



EDCTP

European & Developing Countries Clinical Trials Partnership

EUROPEAN AND AFRICAN CLINICAL RESEARCH

A BIBLIOMETRIC ANALYSIS OF
PUBLICATIONS WITHIN THE
SCOPE OF EDCTP2

2003-2011



Towards the second EDCTP programme

This report presents the bibliometric evaluation of the research output of European and African research in the disease areas of HIV/AIDS, tuberculosis, malaria and neglected infectious diseases, between 2003 and 2011. This evaluation will complement a wider study of European and African national research programmes, partnerships, activities and capacities informing the scope, remit and strategy of EDCTP2 as well as reporting on the existing EDCTP research base.

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EDCTP was created in 2003 as a European response to the global health crisis caused by the three main poverty-related diseases (PRDs) of HIV/AIDS, tuberculosis and malaria. Currently EDCTP-EEIG is a partnership between 16 European countries, the European Union and sub-Saharan African countries. The aim of the programme is to accelerate the development

of new and improved drugs, vaccines, microbicides and diagnostics against HIV/AIDS, tuberculosis and malaria through a balanced partnership of European national research programmes on PRDs with their African counterparts in collaboration with the pharmaceutical industry and like-minded organisations.

The second EDCTP programme started on 2 December 2014 as part of the European research framework programme Horizon 2020. The EDCTP Association currently consists of 14 European countries (Austria, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden and UK) and 14 African countries (Burkina Faso, Cameroon, Congo, Gabon, The Gambia, Ghana, Mali, Mozambique, Niger, Senegal, South Africa, Tanzania, Uganda and Zambia) as Participating States. Its scope is based on the objectives and achievements of the first programme, and has expanded to include: all clinical trial phases (I-IV) including health services optimisation research; other neglected infectious diseases; closer collaboration with industry, like-minded product development partners and development agencies; and collaborative research with other countries outside sub-Saharan Africa when possible and desirable.

Contents

Acronyms and abbreviations – 4

List of figures and tables – 6

I. Executive summary – 11

2. Introduction – 15

2.1. European & Developing Countries Clinical Trials
Partnership – 15

2.2. Objectives – 15

2.3. Thomson Reuters – 15

3. Analysis and reporting – 16

3.1. Bibliometrics and citation analyses – 16

3.2. Data definitions – 21

3.3. Interpretation of data and analyses – 21

3.4. Time, location and subject scope – 22

Time – 22

Geographical coverage – 22

Institutional coverage – 24

Research funding organisations – 27

Subject coverage – 28

3.5. Global burden of disease – 28

3.6. Dataset composition and overlap – 30

Clinical trials and epidemiology research – 32

3.7. Data presentation – 34

4. HIV/AIDS research – 37

4.1. Summary – 37

National disease burden for HIV/AIDS – 39

Clinical trials and epidemiology research – 40

EDCTP-associated funding collaboration – 45

4.2. European research in HIV/AIDS – 46

4.3. European research trends – 47

4.4. EDCTP Member Countries – 48

4.5. EDCTP Prospective Member Countries – 50

4.6. Sub-Saharan African research in HIV/AIDS – 51

Southern Africa – 51

East Africa – 52

West Africa – 53

Central Africa – 53

4.7. Sub-Saharan African research trends – 54

4.8. Southern Africa – 55

4.9. East Africa – 58

4.10.	West Africa	– 60
4.11.	Central Africa	– 62
5.	Tuberculosis research	– 64
5.1.	Summary	– 64
	National disease burden for tuberculosis	– 66
	Clinical trials and epidemiology research	– 66
	EDCTP-associated funding collaboration	– 70
	EDCTP-associated funding collaboration	– 71
5.2.	European research in tuberculosis	– 71
5.3.	European research trends	– 73
5.4.	EDCTP Member Countries	– 74
5.5.	EDCTP Prospective Member Countries	– 76
5.6.	Sub-Saharan African research in tuberculosis	– 77
	Southern Africa	– 77
	East Africa	– 78
	West Africa	– 79
	Central Africa	– 79
5.7.	Sub-Saharan African research trends	– 80
5.8.	Southern Africa	– 81
5.9.	East Africa	– 84
5.10.	West Africa	– 86
5.11.	Central Africa	– 88
6.	Malaria research	– 89
6.1.	Summary	– 89
	National disease burden for malaria	– 91
	Clinical trials and epidemiology research	– 92
	EDCTP-associated funding collaboration	– 97
6.2.	European research in malaria	– 98
6.3.	European research trends	– 99
6.4.	EDCTP Member Countries	– 100
6.5.	EDCTP Prospective Member Countries	– 102
6.6.	Sub-Saharan African research in malaria	– 103
	Southern Africa	– 103
	East Africa	– 104
	West Africa	– 104
	Central Africa	– 105
6.7.	Sub-Saharan African research trends	– 106
6.8.	Southern Africa	– 107
6.9.	East Africa	– 110
6.10.	West Africa	– 113
6.11.	Central Africa	– 116

7. Neglected infectious diseases (NIDs) research	118
7.1. Summary	118
National disease burden for Tropical Cluster Diseases	120
Clinical trials and epidemiology research	122
EDCTP-associated funding collaboration	123
7.2. European research in NIDs	126
7.3. European research trends	127
7.4. EDCTP Member Countries	128
7.5. EDCTP Prospective Member Countries	130
7.6. Sub-Saharan African research in NIDs	131
Southern Africa	131
East Africa	132
West Africa	132
Central Africa	133
7.7. Sub-Saharan African research trends	134
7.8. Southern Africa	135
7.9. East Africa	137
7.10. West Africa	139
7.11. Central Africa	141
8. Conclusion	143

Acronyms and abbreviations

A*STAR	Singapore Agency for Science, Technology and Research	ESP	Spain
AFR	Africa	EST	Estonia
AGO	Angola	ETH	Ethiopia
ANRS	Agence Nationale de Recherche sur le Sida	EUR	Europe
AUT	Austria	FIN	Finland
BDI	Burundi	FIOCRUZ	Fundação Oswaldo Cruz
BEL	Belgium	FP7	Seventh Framework Programme
BEN	Benin	FRA	France
BFA	Burkina Faso	GAB	Gabon
BGR	Bulgaria	GBD	Global Burden of Disease
BMBF	German Federal Ministry of Education and Research	GHA	Ghana
BOTUSA	Botswana-USA Partnership	GIN	Guinea
BRICK	Brazil, Russia, India, China, Korea)	GMB	The Gambia
BWA	Botswana	GNB	Guinea Bissau
CAF	Central African Republic	GNQ	Equatorial Guinea
CALTECH	California Institute of Technology	GRC	Greece
CHE	Switzerland	HEI	Higher education institutions
CHU	Centre Hospitalier Universitaire	Horizon 2020	EU Framework Programme for Research and Innovation
CIRAD	French Agricultural Research for Development	HRV	Croatia
CIV	Côte d'Ivoire	HUN	Hungary
CMR	Cameroon	IGO	Inter-Governmental Organisations
CNRS	Centre National de la Recherche Scientifique	INSERM	Institut Nationale de la Santé et de la Recherche Medicale
COD	Democratic Republic of Congo	IP	Intellectual Property
COG	Congo	IPM	International Partnership for Microbicides
COM	Comoros	IRD	Institut de recherche pour le developpement
COR	Corporate	IRL	Ireland
CPV	Cape Verde	ISO	International Organization for Standardization
CYP	Cyprus	ITA	Italy
CZE	Czech Republic	KAIST	Korea Institute of Advanced Science and Technology
DALY(s)	Disability-adjusted life year(s)	KEMRI	Kenya Medical Research Institute
DBL	Centre for Health Research and Development	KEN	Kenya
DEU	Germany	LBR	Liberia
DFG	German Research Foundation	LSO	Lesotho
DFID	UK Department for International Development	LTU	Lithuania
DNK	Denmark	LUX	Luxembourg
EDCTP	European & Developing Countries Clinical Trials Partnership	LVA	Latvia
ERI	Eritrea	MDG	Madagascar
		MESH	Medical Subject Headings
		MIM	Multilateral Initiative on Malaria
		MLI	Mali

MLT	Malta	TAVI	Tuberculosis Vaccine Initiative
MMV	Medicines for Malaria Venture	TCD	Chad
MOZ	Mozambique	TGO	Togo
MRC	Medical Research Council	TZA	Tanzania
MRC	Medical Research Council	UCL	University College London
MRT	Mauritania	UGA	Uganda
MUS	Mauritius	UK	United Kingdom
MWI	Malawi	UMC	University Medical Center
NAM	Namibia	UN	United Nations
NCI	Normalised Citation Impact	UNICEF	United Nations Children's Fund
NER	Niger	USA	United States of America
NGA	Nigeria	WHO	World Health Organization
NGO	Non-Governmental Organisations	YLD	Years Lived with Disability
NID	Neglected Infectious Diseases	YLL	Years of Life Lost
NIH	US National Institutes of Health	ZAF	South Africa
NIMR	National Institute for Medical Research	ZMB	Zambia
		ZWE	Zimbabwe
NLD	Netherlands		
NOR	Norway		
NRF	National Research Foundation		
OECD	Organisation for Economic Cooperation and Development		
PATH	Program for Appropriate Technology in Health		
PEPFAR	United States President's Emergency Plan for AIDS Relief		
PhD	Doctor of Philosophy		
POL	Poland		
PRD	Poverty-related disease		
PRT	Portugal		
ROU	Romania		
ROW	Rest of the World		
RWA	Rwanda		
SDN	Sudan		
SEN	Senegal		
Sida	Swedish International Development Cooperation Agency		
SLE	Sierra Leone		
SOM	Somalia		
SSD	South Sudan		
STP	São Tomé and Príncipe		
SVK	Slovakia		
SVN	Slovenia		
SWE	Sweden		
SWZ	Swaziland		
SYC	Seychelles		

