic success in the long term. But the numerous problems in doing so have to be solved for each country individually. *EMBO Rep,* 5**,** 127-30.

MULDOON, K. A., BIRUNGI, J., BERRY, N. S., NGOLOBE, M. H., MWESIGWA, R., SHANNON, K. & MOORE, D. M. 2012. Supporting southern-led research: implications for North-South research partnerships. *Can J Public Health,* 103**,** 128-31.

MULLAN, F., FREHYWOT, S., OMASWA, F., BUCH, E., CHEN, C., GREYSEN, S. R., WASSERMANN, T., ABUBAKR, D. E., AWASES, M., BOELEN, C., DIOMANDE, M. J., DOVLO, D., FERRO, J., HAILEAMLAK, A., IPUTO, J., JACOBS, M., KOUMARE, A. K., MIPANDO, M., MONEKOSSO, G. L., OLAPADE-OLAOPA, E. O., RUGARABAMU, P., SEWANKAMBO, N. K., ROSS, H., AYAS, H., CHALE, S. B., CYPRIEN, S., COHEN, J., HAILE-MARIAM, T., HAMBURGER, E., JOLLEY, L., KOLARS, J. C., KOMBE, G. & NEUSY, A. J. 2011. Medical schools in sub-Saharan Africa. *Lancet,* 377**,** 1113-21.

MUULA, A. S. 2007. What drives health research in a developing country? *Croat Med J,* 48**,** 261-7.

MWABA, P., BATES, M., GREEN, C., KAPATA, N. & ZUMLA, A. 2010. Research capacity strengthening in African countries. *Lancet,* 375**,** 1874.

MWANGOKA, G., OGUTU, B., MSAMBICHAKA, B., MZEE, T., SALIM, N., KAFURUKI, S., MPINA, M., SHEKALAGHE, S., TANNER, M. & ABDULLA, S. 2013. Experience and challenges from clinical trials with malaria vaccines in Africa. *Malar J,* 12**,** 86.

NACHEGA, J. B., UTHMAN, O. A., HO, Y. S., LO, M., ANUDE, C., KAYEMBE, P., WABWIRE-MANGEN, F., GOMO, E., SOW, P. S., OBIKE, U., KUSIAKU, T., MILLS, E. J., MAYOSI, B. M. & IJSSELMUIDEN, C. 2012. Current status and

future prospects of epidemiology and public health training and research in the WHO African region. *Int J Epidemiol,* 41**,** 1829-46.

NANTULYA, F. N., KENGEYA-KAYONDO, J. F. & OGUNDAHUNSI, O. A. 2007. Research themes and advances in malaria research capacity made by the Multilateral Initiative on Malaria. *Am J Trop Med Hyg,* 77**,** 303-13.

NCHINDA, T. C. 2002. Research capacity strengthening in the South. *Soc Sci Med,* 54**,** 1699-711.

NJIE-CARR, V., KALENGE, S., KELLEY, J., WILSON, A., MULIIRA, J. K., NABIRYE, R. C., GLASS, N., BOLLINGER, R., ALAMO-TALISUNA, S. & CHANG, L. W. 2012. Research capacity-building program for clinicians and staff at a community-based HIV clinic in Uganda: A pre/post evaluation. *J Assoc Nurses AIDS Care,* 23**,** 431-41.

NTOUMI, F. 2010. Networking and capacity building for health research in Central Africa. *Wien Klin Wochenschr,* 122 Suppl 1**,** 23-6.

NUYENS, Y. 2005. No Development Without Research. Geneva: Global Forum for Health Research.

OGUTU, B. R., BAIDEN, R., DIALLO, D., SMITH, P. G. & BINKA, F. N. 2010. Sustainable development of a GCP-compliant clinical trials platform in Africa: the malaria clinical trials alliance perspective. *Malar J,* 9**,** 103.

OLVEDA, R., LEONARDO, L., ZHENG, F., SRIPA, B., BERGQUIST, R. & ZHOU, X. N. 2010. Coordinating research on neglected parasitic diseases in Southeast Asia through networking. *Adv Parasitol,* 72**,** 55-77.

PANG, T., SADANA, R., HANNEY, S., BHUTTA, Z., HYDER, A. & SIMON, J. 2003. Knowledge for better health — a conceptual framework and foundation for

health research systems. *Bulletin of the World Health Organization,* 81**,** 815-820.

PARLIMENTARY OFFICE OF SCIENCE AND TECHNOLOGY 2004. Scientific Capacity In Developing Countries. *In:* TECHNOLOGY, P. O. O. S. A. (ed.). London: Parlimentary Office of Science and Technology.