List of figures and tables

Figure 3.1.1	Citation count at end-2011 for UK cell biology papers published in 2007 – 12	Figure 4.4.1	Country quadrant for HIV/AIDS research in EDCTP Member Countries – 42
Figure 3.1.2	Impact (citations end-2011/ number of papers) and percentage of papers uncited at the end-2011 – 13	Figure 4.5.1	Country quadrant for HIV/AIDS research in EDCTP Prospective Member Countries – 44
Figure 3.6.1	Data extraction by disease area – 24	Figure 4.7.1	Trends in HIV/AIDS research output in sub-Saharan Africa – 48
Figure 3.6.2	Overlap between disease areas – 25	Figure 4.7.2	Trends in world share of HIV/AIDS research, sub-Saharan Africa – 48
Figure 3.6.3	Papers in Open Access Journals – 26	Figure 4.7.3	Trends in citation impact of HIV/AIDS research, sub-Saharan Africa – 49
Figure 3.6.4	Relative frequency of epidemiology research papers for global data and for sub-Saharan Africa, analysed by disease area – 27	Figure 4.8.1	Country quadrant for HIV/AIDS research, Southern Africa – 49
Figure 3.6.5	Relative frequency of clinical trials research papers for global data and for sub-Saharan Africa, analysed by disease area – 28	Figure 4.9.1	Country quadrant for HIV/AIDS research in East Africa – 52
Figure 4.1.1	National disease burden and research output, HIV/AIDS – 33	Figure 4.10.1	Country quadrant for HIV/AIDS research in West Africa – 54
Figure 4.1.2	Epidemiology research, HIV/AIDS, sub-Saharan Africa and world – 34	Figure 4.11.1	Country quadrant for HIV/AIDS research in Central Africa – 56
Figure 4.1.3	Clinical trials research, HIV/AIDS, sub-Saharan Africa and world – 35	Figure 5.1.1	National disease burden and research output, tuberculosis – 60
Figure 4.1.4	Disease burden in Sub-Saharan Africa, research output in Europe and their collaborative links in HIV – 37	Figure 5.1.2	Epidemiology research, tuberculosis, sub-Saharan Africa and world – 61
Figure 4.1.5	Disease burden and collaborative research links within Sub-Saharan Africa in HIV – 38	Figure 5.1.3	Clinical trials research, tuberculosis, sub-Saharan Africa and world – 62
Figure 4.1.6	Collaboration between EDCTP-associated papers and other funding agencies, HIV/AIDS, sub-Saharan Africa (2008-11) – 9	Figure 5.1.4	Disease burden in Sub-Saharan Africa, research output in Europe and their collaborative links in tuberculosis – 63
Figure 4.3.1	Trends in HIV/AIDS research output in Europe – 41	Figure 5.1.5	Disease burden and collaborative research links within Sub-Saharan Africa in tuberculosis – 64
Figure 4.3.2	Trends in world share of HIV/AIDS research, Europe – 41	Figure 5.1.6	Collaboration between EDCTP-associated papers and other funding agencies, tuberculosis, sub-Saharan Africa (2008-11) – 65
Figure 4.3.3	Trends in citation impact of HIV/AIDS research, Europe – 42	Figure 5.3.1	Trends in tuberculosis research output in Europe – 67

Figure 5.3.2	Trends in world share of tuberculosis research, Europe – 67	Figure 6.3.1	Trends in malaria research output in Europe – 93
Figure 5.3.3	Trends in citation impact of tuberculosis research, Europe – 68	Figure 6.3.2	Trends in world share of malaria research, Europe – 93
Figure 5.4.1	Country quadrant for tuberculosis research in EDCTP Member Countries – 68	Figure 6.3.3	Trends in citation impact of malaria research, Europe – 94
Figure 5.5.1	Country quadrant for tuberculosis research in EDCTP Prospective Member Countries – 70	Figure 6.4.1	Country quadrant for malaria research in EDCTP Member Countries – 94
Figure 5.7.1	Trends in tuberculosis research output in sub-Saharan Africa – 74	Figure 6.5.1	Country quadrant for malaria research in EDCTP Prospective Member Countries – 96
Figure 5.7.2	Trends in world share of tuberculosis research, sub-Saharan Africa – 74	Figure 6.7.1	Trends in malaria research output in sub-Saharan Africa – 100
Figure 5.7.3	Trends in citation impact of tuberculosis research, sub-Saharan Africa – 75	Figure 6.7.2	Trends in world share of malaria research, sub-Saharan Africa – 100
Figure 5.8.1	Country quadrant for tuberculosis research in Southern Africa – 75	Figure 6.7.3	Trends in citation impact of malaria research, sub-Saharan Africa – 101
Figure 5.9.1	Country quadrant for tuberculosis research in East Africa – 78	Figure 6.8.1	Country quadrant for malaria research in Southern Africa – 101
Figure 5.10.1	Country quadrant for tuberculosis research in West Africa – 80	Figure 6.9.1	Country quadrant for malaria research in East Africa – 104
Figure 5.11.1	Country quadrant for tuberculosis research in Central Africa – 82	Figure 6.10.1	Country quadrant for malaria research in West Africa – 107
Figure 6.1.1	National disease burden and research output, malaria – 85	Figure 6.11.1	Country quadrant for malaria research in Central Africa – 110
Figure 6.1.2	Epidemiology research, malaria, sub-Saharan Africa and world – 87	Figure 7.1.1	National disease burden and research output, Tropical Cluster Diseases – 114
Figure 6.1.3	Clinical trials research, malaria, sub-Saharan Africa and world – 87	Figure 7.1.2	Prevalence of NIDs, publication volume, citation impact, 2003-11 – 115
Figure 6.1.4	Disease burden in sub-Saharan Africa, research output in Europe and their collaborative links in malaria – 89	Figure 7.1.3	Epidemiology research, NIDs, sub-Saharan Africa and world – 116
Figure 6.1.5	Disease burden and collaborative research links within sub-Saharan Africa in malaria – 90	Figure 7.1.4	Clinical trials research, NIDs, sub-Saharan Africa and world – 117
Figure 6.1.6	Collaboration between EDCTP-associated papers and other funding agencies, malaria, sub-Saharan Africa (2008-11) – 91	Figure 7.1.5	Disease burden in Sub Saharan Africa, research output in Europe and their collaborative links in neglected infectious diseases – 118

Figure 7.1.6	Disease burden and collaborative research links within Sub-Saharan Africa in neglected infectious diseases – 119	Table 4.4.1	research, HIV/AIDS, by absolute number of papers – 36
Figure 7.3.1	Trends in NIDs research output in Europe – 121	Table 4.4.2	Country data for HIV/AIDS research in EDCTP Member Countries – 43
Figure 7.3.2	Trends in world share of NIDs research, Europe – 121		Institutions in Europe collaborating on HIV/AIDS research with sub-Saharan Africa – 43
Figure 7.3.3	Trends in citation impact of NIDs research, Europe – 122	Table 4.5.1	Country data for HIV/AIDS research in EDCTP Prospective Member Countries – 45
Figure 7.4.1	Country quadrant for NIDs research in EDCTP Member Countries – 122	Table 4.8.1	Country data for HIV/AIDS research in Southern Africa – 50
Figure 7.5.1	Country quadrant for NIDs research in EDCTP Prospective Member Countries – 124	Table 4.8.2	Institutions in Southern Africa collaborating on HIV/AIDS research with Europe – 50
Figure 7.7.1	Trends in NIDs research output in sub-Saharan Africa – 128	Table 4.8.3	Agencies funding Southern African HIV/AIDS research, 2008-11 – 51
Figure 7.7.2	Trends in world share of NIDs research, sub-Saharan Africa – 128	Table 4.9.1	Country data for HIV/AIDS research in East Africa – 53
Figure 7.7.3	Trends in citation impact of NIDs research, sub-Saharan Africa – 129	Table 4.9.2	Institutions in East Africa collaborating on HIV/AIDS research with Europe – 53
Figure 7.8.1	Country quadrant for NIDs research in Southern Africa – 129	Table 4.9.3	Agencies funding East African HIV/AIDS research, 2008-11 – 54
Figure 7.9.1	Country quadrant for NIDs research in East Africa – 131	Table 4.10.1	Country data for HIV/AIDS research in West Africa – 55
Figure 7.10.1	Country quadrant for NIDs research in West Africa – 133	Table 4.10.2	Institutions in West Africa collaborating on HIV/AIDS research with Europe – 55
Figure 7.11.1	Country quadrant for NIDs research in Central Africa – 135	Table 4.10.3	Agencies funding West African HIV/AIDS research, 2008-11 – 56
Table 3.1.1	Indicator values – 16		Country data for HIV/AIDS research in Central Africa – 57
Table 3.4.1	EDCTP Partner Countries – 17	Table 4.11.1	Institutions in Central Africa collaborating on HIV/AIDS research with Europe – 57
Table 3.4.2	Assigning papers to addresses by country and institution – 21	Table 4.11.2	Agencies funding Central African HIV/AIDS research, 2008-11 – 57
Table 3.5.1	Global burden of disease data, population and DALYs in thousands and DALYs per 100,000 population – 23	Table 4.11.3	
Table 4.1.1	Institutions involved in sub-Saharan African clinical trials		