PARRY, C., MOROJELE, N., MYERS, B. & PLUDDEMANN, A. 2013. Addiction research centres and the nurturing of creativity: The Alcohol & Drug Abuse Research Unit at the South African Medical Research Council - strengthening substance abuse research and policy in South Africa. *Addiction,* 108**,** 14-9.

PERKOVIC, V., PATIL, V., WEI, L., LV, J., PETERSEN, M. & PATEL, A. 2012. Global randomized trials: the promise of India and China. *J Bone Joint Surg Am,* 94 Suppl 1**,** 92-6.

PETERSEN, P. E. 2009. Global policy for improvement of oral health in the 21st century--implications to oral health research of World Health Assembly 2007, World Health Organization. *Community Dent Oral Epidemiol,* 37**,** 1-8.

PITAYARANGSARIT, S. & TANGCHAROENSATHIEN, V. 2009. Sustaining capacity in health policy and systems research in Thailand. *Bull World Health Organ,* 87**,** 72-4.

PITISUTTITHUM, P., CHOOPANYA, K. & RERK-NGNAM, S. 2010. HIV-vaccine research and development in Thailand: evolution and challenges. *Vaccine,* 28 Suppl 2**,** B45-9.

PURTY, A. J. 2008. Reflections for research capacity development in India. *Natl Med J India,* 21**,** 263.

RAB, M. A. 2003. Setting global health research priorities: investments for health research for developing countries must be increased. *BMJ,* 326**,** 1399.

RABIU, T. B. & BALOGUN, J. A. 2009. Repositioning health research in developing countries. *Arch Med Res,* 40**,** 223.

RAMJEE, G. 2008. Issues surrounding the implementation of multiple product development partnership clinical trials in developing countries. *In:* RESEARCH, G. F. F. H. (ed.). Geneva: Global Forum for Health Research.

REDMAN-MACLAREN, M., MACLAREN, D. J., HARRINGTON, H., ASUGENI, R., TIMOTHY-HARRINGTON, R., KEKEUBATA, E. & SPEARE, R. 2012. Mutual research capacity strengthening: a qualitative study of two-way partnerships in public health research. *Int J Equity Health,* 11**,** 79.

RERKS-NGARM, S., PITISUTTITHUM, P., GANGULY, N., ZHANG, L., TAMASHIRO, H., COOPER, D. A., VUN, M. C., BELA, B., DITANGCO, R., VAN KINH, N., BERNSTEIN, A., OSMANOV, S., MATHIESON, B., KENT, S. J. & SHAO, Y. 2010. Defining the objectives of the AIDS vaccine for Asia network: report of the WHO-UNAIDS/Global HIV vaccine enterprise regional consultation on expanding AIDS vaccine research and development capacity in Asia. *Curr Opin HIV AIDS,* 5**,** 435-52.

RESNIK, D. B. 2004. The distribution of biomedical research resources and international justice. *Dev World Bioeth,* 4**,** 42-57.

SABZWARI, S., KAUSER, S. & KHUWAJA, A. K. 2009. Experiences, attitudes and barriers towards research amongst junior faculty of Pakistani medical universities. *BMC Med Educ,* 9**,** 68.

SADANA, R., D'SOUZA, C., HYDER, A. A. & CHOWDHURY, A. M. 2004. Importance of health research in South Asia. *BMJ,* 328**,** 826-30.

SAWYERR 2004. African Universities and the Challenge of Research Capacity Development. *JHEA/RESA Vol. 2, No. 1, 2004, pp. 211–240*.

SAYED, S. I., DUTTA, S., MATEEN, S., KAZI, R. & JAGADE, M. 2011. Clinical health research in India: is there a way forward? *J Indian Med Assoc,* 109**,** 270-1.

SCHLUGER, N., KARUNAKARA, U., LIENHARDT, C., NYIRENDA, T. & CHAISSON, R. 2007. Building Clinical Trials Capacity for Tuberculosis Drugs in High-Burden Countries. *PLoS Med,* 4**,** e302.

SEN, F. & MUTHUSWAMY, V. 2006. Capacity building for clinical trials in India. *Indian J Med Res,* 124**,** 605-7.

SHAFIQ, N., PANDHI, P. & MALHOTRA, S. 2009. Investigator-initiated pragmatic trials in developing countries--much needed but much ignored. *Br J Clin Pharmacol,* 67**,** 141-2.

SHANKAR, P. R. 2007. Mentoring a medical student towards applied research in a developing country. *Med Teach,* 29**,** 253-4.

SHANKAR, P. R., CHANDRASEKHAR, T. S., MISHRA, P. & SUBISH, P. 2006. Initiating and strengthening medical student research: time to take up the gauntlet. *Kathmandu Univ Med J (KUMJ),* 4**,** 135-8.