Table 5.1.1	Institutions involved in sub-Saharan African clinical trials research, tuberculosis – 62	Table 6.4.2	Institutions in Europe collaborating on malaria research with sub-Saharan Africa – 95
Table 5.4.1	Country data for tuberculosis research in EDCTP Member Countries – 69	Table 6.5.1	Country data for malaria research in EDCTP Prospective Member Countries – 97
Table 5.4.2	Institutions in Europe collaborating on tuberculosis research with sub-Saharan Africa – 69	Table 6.8.1	Country data for malaria research in Southern Africa – 102
Table 5.5.1	Country data for tuberculosis research in EDCTP Prospective Member Countries – 71	Table 6.8.2	Institutions in Southern Africa collaborating on malaria research with Europe – 102
Table 5.8.1	Country data for tuberculosis research in Southern Africa – 76	Table 6.8.3	Agencies funding Southern African malaria research, 2008-11 – 103
Table 5.8.2	Institutions in Southern Africa collaborating on tuberculosis research with Europe – 76	Table 6.9.1	Country data for malaria research in East Africa – 104
Table 5.8.3	Agencies funding Southern African tuberculosis research, 2008-11 – 77	Table 6.9.2	Institutions in East Africa collaborating on malaria research with Europe – 105
Table 5.9.1	Country data for tuberculosis research in East Africa – 78	Table 6.9.3	Agencies funding East African malaria research, 2008-11 – 106
Table 5.9.2	Institutions in East Africa collaborating on tuberculosis research with Europe – 79	Table 6.10.1	Country data for malaria research in West Africa – 107
Table 5.9.3	Agencies funding East African tuberculosis research, 2008-11 – 79	Table 6.10.2	Institutions in West Africa collaborating on malaria research with Europe – 108
Table 5.10.1	Country data for tuberculosis research in West Africa – 80	Table 6.10.3	Agencies funding West African malaria research, 2008-11 – 109
Table 5.10.2	Institutions in West Africa collaborating on tuberculosis research with Europe – 81	Table 11.1	Country data for malaria research in Central Africa – 110
Table 5.10.3	Agencies funding West African tuberculosis research, 2008-11 – 81	Table 11.2	Institutions in Central Africa collaborating on malaria research with Europe – 111
Table 5.11.1	Country data for tuberculosis research in Central Africa – 82	Table 11.3	Agencies funding Central African malaria research, 2008-11 – 111
Table 6.1.1	Institutions involved in sub-Saharan African clinical trials research, malaria – 88	Table 7.1.1	Institutions involved in sub-Saharan African clinical trials research, NIDs – 117
Table 6.4.1	Country data for malaria research in EDCTP Member Countries – 95	Table 7.4.1	Country data for NIDs research in EDCTP Member Countries – 123
		Table 7.4.2	Institutions in Europe collaborating on NIDs research with sub-Saharan Africa – 123
		Table 7.5.1	Country data for NIDs research in EDCTP Prospective Member Countries – 125

Table 7.8.1	Country data for NIDs research in Southern Africa – 130
Table 7.8.2	Institutions in Southern Africa collaborating on NIDs research with Europe – 130
Table 7.8.3	Agencies funding Southern African NIDs research, 2008-11 – 130
Table 7.9.1	Country data for NIDs research in East Africa – 131
Table 7.9.2	Institutions in East Africa collaborating on NIDs research with Europe – 132
Table 7.9.3	Agencies funding East African NIDs research, 2008-11 – 132
Table 7.10.1	Country data for NIDs research in West Africa – 134
Table 7.10.2	Institutions in West Africa collaborating on NIDs research with Europe – 134
Table 7.10.3	Agencies funding West African NIDs research, 2008-11 – 135
Table 7.11.1	Country data for NIDs research in Central Africa – 136
Table 7.11.2	Institutions in Central Africa collaborating on NIDs research with Europe – 136
Table 7.11.3	Agencies funding Central African NIDs research, 2008-11 – 136

1. Executive summary

EDCTP was created in 2003 as a European response to the global health crisis caused by the three main poverty-related diseases of HIV/AIDS, tuberculosis and malaria. These diseases account for over 6 million deaths each year, with the greatest burden of disease in sub-Saharan Africa, where besides being leading causes of morbidity and mortality, they impede development and cause poverty.

A second phase of the EDCTP Programme (EDCTP2) is now underway as part of Horizon 2020, the EU Framework Programme for Research and Innovation (2014-2020). EDCTP2 has an expanded scope¹ with one of its objectives to include research on neglected infectious diseases, another major poverty-related health burden.²

EDCTP received a Coordination and Support Action grant from the European Commission to carry out a number of activities, in preparation for EDCTP2, including a comprehensive mapping analysis of European and sub-Saharan African research in the disease areas, HIV/AIDS, tuberculosis, malaria and neglected infectious diseases, between 2003 and 2011.

This report presents the bibliometric evaluation of the research output of European and African researchers in each of the disease areas with a particular focus on identifying leading institutions, researchers and funding organisations, and analysing patterns of collaboration between countries and institutions. This evaluation will complement a wider study of European and African national research programmes, partnerships, activities and capacities informing the scope, remit and strategy of EDCTP2 as well as reporting on the existing EDCTP research base.

Research data for this report have been extracted from the Thomson Reuters *Web of Knowledge*SM, widely acknowledged to be the world's leading source of citation and bibliometric data. Burden of disease data, used for contextualisation, are taken from *The global burden of disease: 2004 update* published by the World Health Organization.

The above mentioned poverty related diseases are a research focus for the resource-limited countries of sub-Saharan Africa; Europe conducts over a third of worldwide research. Collaboration between these two regions – moving research from its creation to its need – is the rationale for EDCTP and the focus of this report.

Sections in the report provide, for each disease, a comprehensive bibliometric analysis of European and sub-Saharan African research, focussing on research output and citation impact, as an indicator of research quality. Country and institutional analyses show where leading collaborative research between Europe and sub-Saharan Africa is undertaken. The principal agencies funding sub-Saharan African research have been identified, based on research volume rather than investment. The network of funding agencies with which EDCTP cooperates is visualised. The sections also present data showing how much research is associated with clinical trials and epidemiological studies and the main research institutions participating in this research, using data extracted from the PubMed database maintained by the US National Library of Medicine.

Key findings

Globally, between 2003 and 2011, around 30,000 papers were published in malaria research and around 34,000 in tuberculosis. Research output was higher in neglected infectious disease research, around 45,000 papers, and much higher in HIV/AIDS 95,000 papers.

¹ EDCTP (August 2012) *Charting Research: EDCTP member state programmes and activities in the scope of EDCTP-II*.

² World Health Organization (2012) *Accelerating work to overcome the global impact of neglected tropical diseases: a roadmap for implementation*.

The European share of world research in HIV/AIDS, tuberculosis and neglected infectious diseases is around one-third and sub-Saharan Africa contributes around one-tenth. Both regions contribute relatively more to the global research output in malaria research. More than one-fifth of malaria research is published with at least one sub-Saharan African author.

Whilst European research output has grown, it has not kept pace with global research growth, so the European share of the world output has fallen. This is due to global research trends with the rise of the BRICK research economies, but also research growth in sub-Saharan Africa. There has been a dramatic growth in research across sub-Saharan Africa over the last decade in poverty related diseases, particularly in HIV/AIDS and tuberculosis. Research in HIV/AIDS has quadrupled in volume terms, with a surge of research interest in tuberculosis in the latter part of the last decade, related to HIV/AIDS and tuberculosis co-infection. Collaboration with Europe accounts for a substantial part of sub-Saharan African research in these disease areas.

Broadly speaking, the trends and research publishing patterns of European³ and sub-Saharan African collaborative research in HIV/AIDS and tuberculosis are similar, as are those in malaria and neglected infectious diseases. HIV/AIDS and tuberculosis collaboration has increased over the decade and principally involved South and East Africa. This contrasts with malaria and neglected infectious diseases research collaboration which has remained static as a share of world output and is focused on East and West Africa. Our analyses have shown that open access journals are increasingly used as a mode of research communication in these disease areas which may make this research more accessible to researchers in sub-Saharan Africa and facilitate collaboration.

³ The collaboration of EDCTP Prospective Member Countries with Sub-Saharan Africa across the disease areas is very small, and has been combined with that of EDCTP Member Countries.

European/sub-Saharan Africa research collaboration in all these poverty-related diseases is exceptionally highly-cited. Such collaboration brings together institutions and funding agencies from across Europe, sub-Saharan Africa and the rest of the world. This highly-cited, highly-collaborative research is led by a core group of European countries. The UK and the London School of Hygiene & Tropical Medicine are the leading collaborating partners of sub-Saharan Africa. Benelux, Scandinavian and Swiss research is notable for its outreach and quality, with networks encompassing the academic, health and non-governmental sectors. The extent of Scandinavian and Benelux collaboration with sub-Saharan Africa perhaps reflects their relatively high contribution of overseas development assistance as a percentage of the Organisation for Economic Cooperation and Development (OECD) donors' gross national income.⁴

With the exception of HIV/AIDS, research effort is not always correlated with burden of disease. Typically, the number of papers produced by sub-Saharan African countries is small; and, in some areas of high disease burden, there is little or no research at all. Furthermore, burden of disease has an absolute, as well as a relative dimension. Countries such as Nigeria, Ethiopia and the Democratic Republic of Congo, with their large populations, have relatively large national research efforts but these are less connected to international and European research networks. This is particularly the case for Nigeria. Whilst research output differs by disease area across the four regions of sub-Saharan Africa, Central African research output is small in all disease areas, whereas research output (and European research links) tend to be greater in Southern and East Africa. There is little collaboration between the sub-Saharan African countries, and even less when there is no European collaboration. This suggests two things: that

⁴ <http://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=568>

sub-Saharan African research is stimulated by external partners and that European research collaboration tends to be with a single sub-Saharan African country rather than multilateral.

France is an important link between Europe and the countries of West and Central Africa. It operates in areas with few other national or international agencies. However – with the exception of neglected infectious diseases – less of its national research output is collaborative with sub-Saharan Africa compared to the European average. The efforts of French institutions, such as Institut de recherche pour le développement (IRD) and Institut Pasteur, to build local capacity and European/sub-Saharan African research partnerships could be strengthened.