SHANN, F. 2002. Research in developing countries. *N Engl J Med,* 346**,** 627-8.

SHIRAHATTI, R. V., SURA, S., SUMANTHPRASAD, G. R. & KHURANA, L. 2010. Dental students research inventory: a questionnaire to assess research challenges and opportunities. *J Dent Educ,* 74**,** 1308-18.

SIEGFRIED, N. L. & HUGHES, G. 2012. Herbal medicine, randomised controlled trials and global core competencies. *S Afr Med J,* 102**,** 912-3.

SILKAVUTE, P., TUNG, D. X. & JONGUDOMSUK, P. 2013. Sustaining a regional emerging infectious disease research network: a trust-based approach. *Emerg Health Threats J,* 6.

SILOVE, D., REES, S., TAM, N., LIDDELL, B. & ZWI, A. 2011. Staff management and capacity building under conditions of insecurity: lessons from developing mental health service and research programs in post-conflict Timor-Leste. *Australas Psychiatry,* 19 Suppl 1**,** S90-4.

SIRIWARDHANA, C., SUMATHIPALA, A., SIRIBADDANA, S., SAMARAWEERA, S., ABEYSINGHE, N., PRINCE, M. & HOTOPF, M. 2011. Reducing the scarcity in mental health research from low and middle income countries: a success story from Sri Lanka. *Int Rev Psychiatry,* 23**,** 77-83.

SITTHI-AMORN, C., PONGPANICH, S., SOMRONGTHONG, R., LIKITKIRIRAT, T. & LIKITKIRIRAT, P. 2002. The Asian Voice in building equity in health for development - from the Asian Forum for Health Research, Manila, February 2000. *Health Policy Plan,* 17**,** 213-7.

SITTHI-AMORN, C. & SOMRONGTHONG, R. 2000. Strengthening health research capacity in developing countries: a critical element for achieving health equity. *BMJ,* 321**,** 813-7.

SMITH, R. 2002. Publishing research from developing countries. *Stat Med,* 21**,** 2869-77.

SPARKS, B. L. & GUPTA, S. K. 2004. Research in family medicine in developing countries. *Ann Fam Med,* 2 Suppl 2**,** S55-9.

STEPHEN, C. & DAIBES, I. 2010. Defining features of the practice of global health research: an examination of 14 global health research teams. *Glob Health Action,* 3.

SUAALII-SAUNI, T., AIAVAO, F., FAAFEU-HOPE, E., SOPOAGA, T., PAUL, C., RIGHARTS, A., MCCOOL, J., KIRIFI-ALAI, T. N., HILL, P. & FUATAI, F. L. 2011. Strengthening health research capacity from within Samoa. *Asia Pac J Public Health,* 23**,** 100-9.

SUMATHIPALA, A., SIRIBADDANA, S., SAMARAWEERA, S. & DAYARATNE, D. A. 2003. Capacity building through multi-disciplinary research: a report from Sri Lanka. *Br J Psychiatry,* 183**,** 457-8.

THAMARANGSI, T. 2013. Addiction research centres and the nurturing of creativity: Center for Alcohol Studies (CAS), Thailand. *Addiction,* 108**,** 1201-6.

THATTE, U. M. & BAVDEKAR, S. B. 2008. Clinical research in India: great expectations? *J Postgrad Med,* 54**,** 318-23.

THORNICROFT, G., COOPER, S., BORTEL, T. V., KAKUMA, R. & LUND, C. 2012. Capacity building in global mental health research. *Harv Rev Psychiatry,* 20**,** 13-24.

TIERNEY, W. M., NYANDIKO, W. N., SIIKA, A. M., WOOLS-KALOUSTIAN, K., SIDLE, J. E., KIPLAGAT, J., BELL, A. & INUI, T. S. 2013. "These are Good Problems to Have...": Establishing a Collaborative Research Partnership in East Africa. *J Gen Intern Med*.

TSAI, S. L. 2000. Nurses' participation and utilization of research in the Republic of China. *Int J Nurs Stud,* 37**,** 435-44.

TUGWELL, P., SITTHI-AMORN, C., HATCHER-ROBERTS, J., NEUFELD, V., MAKARA, P., MUNOZ, F., CZERNY, P., ROBINSON, V., NUYENS, Y. & OKELLO, D. 2006. Health Research Profile to assess the capacity of low and middle income countries for equity-oriented research. *BMC Public Health,* 6**,** 151.

UTHMAN, O. A. 2008. Performance, priorities, and future of biomedical research publications in Africa: Need for networks between scientists in developed and developing countries. *Pan Afr Med J,* 1**,** 5.

VAMADEVAN, A. S., SHAH, B. R., CALIFF, R. M. & PRABHAKARAN, D. 2011. Cardiovascular research in India: a perspective. *Am Heart J,* 161**,** 431-8.

VAN HELDEN, P. 2012. The cost of research in developing countries. *EMBO Rep,* 13**,** 395.

VAN ROYEN, K., LACHAT, C., HOLDSWORTH, M., SMIT, K., KINABO, J., ROBERFROID, D., NAGO, E., GARIMOI ORACH, C. & KOLSTEREN, P. 2013. How can the operating environment for nutrition research be improved in sub-saharan Africa? The views of african researchers. *PLoS One,* 8**,** e66355.

VARKEVISSER, C. M., MWALUKO, G. M. & LE GRAND, A. 2001. Research in action: the training approach of the Joint Health Systems Research Project for the Southern African Region. *Health Policy Plan,* 16**,** 281-91.

VASQUEZ, E., HIRSCH, J., GIANG, L. & PARKER, R. 2013. Rethinking health research capacity strengthening. *Global Public Health*.

VOGEL, I. 2011. Research Capacity Strengthening: Learning from Experience. *In:* (UKCDS), U. C. O. D. S. (ed.). UK Collaborative on Development Sciences (UKCDS).

VOLMINK, J. & DARE, L. 2005. Addressing inequalities in research capacity in Africa. *BMJ,* 331**,** 705-6.

WERTHEIM, H. F., PUTHAVATHANA, P., NGHIEM, N. M., VAN DOORN, H. R., NGUYEN, T. V., PHAM, H. V., SUBEKTI, D., HARUN, S., MALIK, S., ROBINSON, J., RAHMAN, M., TAYLOR, W., LINDEGARDH, N., WIGNALL, S., FARRAR, J. J. & DE JONG, M. D. 2010. Laboratory capacity building in Asia for infectious disease research: experiences from the South East Asia Infectious Disease Clinical Research Network (SEAICRN). *PLoS Med,* 7**,** e1000231.

WHITE, F. 2002. Capacity-building for health research in developing countries: a manager's approach. *Rev Panam Salud Publica,* 12**,** 165-72.

WHITE, M. T. 2007. A right to benefit from international research: a new approach to capacity building in less-developed countries. *Account Res,* 14**,** 73-92.

WHITE, N. W. 2004. Capacity building for research: report on a UNION Strategic Planning Workshop. Report of a workshop held during the International Union Against Tuberculosis and Lung Disease World Conference on Lung Health, Montreal, Canada, 7 October 2002. *Int J Tuberc Lung Dis,* 8**,** 910-4.

WHITWORTH, J., SEWANKAMBO, N. K. & SNEWIN, V. A. 2010. Improving implementation: building research capacity in maternal, neonatal, and child health in Africa. *PLoS Med,* 7**,** e1000299.

WILLCOX, M., SIEGFRIED, N. & JOHNSON, Q. 2012. Capacity for clinical research on herbal medicines in Africa. *J Altern Complement Med,* 18**,** 622-8.

WILLIAMS, J. R., SCHATZ, E. J., CLARK, B. D., COLLINSON, M. A., CLARK, S. J., MENKEN, J., KAHN, K. & TOLLMAN, S. M. 2010. Improving public health

training and research capacity in Africa: a replicable model for linking training to health and socio-demographic surveillance data. *Glob Health Action,* 3.

WORLD HEALTH ORGANISATION 2002. National Health Research Systems. Report of an international workshop, Cha-am, Thailand, 12–15 March 2001. Geneva: World Health Organisation.

WORLD HEALTH ORGANISATION 2004. World report on knowledge for better health: strengthening health systems. Geneva: World Health Organisation.

WORLD HEALTH ORGANISATION 2005. Ministerial Summit on Health Research (2004: Mexico City, Mexico). *In:* REPORT FROM THE MINISTERIAL SUMMIT ON HEALTH RESEARCH: IDENTIFY CHALLENGES, I. A., CORRECT INEQUITIES. (ed.). Geneva: World Health Organisation.

WORLD HEALTH ORGANISATION 2009. Scaling up research and learning for health systems: now is the time. *In:* REPORT OF A HIGH LEVEL TASK FORCE, P. A. E. A. T. G. M. F. O. R. F. H., BAMAKO, MALI (ed.). Geneva: World Health Organisation.

WORLD HEALTH ORGANISATION 2012. The WHO strategy on research for health. Geneva: World Health Organisation.

WRIGHT MDA, G., CAUFIELD, C., GRAY, G. & OLSON, J. 2005. International Research Capacity-Building Programs for Nurses to Study the Drug Phenomenon in Latin America: challenges and perspectives. *Rev Lat Am Enfermagem,* 13 Spec No**,** 1095-101.

YUSUF, S. 2002. Clinical research and trials in developing countries. *Stat Med,* 21**,** 2859-67.