EDCTP-associated papers related to HIV/AIDS, tuberculosis and their co-infection, involving authors from Southern Africa and East Africa, are exceptionally highly-cited: around five times the world average. EDCTP-associated papers in malaria are fewer, and cited below the global average. EDCTP works with leading European and sub-Saharan African institutions collaborating in these disease areas. This shows that EDCTP has a strong understanding of the research network engaged in these research efforts.

HIV/AIDS

Sub-Saharan African HIV/AIDS research has quadrupled over the last decade. Its world share has risen to over 15% by 2011. This research is highly-cited, but European/sub-Saharan African collaborative research is exceptionally highly-cited, and the citation impact of this research is rising rapidly. This reflects a worldwide research effort.

This research effort is directed to areas of Southern Africa and East Africa where the burden of HIV is greatest. For South Africa – the leading

sub-Saharan African country in HIV/AIDS research – this effort is as much national as international. Around 8.5 million disability-adjusted life years were estimated to have been lost to HIV in 2004, the highest worldwide.

Tuberculosis

Sub-Saharan African research in tuberculosis has increased markedly since 2003, trebling in terms of volume, and doubling in terms of world share. A shift in focus towards HIV/AIDS and tuberculosis co-infection is behind this trend, with a rapid shift in the latter part of the decade. This has been accompanied by a soaring citation impact: to over twice the world average.

Sub-Saharan African tuberculosis research, in terms of both volume and citation impact, is led by Southern Africa, and South Africa accounts for over half of sub-Saharan Africa's total. However, there are countries lying outside the European/sub-Saharan African collaborative research network, and intra-sub-Saharan African collaboration is weak.

Djibouti, the country with the highest burden of tuberculosis worldwide, is not a participating EDCTP Member Country. There are countries where the burden of tuberculosis is high but research output is negligible, such as Sierra Leone and Togo. This may be because whilst tuberculosis is a treatable and curable disease, it is a leading killer of people living with HIV causing one quarter of all deaths.⁵

Malaria

Malaria research is the most cited of the disease areas. Sub-Saharan Africa produces over 20% of the world's malaria research; and over 60% is co-authored by European researchers. Whilst collaboration has increased, it has remained static as a share of global research output.

⁵ <http://www.who.int/mediacentre/factsheets/fs104/en/>

Much of this research is produced in East Africa and West Africa. However, whilst East African research is very well-cited, West African research is less so (around the global average). There are indications of rising research interest in West and Central Africa. This is important as there is little correlation between disease burden and research effort in these regions.

For example, Niger (with the highest relative burden of malaria worldwide) produces around the median number of papers. Research from Nigeria (with the highest absolute burden of malaria in the world) is very poorly-cited, and less connected to European research networks.

Neglected Infectious Diseases

Research in neglected infectious diseases is less well-cited compared to other disease areas, just below the global average and flat. There has been a recent lift in research attention in West and Central Africa, which is needed given the disease burden in these regions, the proxy for which is the WHO definition of ‘Tropical-Cluster Diseases’.

Whilst collaboration between Europe and sub-Saharan Africa has grown in volume terms, it is flat as a share of world research output. There is very little intra-sub-Saharan African research collaboration in neglected infectious diseases. There are few funders of neglected infectious diseases research, and those few that there are, are those active in malaria research. This may suggest a possible complementarity of research agendas.

Launched on 30 January 2012, the London Declaration represents a new, coordinated push to accelerate progress toward eliminating or controlling 10 neglected infectious diseases by the end of the decade. Partners pledge to work together to improve the lives of the 1.4 billion people worldwide affected by these diseases, most of whom are among the world’s poorest. These partnerships may open up opportunities for neglected infectious diseases research collaboration across sub-Saharan Africa.

2. Introduction

2.1. European & Developing Countries Clinical Trials Partnership

The European & Developing Countries Clinical Trials Partnership (EDCTP) was founded in 2003 in response to the overwhelming burden of poverty-related diseases of HIV/AIDS, tuberculosis and malaria. EDCTP is a partnership of European member states and sub-Saharan African countries with the objective of accelerating the research, development of tools and capacity to fight these diseases. As part of preparations for the second EDCTP programme (EDCTP2), which started on 2 December 2014 under Horizon 2020, the EU Framework Programme for Research, Thomson Reuters was commissioned by EDCTP to conduct a bibliometric analysis. The overall aim of this analysis is to identify progress, gaps and opportunities in both European member states and sub-Saharan African countries that EDCTP2 can monitor, address and build upon.

2.2. Objectives

The bibliometric analysis focuses on the disease areas **that will be** supported under EDCTP2, including: HIV/AIDS, tuberculosis, malaria and neglected infectious diseases (NIDs). Bibliometric data have been used to analyse publication outputs related to selected disease areas to quantify the volume of research produced and compare the relative research contributions of different institutions, countries and regions. Bibliometric methods also enabled the mapping of research collaboration at the national, regional and international level and comparison of the respective impact. This analysis is only based on publication outputs. Other factors that influence research collaboration have not been considered in this analysis. It should be noted that global research outputs were included, but the report focuses

on analysing European and sub-Saharan African research.

This report was funded by a grant received under the FP7 programme, (call: FP7-Adhoc-2007-13, grant agreement no: 304786). The project title is: EDCTP-Plus: laying the foundations for the EDCTP2 programme.

2.3. Thomson Reuters

Thomson Reuters is the world's leading source of intelligent information for business and professionals. Thomson Reuters combine industry expertise with innovative technology to deliver critical information to leading decision makers in the financial, legal, tax and accounting, healthcare, science and media markets, powered by the world's most trusted news organisation. Thomson Reuters Research Analytics is a suite of products, services and tools that provide comprehensive research analysis, evaluation and management. For over half a century Thomson Reuters have pioneered the world of citation indexing and analysis, helping to connect scientific and scholarly thought around the world. Today, academic and research institutions, governments, not-for-profits, funding agencies, and all others with a stake in research need reliable, objective methods for managing and measuring performance.

Thomson Reuters Research Analytics & Engineered Solutions provide reporting and consultancy services within Research Analytics using customised analyses to bring together several indicators of research performance in such a way as to enable customers to rapidly make sense and interpret of a wide-range of data points to facilitate research strategy decision-making.

3. Analysis and reporting

3.1. Bibliometrics and citation analyses

Bibliometrics are about publications and their citations. The academic field emerged from ‘information science’ and now usually refers to the methods used to study and index texts and information.

Publications cite other publications. These citation links grow into networks, and their numbers are likely to be related to the significance or impact of the publication. The meaning of the publication is determined from keywords and content. Citation analysis and content analysis have therefore become a common part of bibliometric methodology. Historically, bibliometric methods were used to trace relationships amongst academic journal citations. Now, bibliometrics are important in indexing research performance.

Bibliometric data have particular characteristics of which the user should be aware, and these are considered here.

Journal papers (publications, sources) report research work. Papers refer to or ‘cite’ earlier work relevant to the material being reported. New papers are cited in their turn. Papers that accumulate more citations are thought of as having greater ‘impact’, which is interpreted as significance or influence on their field. Citation counts are therefore recognised as a measure of impact, which can be used to index the excellence of the research from a particular group, institution or country.

The origins of citation analysis as a tool that could be applied to research performance can be traced to the mid-1950s, when Eugene Garfield proposed the concept of citation indexing and introduced the Science Citation Index, the Social Sciences Citation Index and the Arts & Humanities Citation Index, produced by the Institute of Scientific Information (currently

the IP & Science business of Thomson Reuters).⁶

We can count citations, but they are only ‘indicators’ of impact or quality – not metrics. Most impact indicators use average citation counts from groups of papers, because some individual papers may have unusual or misleading citation profiles. These outliers are diluted in larger samples.

Data source

The data we use come from the Thomson Reuters databases underlying the *Web of Knowledge*, which gives access not only to journals but also to conference proceedings, books, patents, websites, and chemical structures, compounds and reactions. It has a unified structure that integrates all data and search terms together and therefore provides a level of comparability not found in other databases. It is widely acknowledged to be the world’s leading source of citation and bibliometric data. The *Web of Science* is one part of the *Web of Knowledge*, and focuses on research published in journals, conferences and books in science, medicine, arts, humanities and social sciences.

The *Web of Science* was created as an awareness and information retrieval tool but it has acquired an important secondary use as a tool for research evaluation, using citation analysis and bibliometrics. Data coverage is both current and retrospective in the sciences, social sciences, arts and humanities, in some cases back to 1900. Within the research community this data source is often still referred to by the acronym ‘ISI’.

Unlike other databases, the *Web of Science* and underlying databases are selective, that is: the journals abstracted are selected using rigorous editorial and quality criteria. The

⁶ Garfield, E (1955) Citation Indexes for Science – New dimension in documentation through association of ideas. *Science*, 122: 108–111.

authoritative, multidisciplinary content covers over 12,000 of the highest impact journals worldwide, including Open Access journals, and over 150,000 conference proceedings. The abstracted journals encompass the majority of significant, frequently cited scientific reports and, more importantly, an even greater proportion of the scientific research output which is cited. This selective process ensures that the citation counts remain relatively stable in given research fields and do not fluctuate unduly from year to year, which increases the usability of such data for performance evaluation.

Whilst coverage of regional journals in the Thomson Reuters *Web of Knowledge* has increased, and coverage of French and Portuguese language journals has increased, the coverage of English-language journals is the most comprehensive.

Evidence, now as part of Thomson Reuters, has extensive experience with databases on research inputs, activity and outputs and has developed innovative analytical approaches for benchmarking and interpreting international, national and institutional research impact.

Most analyses start with an overall view across the data, then move to a view across broad categories and only then focus in at a finer level in the areas of greatest interest to policy, programme or organisational purpose.

Citation counts

A publication accumulates citation counts when it is referred to by more recent publications. Some papers get cited frequently and many get cited rarely or never, so the distribution of citations is highly skewed.