ZACHARIAH, R., HARRIES, A. D., ISHIKAWA, N., RIEDER, H. L., BISSELL, K., LASERSON, K., MASSAQUOI, M., VAN HERP, M. & REID, T. 2009. Operational research in low-income countries: what, why, and how? *Lancet Infect Dis,* 9**,** 711-7.

ZACHARIAH, R., REID, T., SRINATH, S., CHAKAYA, J., LEGINS, K., KARUNAKARA, U. & HARRIES, A. D. 2011. Building leadership capacity and future leaders in operational research in low-income countries: why and how? *Int J Tuberc Lung Dis,* 15**,** 1426-35, i.

ZAIN, R. B., GHANI, W. M., RAZAK, I. A., LATIFAH, R. J., SAMSUDDIN, A. R., CHEONG, S. C., ABDULLAH, N., ISMAIL, A. R., HUSSAINI, H. B., TALIB, N. A. & JALLALUDIN, A. 2009. Building partnership in oral cancer research in a developing country: processes and barriers. *Asian Pac J Cancer Prev,* 10**,** 513-8.

ZHOU, X. N., WAYLING, S. & BERGQUIST, R. 2010. Concepts in research capabilities strengthening positive experiences of network approaches by TDR in the People's Republic of China and Eastern Asia. *Adv Parasitol,* 73**,** 1-19.

ZICKER, F. 2001. Strengthening capability for malaria research in Africa. *Emerg Infect Dis,* 7**,** 529-30.

ZUMLA, A., HUGGETT, J., DHEDA, K., GREEN, C., KAPATA, N. & MWABA, P. 2010. Trials and tribulations of an African-led research and capacity development programme: the case for EDCTP investments. *Trop Med Int Health,* 15**,** 489-94.

Supplementary file S2: Key terminology and definitions used in this synthesis

Term	Definition adopted	Examples	Comments and caveats
Health research capacity development (HRCD)	"Capacity development is defined as the ability of individuals, organisations or systems to perform appropriate functions effectively, efficiently and in a sustainable manner. When applied to health research, this translates to enabling both individuals and institutions to define health problems, set objectives and priorities, build sustainable institutions and organisations and identify solutions to key national health problems". [1]	Conducted by a large numbers of actors including: private foundations, multi and bi-lateral funders, international organisations, consortia, research councils, universities, NGOs and Industry. Examples include Rockefeller Foundation, The Swedish International Development Agency and WHO TDR. Usually involves knowledge or resource transfer at individual, institutional or macro levels.	This definition by Magwaza et al. [1] was found to be the most straightforward and encompassing definition of health research capacity development. Although the term "capacity development" has some pejorative connotations (assumption that there is little extant capacity), in its broadest sense capacity development could involve both building new capacity and strengthening existing capacity. It also semantically links capacity development to the international development agenda.
Research system	Concept representing a system designed to coordinate and manage health research at all stages of the knowledge cycle with the goal of improving health and health equity. The research system can be conceptualised as the environment or ecosystem that research takes place in [2].	Research systems encompass health research structures, regulations, governance, ethics, infrastructure, priority setting, financial and resource planning, acquisition and allocation at national, regional or global levels [3]. They include and connect all other levels, including the supra-national level.	Research system is not to be confused with "System Level". "System Level" is sometimes used to describe the "Macro Level".
Development modality	Modality refers to the methods or organisational setup used to deliver development interventions	May include basket funding to institutions, vertical support to projects, or horizontal capacity development, collaboration or partnerships [4].	Similar to research model. Modality is distinct from "strategy" which more specifically describes the development intervention.
Development strategy	Strategy refers to the selection and deployment of interventions aimed at resolving specific development barriers	Strategies can focussed at the individual, institutional, or macro level. Examples include training fellowships, building laboratories, or creating knowledge development platforms.	Modality is distinct from "strategy" which more specifically describes the development intervention.
Macro level capacity	The highest level of the national research system. Capacities at this level may be agenda setting, policies, national budgetary allocations, demand creation and strategic planning [5].	Government ministries such as Ministry of Health, Research or Education. Also includes regulatory and ethics bodies, funding bodies, top level administrative structures, professional associations and national registries.	Often used interchangeably with "System Level" [5]. However, this is confusing because the system encompasses individual, institutional, macro and supra-national levels.

Institutional level capacity	Refers to the ability of institutions to fund, manage and sustain themselves to perform all tasks required to deliver their services or goals. Common institutions include: universities, hospitals, and ministerial departments.	Elements of institutions include: human resources, material resources (computers and machinery), infrastructure (libraries and laboratories), service connections (internet, water, and power), service delivery and finance and management systems.	Based on the working definitions used by The Global Forum for Health Research and the World Health Organisation as they encompass the most common conceptualisations of the term [2, 5-7].
Organisational level capacity	The capacities of individual units within and governed by "institutions".	Usually include departments or research units within universities or research divisions within ministries of health	The term "institution" is often used interchangeably with "organisation". However, differentiating between these terms is useful because it distinguishes between the wider governing institution and organisational units within institutions [8].
Individual level capacity	Individual capacity development attempts to increase the capacities of individuals to perform their work effectively	Traditionally focused on producers of research. More recently extended to other stakeholders and includes "soft" skills training such as leadership.	Based on commonly accepted definitions used by The Global Forum for Health Research and the World Health Organisation [2, 5-7].

References

1. Magwaza S, Mathambo V, Magongo B, Mvo E, Makhanya N. Health research Capacity Building in South Africa: Current knowledge and practices. Durban: Health Systems Trust; 2003.

2. World Health Organisation. World report on knowledge for better health: strengthening health systems. Geneva: World Health Organisation; 2004.

3. Chanda-Kapata P, Campbell S, Zarowsky C. Developing a national health research system: participatory approaches to legislative, institutional and networking dimensions in Zambia. Health Res Policy Syst. 2012;10:17. Epub 2012/06/08. doi: 10.1186/1478-4505-10-17. PubMed PMID: 22672331; PubMed Central PMCID: PMC3463500.

4. Jones N, Bailey M, Lyytikainen M. Research capacity strengthening in Africa: Trends, gaps and opportunities. In: Institute OD, editor. London: Overseas Development Institute; 2007.

5. Nuyens Y. No Development Without Research. Geneva: Global Forum for Health Research; 2005.

6. Global Forum for Health Research. The 10/90 report on health research 2000. In: Research GFfH, editor. Geneva: Global Forum for Health Research; 2000.

7. World Health Organisation. National Health Research Systems. Report of an international workshop, Cha-am, Thailand, 12–15 March 2001. Geneva: World Health Organisation; 2002.

8. DFID. Capacity Building in Research. In: Development DfI, editor. 2010.

Supplementary file S3: Typology of capacity development actors

Actor	Examples	History	Roles	Development strategies	Research focus
Private foundations or charities	Wellcome Trust, Gates Foundation, Rockefeller Foundation	Most are relatively new to HRCD but some well-established	Funding	Mostly individual-level development to undertake specific projects. Little investment in local institutions.	Mostly support research generation but recent moves to translation
Multi-lateral agencies	World Health Organisation, World Bank, African Development Bank, Global Fund	WHO TDR & HRP are some of the oldest actors in HRCD. Most relatively new to HRCD.	Governance, stewardship, agenda setting, advocacy & funding	Usually channel funds through independent or subsidiary organisations. WHO offers individual-level development. Traditionally did not support institutions & had little system interest. However, now taking the lead in system approaches & may channel funds though local institutions.	Typically support research generation but increasing emphasis on translation, & dissemination
Bilateral agencies	Swedish International Development Agency, Department for International Development	Generally the longest running financial supporters of HRCD, but some are newer.	Varied	Usually support individual & institutional development. Little system development until very recently.	Historical focus on knowledge generation but progressively more emphasis on knowledge utilisation & dissemination
Global organisations	Global Forum for Health Research, European & Developing Countries Clinical Trial Partnership	Mostly since mid-1990s but some older. Often formed by, or as, a subsidiary of multi-laterals.	Stewardship roles set & promote global agendas. Also have multi-lateral funding brokerage roles.	Act as a catalyst to support & direct diverse actors to common goals. Usually fund & work with networks & consortia. Organise forums. Historically supported individual & institutional development but now support HRCD at most levels & modes. Provide advice & strong advocacy roles.	Originally interested in knowledge generation & translation but now tackle all stages of knowledge cycle
Consortia & networks	Alliance for Health Policy & Systems Research, International Network for Clinical Epidemiology, Central African Network on TB HIV/AIDS & Malaria	Largely a recent phenomenon forming mid-late 1990s onwards	Development, advocacy or funding brokerage roles Global, regional or local reach.	Individual & institutional support for specific projects or organisations that are thematically focussed. Not traditionally institution-wide or system development but recently more attention to those areas. Mixture of horizontal & vertical initiatives.	Collectively they cover the entire knowledge cycle but most have specific focus.
Public private partnerships & product development partnerships	Medicines for Malaria Venture, International AIDS Vaccine Initiative, Global Alliance for TB Drug Development	Largely a recent phenomenon forming mid-late 1990s onwards. Over 70 formed between 1995 & 2003.	Thematically based on disease or intervention of interest. Product development "upstream" R&D research.	Development approaches usually concentrated on building capacity to run specific studies through vertical interventions. Recently a little more attention to individual level & infrastructure development.	Knowledge generation & strong emphasis on translation