Why are many papers never cited? Certainly some papers remain uncited because their content is of little or no impact, but that is not the only reason. It might be because they

have been published in a journal not read by researchers to whom the paper might be interesting. It might be that they represent important but 'negative' work reporting a blind alley to be avoided by others. The publication may be a commentary in an editorial, rather than a normal journal article and thus of general rather than research interest. Or it might be that the work is a 'sleeping beauty' that has yet to be recognised for its significance.

Other papers can be very highly cited: hundreds, even thousands of times. Again, there are multiple reasons for this. Most frequently cited work is being recognised for its innovative significance and impact on the research field of which it speaks. Impact here is a good reflection of quality: it is an indicator of excellence. But there are other papers which are frequently cited because their significance is slightly different: they describe key methodology; they are a thoughtful and wide-ranging review of a field; or they represent contentious views which others seek to refute.

Citation analysis cannot make value judgments about why an article is uncited nor about why it is highly cited. The analysis can only report the citation impact that the publication has achieved. We normally assume, based on many other studies linking bibliometric and peer judgments that high citation counts correlate on average with the quality of the research.

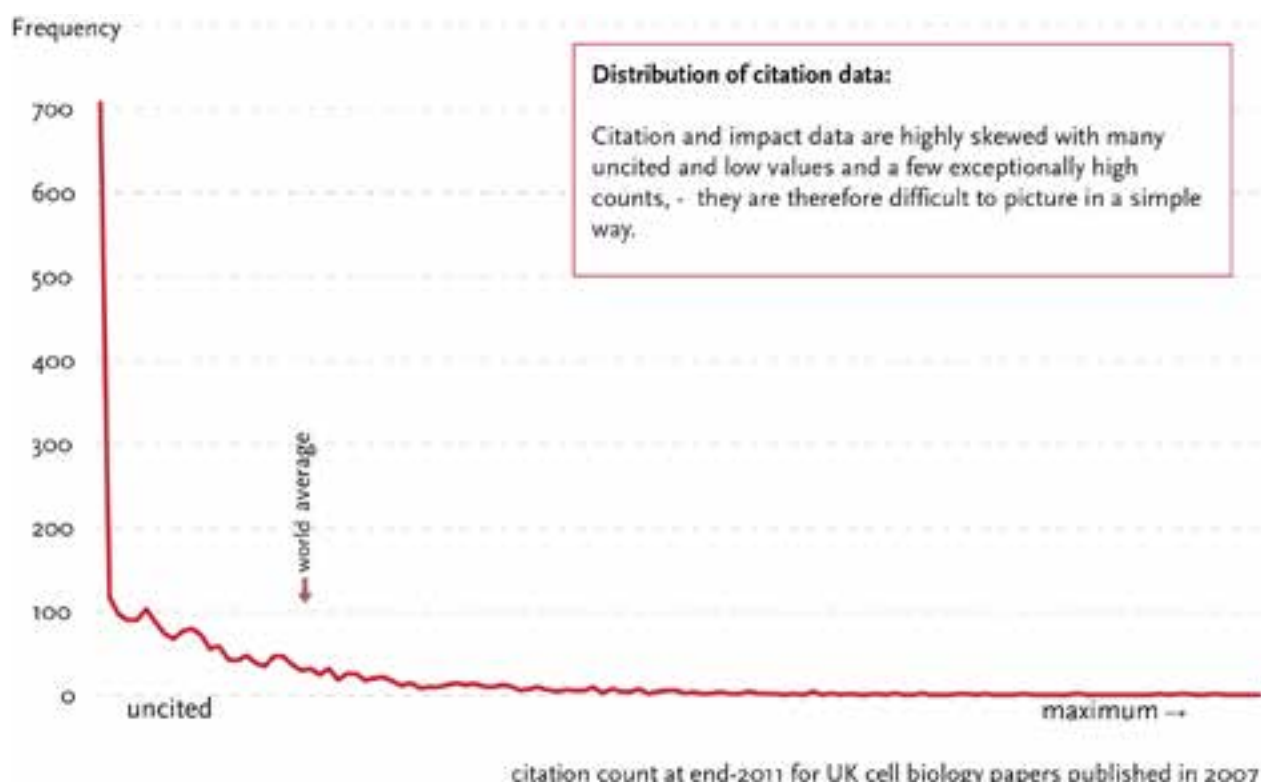


Figure 3.1.1 Citation counts

The figure shows the skewed distribution of more or less frequently cited papers from a sample of UK authored publications in cell biology. The skew in the distribution varies from field to field. It is to compensate for such factors that actual citation counts must be normalised, or rebased, against a world baseline.

We do not seek to account separately for the effect of self-citation. If the citation count is significantly affected by self-citation then the paper is likely to have been infrequently cited. This is therefore only of consequence for low impact activity. Studies show that for large samples at national and organisational level the effect of self-citation has little or no effect on the analytical outcomes and would not alter interpretation of the results.

Time factors

Citations accumulate over time. Older papers therefore have, on average, more citations than more recent work. The graph below shows the

pattern of citation accumulation for a set of 33 journals in the journal category **Materials Science, Biomaterials**. Papers less than eight years old are, on average, still accumulating additional citations. The citation count goes on to reach a plateau for older sources.

The graph shows that the percentage of papers that have never been cited drops over about five years. Beyond five years, between 5% and 10% or more of papers remain uncited.

Account must be taken of these time factors in comparing current research with historical patterns. For these reasons, it is sometimes more appropriate to use a fixed five-year window of papers and citations to compare two periods than to look at the longer term profile of citations and of uncitedness for a recent year and an historical year.

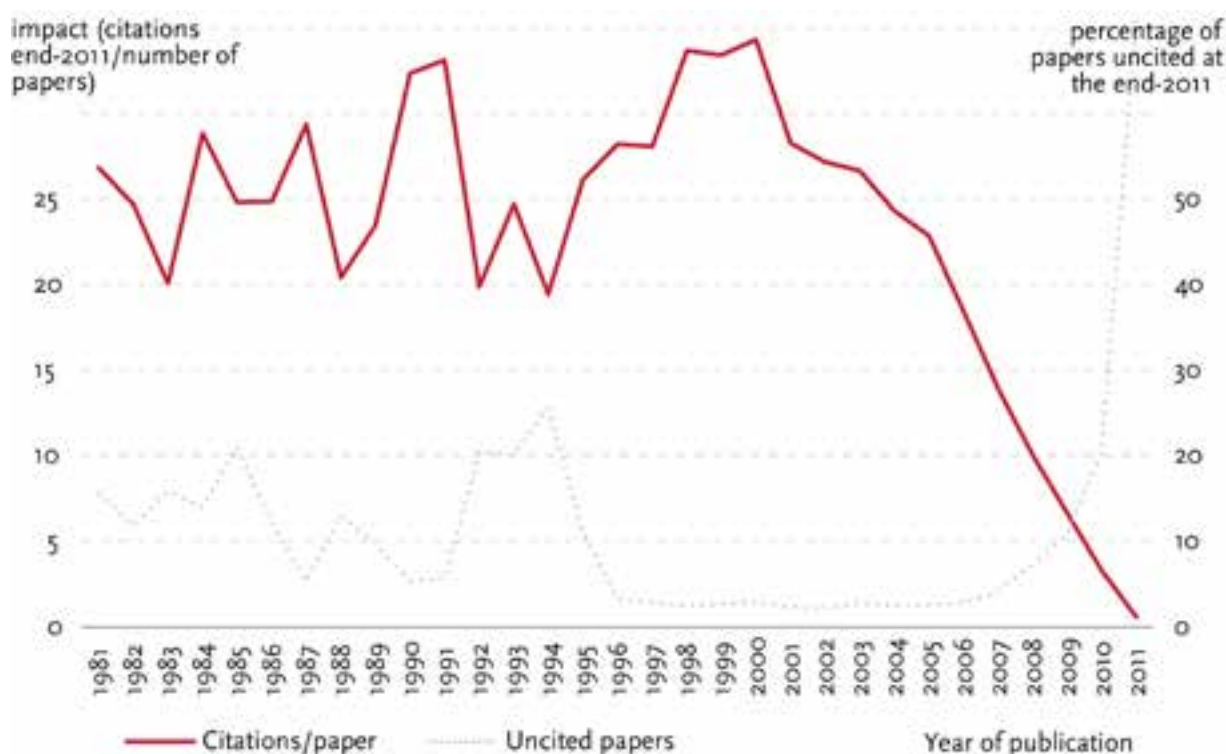


Figure 3.1.2 Time factors

Discipline factors

Citation rates vary between disciplines and fields. For the UK science base as a whole, ten years produces a general plateau beyond which few additional citations would be expected. On the whole, citations accumulate more rapidly and plateau at a higher level in biological sciences than physical sciences, and natural sciences generally cite at a higher rate than social sciences.

Papers are assigned to disciplines (journal categories or research fields) by Thomson Reuters, bringing cognate research areas together. The journal category classification scheme has been recently revised and updated. Before 2007, journals were assigned to the older, well established Current Contents categories which were informed by extensive work by Thomson and with the research community since the early 1960s. This scheme has been superseded by the 252 Web of Science journal categories which allow for greater disaggregation for the growing volume of research which is published and abstracted.

Papers are allocated according to the journal in which the paper is published. Some journals may be considered to be part of the publication record for more than one research field. As the example below illustrates, the journal *Acta Biomaterialia* is assigned to two journal categories: **Materials Science, Biomaterials and Engineering, Biomedical**.

Very few papers are not assigned to any research field and as such will not be included in specific analyses using normalised citation impact data. The journals included in the Thomson Reuters databases and how they are selected are detailed here <http://scientific.thomsonreuters.com/mjl/>.