LMIC research councils & institutes of health	South African Medical Research Council, The National Research Council of Sri Lanka	Much less common than in HICs but increasing & some well-established.	Varies widely but usually in accordance with national priorities & focus on specific conditions or projects.	Funding is often limited but appears to be increasing. Formation of research sites, particularly centres of excellence. Individual & institutional development. Often in collaboration with international networks. Early moves towards system development. May also carry out own research.	Mostly knowledge generation
LMIC Governments	South Africa, Brazil, Zambia	Highly variable often according to GDP but also economic policies. Some investing a lot, others not at all. Typically only recent investments in HRCD.	Variable but usually in accordance with national priorities. May be linked to infrastructure development.	Some ministries have their own research centres & develop capacity "in house". Others provide project grants or individual development. Governments may upgrade or create research institutions. Investment value typically small due to resource constraints or low priority of research. However, some countries investing heavily. More recent attention to macro level capacities.	Varied. Knowledge generation common but recently agenda setting, stewardship, demand creation & knowledge utilisation
LMIC academic & healthcare institutions	University of KwaZulu-Natal, Makerere University, Fundação Oswaldo Cruz	Varied history. Some very well established in research but most new to HRCD. May be public or private.	Variable. Research may be in accordance with national or global priorities, or investigator interest.	Mainly undergraduate & some graduate training. Provide institutional resources for research. Development of institutions usually reliant on governmental funds, unless private. Normally training & education takes precedence over research.	Knowledge generation
HIC research councils & institutes of health	Medical Research Council (UK), NIH (USA), Canadian Institutes for Health Research, Royal Society	Institutions with a long history but only recently (around 2000) expanding their role in HRCD	Varied. But no specific remit to conduct capacity development.	Provide various funding & scholarships for individuals to undertake post graduate training. Also fund specific research projects which may include institutional development. Normally work in collaboration with institutions from donor country. Usually not system level. Some encourage scientific excellence by forming links with other LMIC societies, but do not conduct HRCD directly.	May conduct research themselves. Mostly support knowledge generation but may have smaller investments in knowledge utilisation.
HIC academic & healthcare institutions	University of Oxford, Institut Pasteur, Johns Hopkins University	A long history of research in LMICs. Some project specific HRCD but only recently taking on more explicit capacity development.	Project focused around research goals. Mostly investigator-led but may follow national priorities.	Development is usually to facilitate a specific project. May involve developing research sites & staff. Often focus on centres of excellence. Individual development either in-country or at HIC universities. System development not common. Normally in partnership with local groups which increases knowledge transfer.	Mostly knowledge generation. Specific projects may target knowledge utilisation & sometimes dissemination but much rarer.

Industry	GlaxoSmithKline, IBM, local industries	Pharmaceutical companies important but IT companies increasingly involved. International & national industry involved.	Product development & innovation technologies. Mostly in Asia. Currently less reach to Africa.	Develop capacity through technology or "know how" transfer. Infrastructure strengthening, particularly IT. May fund individual training or institutional development. May also provide services at favourable rate or free. Usually work in partnership with other actors.	Knowledge generation & translation but also knowledge management. May work in other areas depending on company.
Non-governmental organisations (NGO)	Medicine Sans Frontiers, Drugs for Neglected Diseases Initiative, One World Health, local NGOS	Recent involvement in research & HRCD (post 2005)	Either highly applied research or product development R&D. Some work in partnerships with other actors.	Strengthen research within networks or embedded in health delivery. Usually individual or specialised institutional support. As part of civil society, have strong advocacy & moderation roles. Can mobilise resources towards non-profit activities.	All stages of knowledge cycle.
Academic journals	International Committee of Medical Journal Editors, Lancet, PLOS, Tanzanian Journal of Health Research	Long history of discussion on HRCD but becoming increasingly prominent in last 5 years.	Advocacy & opinion leaders. Role as moderators & amplifiers. Provide access to information & publishing.	Improve access to information & enable individuals to publish by changing publication & subscription policies. Promoting best practice & improving quality & reliability of publications. Encourage debate & advocate.	Knowledge dissemination

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Page 1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	Pages 2-3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	Pages 5-6
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	Page 6 (end)
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	No formal protocol exists
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Section 2.1, page 7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	Section 2.2., pages 7
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Box 1, page 8
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	Sections 2.2 & 2.3, pages 7. Also figure 1.
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	Section 2.4, pages 9
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Section 2.4, pages 9.
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	Section 2.3. Page 8
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	Section 2.4,

PRISMA 2009 Checklist

			pages 9
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	Section 2.4, pages 9