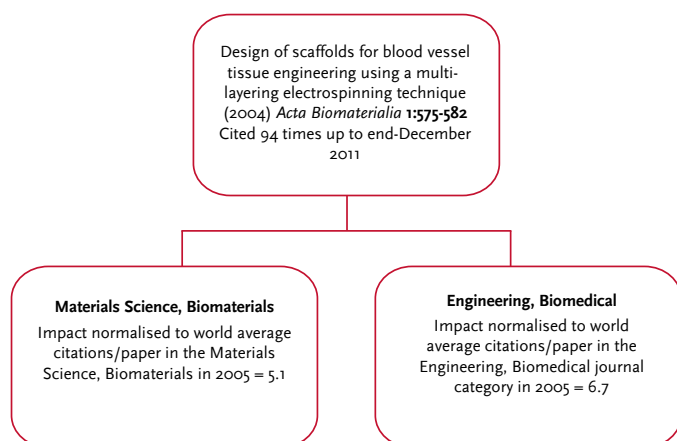
Some journals with a very diverse content, including the prestigious journals *Nature* and *Science* were classified as **Multidisciplinary** in databases created prior to 2007. The papers from these **Multidisciplinary** journals are now re-assigned to more specific research fields using an algorithm based on the research area(s) of the references cited by the article.

Normalised citation impact

Because citations accumulate over time at a rate that is dependent upon the field of research, all analyses must take both field and year into account. In other words, because the absolute citation count for a specific article is influenced by its field and by the year it was published, we can only make comparisons of indexed data after normalising with reference to these two variables.

We only use citation counts for reviews and articles in calculations of impact, because document type influences the citation count. For example, a review will often be cited more frequently than an article in the same field, but editorials and meeting abstracts are rarely cited and citation rates for conference proceedings are extremely variable. The most common normalisation factors are the average citations per paper for (1) the year and (2) either the field or the journal in which the paper was published. This normalisation is also referred to as 'rebas-ing' the citation count.

Impact is therefore most commonly analysed in terms of 'normalised impact', or NCI. The following schematic illustrates how the normalised citation impact is calculated at paper level and journal category level.



This article in the journal *Acta Biomaterialia* is assigned to two journal categories: **Materials Science, Biomaterials** and **Engineering, Biomedical**. The world average baselines for, as an example, **Materials science, Biomaterials** are calculated by summing the citations to all the articles and reviews published worldwide in the journal *Acta Biomaterialia* and the other 32 journals assigned to this category for each year, and dividing this by the total number of articles and reviews published in the journal category. This gives the category-specific normalised citation impact (in the above example the category-specific NCI_F for **Materials Science, Biomaterials** is 5.1 and the category-specific NCI_F for **Engineering, Biomedical** is higher at 6.7). Most papers (nearly two-thirds) are assigned to a single journal category whilst a minority are assigned to more than 5.

Citation data provided by Thomson Reuters are assigned on an annual census date referred to as the Article Time Period. For the majority of publications the Article Time Period is the same as the year of publication, but for a few publications (especially those published at the end of the calendar year in less main-stream journals) the Article Time Period may vary from the actual year of publication.

World average impact data are sourced from the Thomson Reuters National Science Indicators baseline data for 2011.

Mean normalised citation impact

Research performance has historically been indexed by using average citation impact, usually compared to a world average that accounts for time and discipline. As noted, however, the distribution of citations amongst papers is highly skewed because many papers are never cited while a few papers accumulate very large citation counts. That means that an average may be misleading if assumptions are made about the distribution of the underlying data.

In fact, almost all research activity metrics are skewed: for research income, PhD numbers and publications there are many low activity values and a few exceptionally high values. In reality, therefore, the skewed distribution means that average impact tends to be greater than and often significantly different from either the median or mode in the distribution. This should be borne in mind when reviewing analytical outcomes.

The average (normalised) citation impact can be calculated at an individual paper level where it can be associated with more than one journal category. It can also be calculated for a set of papers at any level from a single country to an individual researcher's output. In the example above, the average citation impact of the *Acta Biomaterialia* paper can be expressed as $((5.1 + 6.7)/2) = 5.9$.

3.2. Data definitions

Papers/publications: Thomson Reuters abstracts publications including editorials, meeting abstracts and book reviews as well as research journal articles. The terms 'paper' and 'publication' are often used interchangeably to refer to printed and electronic outputs of many types. In this report, the term 'paper' has been used exclusively to refer to substantive journal articles, reviews and proceedings papers published in peer-reviewed journals and excludes editorials, meeting abstracts or other types of publication. Papers are the subset of publications for which citation data are most informative and which are used in calculations of citation impact.

Citations: The citation count is the number of times that a citation has been recorded for a given publication since it was published. Not all citations are necessarily recorded since not all publications are abstracted. However, the

material abstracted by Thomson Reuters is estimated to attract about 95% of global citations.

Citation impact: 'Citations per paper' is an index of academic or research impact (as compared with economic or social impact). It is calculated by dividing the sum of citations by the total number of papers in any given dataset (so, for a single paper, citation impact is the same as its citation count). Citation impact can be calculated for papers within a specific research field such as Clinical Neurology, or for a specific institution or group of institutions, or a specific country. Citation count declines in the most recent years of any time-period as papers have had less time to accumulate citations (papers published in 2007 will typically have more citations than papers published in 2010).

Field-normalised citation impact: Citation rates vary between research fields and with time, consequently, analyses must take both field and year into account. In addition, the type of publication will influence the citation count. For this reason, only citation counts of papers (as defined above) are used in calculations of citation impact. The standard normalisation factor is the world average citations per paper for the year and journal category in which the paper was published. This normalisation is also referred to as 'rebasing' the citation count.

Average normalised citation impact: The average citation impact for any specific dataset is calculated as the mean of the field-normalised citation impact of all papers within that dataset.

3.3. Interpretation of data and analyses

Papers: The minimum number of papers suitable as a sample for quantitative research evaluation is a subject of widespread discussion.

Larger samples are always more reliable, but a very high minimum may defeat the scope and specificity of analysis. Experience has indicated that a threshold between 20 and 50 papers can generally be deemed appropriate. For work that is likely to be published with little contextual information, the upper boundary (≥ 50) is a desirable starting point. For work that will be used primarily by an expert, in-house group then the lower boundary (≥ 20) may be approached, with caution. Because comparisons for in-house evaluation often involve smaller, more specific research groups (compared to broad institutional comparisons) a high volume threshold is self-defeating. Smaller samples may be used but outcomes must be interpreted with caution and expert review should draw on multiple information sources before reaching any conclusions.

Average field normalised citation impact:

Citation impact values for individual papers vary widely and it is more useful to consider the average field normalised citation impact. This average can be at several different levels: field (either journal category or field), annual and overall (total output under consideration). When considering such average citation impact data points, care must be taken to understand that these data are highly skewed and the average can be driven by a single, highly-cited paper (this would be highlighted in accompanying text though not apparent from tables & figures). The world average is 1.0, so any citation impact value higher than this indicates a paper, or set of papers, which are cited more than average for similar research worldwide. For research management purposes, experience suggests that citation impact values between 1.0 and 2.0 should be considered to be indicative of research which is influential at a national level whilst that cited more than twice the world average has international recognition.

For bibliometric analyses, the ‘world average’ is 1.0, however in this report we have used ‘global average’ to refer to the specific global citation impact in each the disease area. These are listed in the table below.

Table 3.3.1 Indicator values:

Indicator	Threshold
Number of publications (all output types)	No threshold
Number of papers (articles and reviews)	Citation analyses based on fewer than 20 papers at any particular aggregation, e.g. year or field are not reliable.
Average normalised citation impact (an indication of paper quality within the field)	A value of more than 1.0 indicates better than the world average. This varies by disease area and these are referred to in this report as the global average: <ul style="list-style-type: none">• HIV/AIDS (1.14)• Tuberculosis (1.05)• Malaria (1.24)• NIDs (0.98)

3.4. Time, location and subject scope

Time

Publication data for this report have been extracted for the time frame 2003-12. Citation data are currently only available to end 2011.⁷ Citation analyses in this report are for 2003-11. Data are presented as either a total or an average for 2003-11, or as five-year moving averages (2003-07, 2004-08, 2005-09, 2006-10, 2007-11).

Geographical coverage

Publication data have been extracted globally. Analyses in this report focus upon selected EDCTP European and sub-Saharan African Partner Countries. The following countries

⁷ Citation data for 2012 papers will be available after March 2013.

have participated in EDCTP projects up to the end of Dec 2012:

Sub-Saharan Africa

Benin, Botswana, Burkina Faso, Cameroon, Democratic Republic of Congo, Ethiopia, Gabon, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Namibia, Nigeria, Republic of Congo, Rwanda, Senegal, South Africa, Tanzania, The Gambia, Togo, Sudan, Uganda, Zambia, Zimbabwe

Europe

Austria, Belgium, Denmark, Finland*, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Norway, Slovak Republic*, Spain, Sweden, Switzerland, United Kingdom

*Finland and the Slovak Republic are EU Member States but not members of the EDCTP-EEIG.

These are listed with UN ISO 3166-1 Short Codes⁸ which are used throughout this report.

Table 3.4.1 EDCTP Partner Countries

EDCTP Member Countries ⁹		EDCTP Prospective Member Countries ¹⁰	
Austria	AUT	Bulgaria	BGR
Belgium	BEL	Croatia ¹¹	HRV
Denmark	DNK	Cyprus	CYP
France	FRA	Czech Republic	CZE
Germany	DEU	Estonia	EST
Greece	GRC	Finland ¹²	FIN
Ireland	IRL	Hungary	HUN
Italy	ITA	Latvia	LVA
Luxembourg	LUX	Lithuania	LTU
Netherlands	NLD	Malta	MLT
Portugal	PRT	Poland	POL
Spain	ESP	Romania	ROU
Sweden	SWE	Slovakia	SVK
UK	UK	Slovenia	SVN
Norway	NOR		
Switzerland	CHE		

⁸ <http://unstats.un.org/unsd/methods/m49/m49.htm>

⁹ EDCTP Member Countries: Members of the EDCTP-EEIG and represented in the EDCTP General Assembly.

¹⁰ EDCTP Prospective Member Countries: European Member States not yet members of the EDCTP General Assembly. EDCTP seeks increased collaboration with these countries.

¹¹ Croatia joined the European Union on 1 July 2013.

¹² Finland decided not to join the first programme but confirmed participation in EDCTP2

Southern Africa		West Africa	
Botswana	BWA	Benin	BEN
Comoros	COM	Burkina Faso	BFA
Lesotho	LSO	Cape Verde	CPV
Madagascar	MDG	Côte d'Ivoire	CIV
Malawi	MWI	Ghana	GHA
Mauritius	MUS	Guinea	GIN
Mozambique	MOZ	Guinea Bissau	GNB
Namibia	NAM	Liberia	LBR
Seychelles	SYC	Mali	MLI
South Africa	ZAF	Mauritania	MRT
Swaziland	SWZ	Niger	NER
Zambia	ZMB	Nigeria	NGA
Zimbabwe	ZWE	Senegal	SEN
		Sierra Leone	SLE
		The Gambia	GMB
		Togo	TGO
Central Africa		East Africa	
Angola	AGO	Burundi	BDI
Cameroon	CMR	Eritrea	ERI
Central African Republic	CAF	Ethiopia	ETH
Chad	TCD	Kenya	KEN
Congo	COG	Rwanda	RWA
Democratic Republic of Congo	COD	Somalia	SOM
Equatorial Guinea	GNQ	South Sudan	SSD
Gabon	GAB	Sudan	SDN
São Tomé and Príncipe	STP	Tanzania	TZA
		Uganda	UGA

Analyses of collaborative research between Europe and sub-Saharan Africa use the combined data for EDCTP Member Countries and EDCTP Prospective Member Countries, as collaborative research produced by the EDCTP Prospective Member Countries is small. This is termed 'European Collaboration with Sub-Saharan Africa'.

This terminology is used throughout the report based on the definitions in Table 3.4.I:

- EDCTP (Member Countries)
- EDCTP (Prospective Member Countries)
- EDCTP (Sub-Saharan Africa Partner Countries)

- European Collaboration with Sub-Saharan Africa

This terminology is used to differentiate between the different membership groupings of EDCTP, both current and prospective; and the presentation of the research output of these groupings is not intended to reflect the research output of EDCTP.

Institutional coverage

Researchers record their affiliations, and funding acknowledgements, on papers using variants of institutional names which precludes using these data, unless further processed, for analyses to identify principal research

organisations or funding agencies. To enable these analyses, algorithms to identify and unify the institutions as listed in the author addresses have been applied to raw address data associated with the collated papers. Unifications have been applied to author addresses and funding agencies.

For the UK and Ireland, Thomson Reuters (*Evidence*) maintains a complete address reconciliation for our databases and the data tables provided have drawn on this extensive, prior background work. Consequently, the numbers of papers for UK organisations can be given with a high degree of accuracy. For non-UK countries, unification from previous projects and those of other Thomson Reuters analysts has been applied in addition to the customised unification described above. Paper numbers here should be regarded as indicative rather than absolute. Non-UK coverage is extensive, but it is important to recognise it is not exhaustive. Address variants occurring with low frequency may not have been unified under a full institutional name. However, the targets for unification in this project (addresses associated with either a sub-Saharan African institution, or a European institution collaborating with a sub-Saharan African institution), have been unified to a coverage of 95% or more.

These unifications typically identify variation in:

- Common abbreviations: for example, CALTECH for the California Institute of Technology, KAIST for the Korea Institute of Advanced Science and Technology and UCL for University College London;
- Significant institute/centre names which can be considered part of the parent organisation: for example, GKT Medical School assigned to Kings College London, Centre of Geographical Medicine Research, Coast assigned to Kenya Medical Research Institute (KEMRI) and the College

of Medicine, Malawi assigned to the University of Malawi;

- Common variants of parent organisation: for example, FIOCRUZ MS, Inst Oswaldo Cruz and Fundacao Oswaldo Cruz all assigned to Fundação Oswaldo Cruz (FIOCRUZ);
- Disambiguation of the same organisation name in different countries: for example, Ministry of Health; National Institute for Medical Research/NIMR identified by country/funding body;
- Disambiguation of similar organisation names in same country: for example (University of) Washington (University) in St Louis or Seattle;
- Previous names in Thomson Reuters catalogues: for example, the Chinese Academy of Sciences was previously indexed as Academia Sinica;
- Common spelling mistakes: for example, John Hopkins University correctly unified to Johns Hopkins University.
- Country specific corporate suffixes: for example, Pfizer SA, Pfizer GmbH and Pfizer Oy unified to Pfizer.

These strategies will compensate for many of the limitations of the raw address data. There are some organisations for which institutional name variants have been brought under the parent organisation, as the number of name and address variants is large and often inconsistent, for example, the US Centers for Disease Control and Prevention across sub-Saharan Africa. For the French IRD, sub-Saharan African address variants have been standardised to specific centres, such as the Coordination Organization for the Fight Against Endemic Diseases in Central Africa in Cameroon and Senegal and Centre de Recherche Entomologique de Cotonou in Cotonou, Benin. Where it has not been possible to identify a specific centre, the parent organisation name has been retained.

Addresses for university hospitals which are affiliated to universities (such as Groote Schuur Hospital and the University of Cape Town) are treated as autonomous entities, unless teaching activity is associated with the university hospital address (for example, the Faculty of Health Sciences at the University of Cape Town).

EDCTP provided Thomson Reuters (*Evidence*) with a list of the principal institutions it works with across Europe and sub-Saharan Africa. Institutional data were cross-referenced against this list. EDCTP works with all the principal European and sub-Saharan African institutions involved with collaborative research in these disease areas.

Assigning papers to addresses

A paper is assigned to each country and each organisation whose address appears at least once for any author on that paper. One paper counts once and only once for each assignment, however many address variants occur for the country or organisation. No weighting is applied. This is illustrated for this EDCTP-associated paper: ¹³

Three important methodological issues are raised by the address data.

Firstly, when sub-Saharan African research is referred to in the report, it should be recognised that collaborative papers in this dataset will also be included in other regional datasets and that papers in this dataset will include researchers from other countries. In the example above, the paper includes authors from Peru and the USA.

Secondly, international governmental and non-governmental organisations are assigned according to the country given by the author. This includes organisations, such as the WHO

(headquartered in Geneva, Switzerland), Médecins sans Frontières (headquartered in Luxembourg) and the International Union Against Tuberculosis and Lung Disease (headquartered in Paris, France). The percentages of national research output these organisations account for in Europe are referenced in the report. In the example above, both Paul Nunn and Matteo Zignol are based in the WHO Stop TB Department in Geneva, Switzerland. Their research output is therefore attributed to Switzerland. Equal treatment is applied to regional offices of these organisations in sub-Saharan Africa, and research is associated with the country in which the author is based, for example, the WHO Africa Regional Office in Harare, Zimbabwe, is assigned to Zimbabwe and not to Switzerland.

Thirdly, WHO Programmes with national remits, such as the National Malaria Control Programme have been assigned to Ministries of Health, for example, this programme in Cameroon, has been assigned to the Ministry of Health, Cameroon.

Using author-based assignments of institutions to countries is standard methodology used by bibliometricians.

¹³ Gandhi NR et al. (2010) Multidrug-resistant and extensively drug-resistant tuberculosis: a threat to global control of tuberculosis. *Lancet*, 375:9728 1830-1843

Table 3.4.2 Assigning papers to addresses by country and institution

Author	Organisation	Department	City	Country	Institution	Country
Bayona, J	Socios Salud & Partners Hlth		Lima	Peru	Not unified (out of area)	Counts for Peru
Dheda, K	Univ Cape Town	Dept Med	Cape Town	South Africa	Counts for University of Cape Town	Counts for South Africa
Dheda, K	Univ Cape Town	Inst Infect Dis & Mol Med	Cape Town	South Africa	No gain for the University of Cape Town	No gain for South Africa
Dheda, K	UCL	Dept Infect	London	UK	Counts for University College London	Counts for UK
Ghandi, NR	Albert Einstein Coll Med	Dept Med	New York	USA	Not unified (out of area)	Counts for USA
Ghandi, NR	Montefiore Med Ctr	Div Gen Internal Med	New York	USA	Not unified (out of area)	No gain for USA
Ghandi, NR	Tugela Ferry Care & Res Collaborat TF CARES		Tugela Ferry	South Africa	Counts for Tugela Ferry Care and Research Collaboration	No gain for South Africa
Ghandi, NR (Reprint author)	Albert Einstein Coll Med	Dept Med	New York	USA	Not unified (out of area)	No gain for USA
Jensen, P	Ctr Dis Control & Prevent	Div TB Eliminat	Atlanta	USA	Not unified (out of area)	No gain for USA
Nunn, P	WHO	Stop TB Dept	Geneva	Switzerland	Counts for World Health Organization	Counts for Switzerland
Schaaf, HS	Univ Stellenbosch	Dept Pediat & Child Hlth	Cape Town	South Africa	Counts for University of Stellenbosch	No gain for South Africa
Van Sooling, D	Natl Inst Publ Hlth & Environm	TB Reference Lab	Bilthoven	Netherlands	Counts for National Institute for Public Health and the Environment	Counts for Netherlands
Zignol, M	WHO	Stop TB Dept	Geneva	Switzerland	No gain for the World Health Organization	No gain for Switzerland

Research funding organisations

Research publications typically acknowledge the source of funding that enabled the work but this has only been indexed on a consistent basis since mid-2008. Algorithms to identify and unify the acknowledgement data about funding organisations have been applied. The following should be borne in mind during interpretation:

- The 'US National Institutes of Health' includes unique papers from NIH overall and its individual institutions.
- The 'European Commission' includes unique papers from all European Union programmes, funds and fellowships.