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	Section 4.4., pages 27, and section 3.6, pages 22
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	NA
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Section 2.2., Pages 7. Figure 1.
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Section 3.2, pages 11. Table 2.
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	NA – See section 2.3, page 8.
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	NA
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Sections 3.3. and 3.4, pages

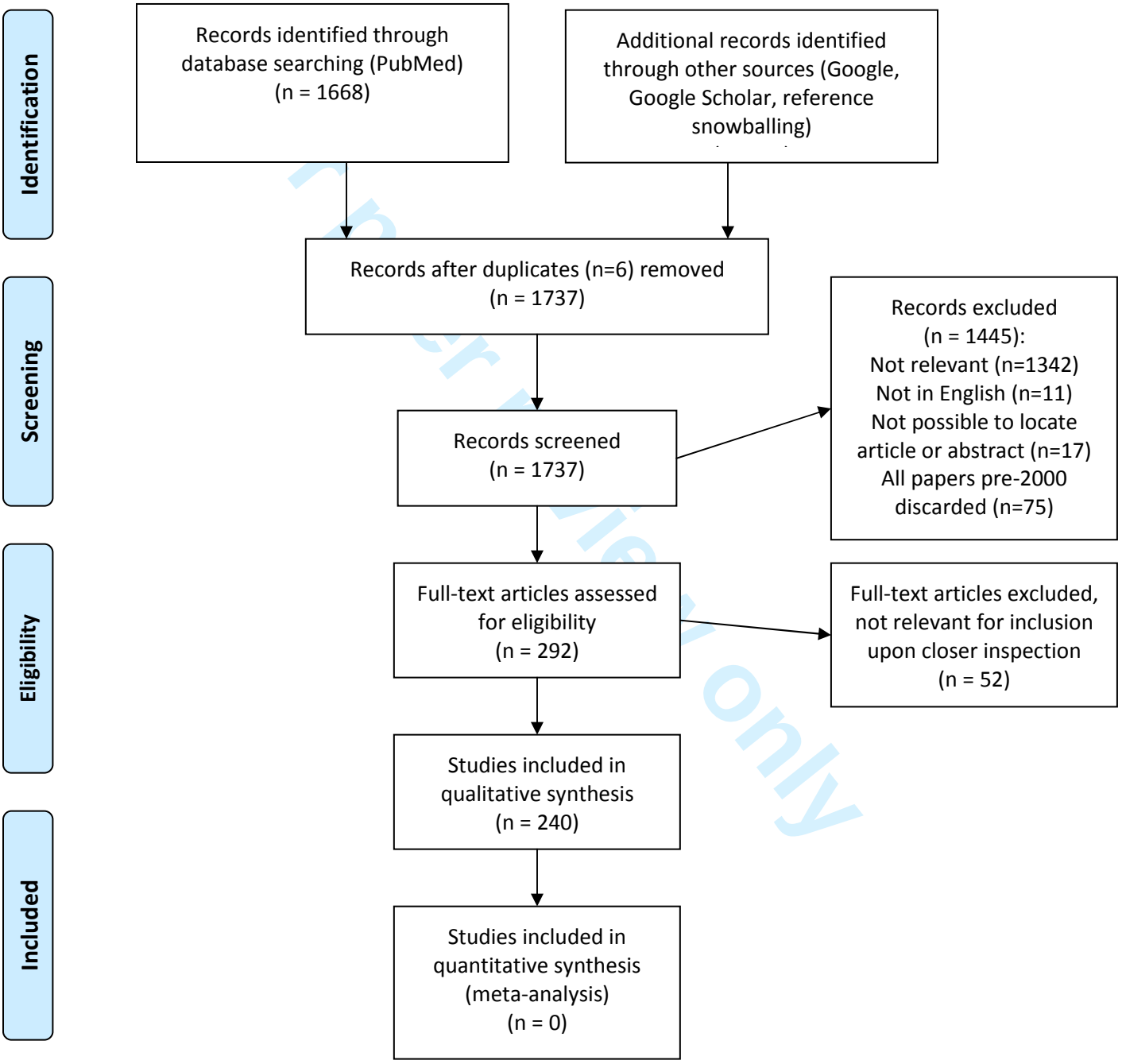
PRISMA 2009 Checklist

			12-22
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	NA – See section 2.3, page 8.
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	NA
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	Section 4.1, page 25, and 4.3 pages 27
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	Section 4.4, pages 28-29
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	Sections 4.2 pages 27 & 4.5 page 28
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	Funding statement, page 29

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: www.prisma-statement.org.

PRISMA 2009 Flow Diagram: Health research capacity development in Low and Middle Income Countries: reality or rhetoric? A systematic meta-narrative review of the qualitative literature



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit www.prisma-statement.org.