- Corporate funding agencies are treated as global entities, and are not country specific. These are mainly, though not exclusively, pharmaceutical companies.

Data are divided into regions: Europe (EUR), Africa (AFR), Inter-Governmental Organisations (IGO), Non-Governmental Organisations (NGO), Corporate (COR), Rest of the World (ROW).

Data for EDCTP have been standardised in a comparable way to other funding agencies, in that, any paper which acknowledges EDCTP is attributed to EDCTP. This research is termed 'EDCTP-associated'. This may or

may not reflect funding support received from EDCTP but reflects that authors have chosen to acknowledge EDCTP in these papers.

Subject coverage

In this report, keywords were used to collate the research publication datasets for the disease areas HIV/AIDS, tuberculosis, malaria and NIDs.

The relevant research publications for each disease area were identified using search terms in titles, abstracts and keywords – methodology used by Thomson Reuters (*Evidence*) in previous projects. This process is not an ‘exact science’ and relies upon interpretation and re-iteration to achieve results which give a dataset of ‘best fit’ that will adequately describe the research area whilst excluding publications of marginal relevance. The search terms were tested for suitability prior to use, and were agreed following discussions with EDCTP with the advice of an expert EDCTP parasitologist. Data cover all sectors of the research community including higher education institutions (HEIs), companies, public sector research organisations and charities.

a single, common metric. Traditionally, health liabilities were expressed using one measure: (expected or average number of) ‘Years of Life Lost’ (YLL). The impact of disability can be taken into account by also measuring: ‘Years Lived with Disability’ (YLD). DALYs are the sum of these two components where $DALY = YLL + YLD$. One DALY is therefore equal to one year of healthy life lost. Japanese life expectancy is the standard reference for measuring premature death, as the Japanese have the longest life expectancies.

DALY rates are expressed per 100,000 population using 2004 population estimates. The Institute for Health Metrics and Evaluation and other academic partners have collaborated on a new Global Burden of Disease 2010 study published in December 2012 which provides regional estimates of deaths and DALYs (using a new method for calculating DALYs) for the years 1990, 2005 and 2010. It is anticipated that this will contribute to revisions for WHO global health estimates in 2013. These were not used in the analyses in this report, as they are experimental estimates, whereas the WHO Global Burden of Disease estimates are official WHO statistics.

3.5. Global burden of disease

This report includes data from WHO Global Burden of Disease¹⁴ estimates for 2004. This provides a comprehensive and comparable assessment of mortality and loss of health due to diseases, injuries and risk factors for all regions of the world.

The overall burden of disease is assessed using the disability-adjusted life year (DALY), a time-based measure that combines years of life lost due to premature mortality and years of life lost due to time lived in states of less than full health. This links mortality and morbidity into

¹⁴ http://www.who.int/healthinfo/global_burden_disease/en/

Table 3.5.1 Global burden of disease data, population and DALYs in thousands and DALYs per 100,000 population

		HIV		Tuberculosis		Malaria		Tropical cluster diseases	
	Population	DALYs	Rate	DALYs	Rate	DALYs	Rate	DALYs	Rate
BWA	1,815	451	24,870	17	929	1	50	5	288
COM	778	0	37	2	208	14	1,795	5	590
LSO	1,966	460	23,386	16	792	0	6	0	15
MDG	18,135	15	85	198	1,090	92	505	119	655
MOZ	20,078	2,167	10,792	316	1,575	905	4,507	142	709
MUS	1,231	2	200	1	54	0	1	0	0
MWI	12,894	1,862	14,443	158	1,224	620	4,809	133	1,032
NAM	1,994	284	14,231	18	884	15	768	4	214
SWZ	1,114	269	24,104	20	1,823	1	45	0	0
SYC	85	0	170	0	35	0	52	0	0
ZAF	47,541	8,545	17,975	1,143	2,404	6	13	59	125
ZMB	11,270	2,131	18,906	171	1,520	570	5,059	152	1,351
ZWE	13,025	5,010	38,461	202	1,551	63	485	87	670
BDI	7,566	334	4,416	140	1,848	291	3,850	53	697
ERI	4,354	60	1,378	58	1,326	7	153	8	189
ETH	76,995	2,530	3,286	1,256	1,631	1,807	2,347	313	407
KEN	34,675	3,567	10,288	708	2,042	1,056	3,046	253	730
RWA	9,052	557	6,159	187	2,065	277	3,061	73	805
SDN	36,145	627	1,734	523	1,447	1,138	3,148	321	888
SOM	7,954	35	445	102	1,277	117	1,472	21	267
TZA	37,508	3,276	8,734	493	1,314	1,644	4,383	361	962
UGA	28,028	2,649	9,450	429	1,531	1,514	5,403	216	769
BEN	8,224	105	1,282	33	397	481	5,850	53	649
BFA	13,507	254	1,881	178	1,319	918	6,794	181	1,341
CIV	18,275	1,274	6,971	315	1,724	767	4,197	272	1,487
CPV	495	0	37	6	1,141	1	125	0	0
GHA	22,057	572	2,592	241	1,091	923	4,186	221	1,002
GIN	8,833	112	1,263	104	1,176	513	5,806	56	637
GMB	1,571	13	855	15	985	77	4,910	13	849
GNB	1,549	28	1,801	12	800	108	6,974	15	970
LBR	3,348	57	1,698	47	1,397	229	6,826	49	1,468
MLI	11,265	153	1,354	191	1,694	726	6,441	139	1,231
MRT	2,882	14	493	47	1,627	83	2,876	7	237
NER	12,808	81	629	118	925	1,052	8,212	91	712
NGA	138,001	4,860	3,522	2,199	1,593	8,722	6,320	1,201	871
SEN	11,472	50	437	157	1,371	366	3,187	51	446

SLE	5,390	86	1,603	143	2,645	349	6,473	47	880
TGO	6,071	233	3,834	131	2,156	327	5,379	34	563
AGO	15,636	308	1,972	117	749	784	5,012	220	1,405
CAF	4,123	303	7,350	59	1,431	197	4,783	63	1,517
CMR	17,409	1,151	6,614	94	542	850	4,880	144	830
COD	56,918	2,149	3,776	842	1,480	3,681	6,467	1,066	1,873
COG	3,530	211	5,988	48	1,368	174	4,944	43	1,207
GAB	1,270	81	6,364	13	1,013	33	2,594	11	832
GNQ	473	20	4,134	5	1,015	33	7,011	3	674
STP	150	0	30	2	1,074	1	559	2	1,228
TCD	9,810	348	3,544	159	1,616	641	6,532	102	1,044

3.6. Dataset composition and overlap

A publication may cover more than one disease area but analysis shows that the datasets for this project were relatively specific and that each analysis will be distinct. The figures below show the numbers of publications and papers and the overlap between disease areas.

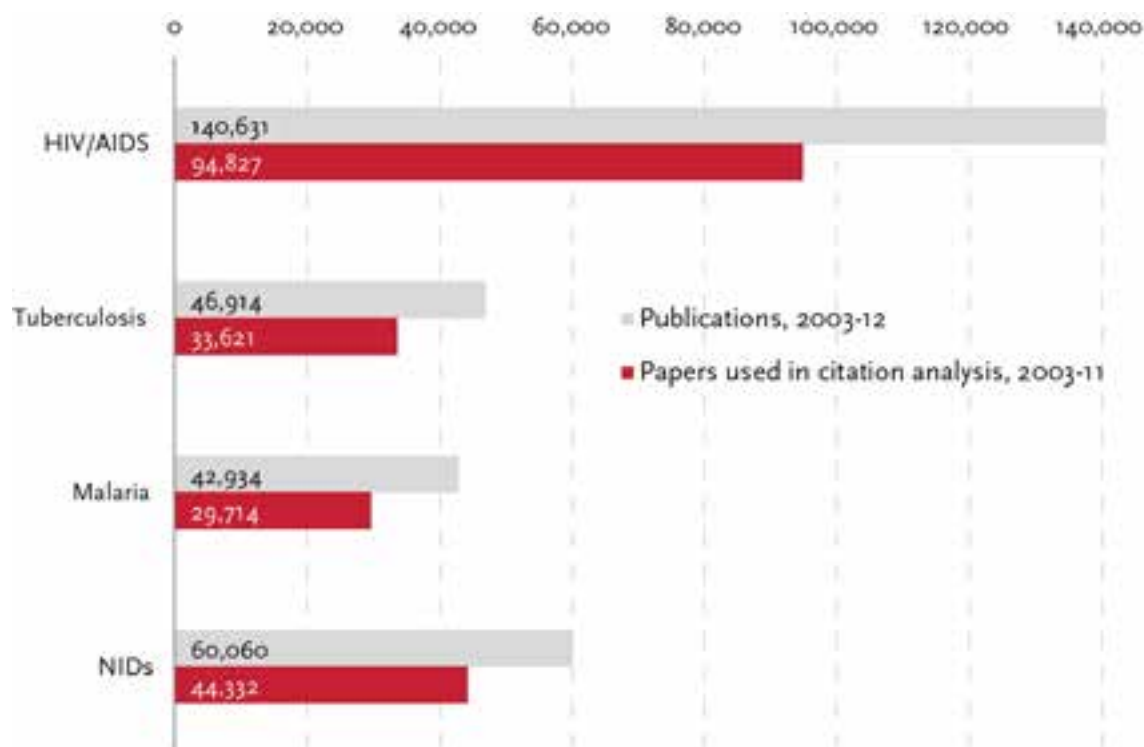


Figure 3.6.1 Data extraction by disease area

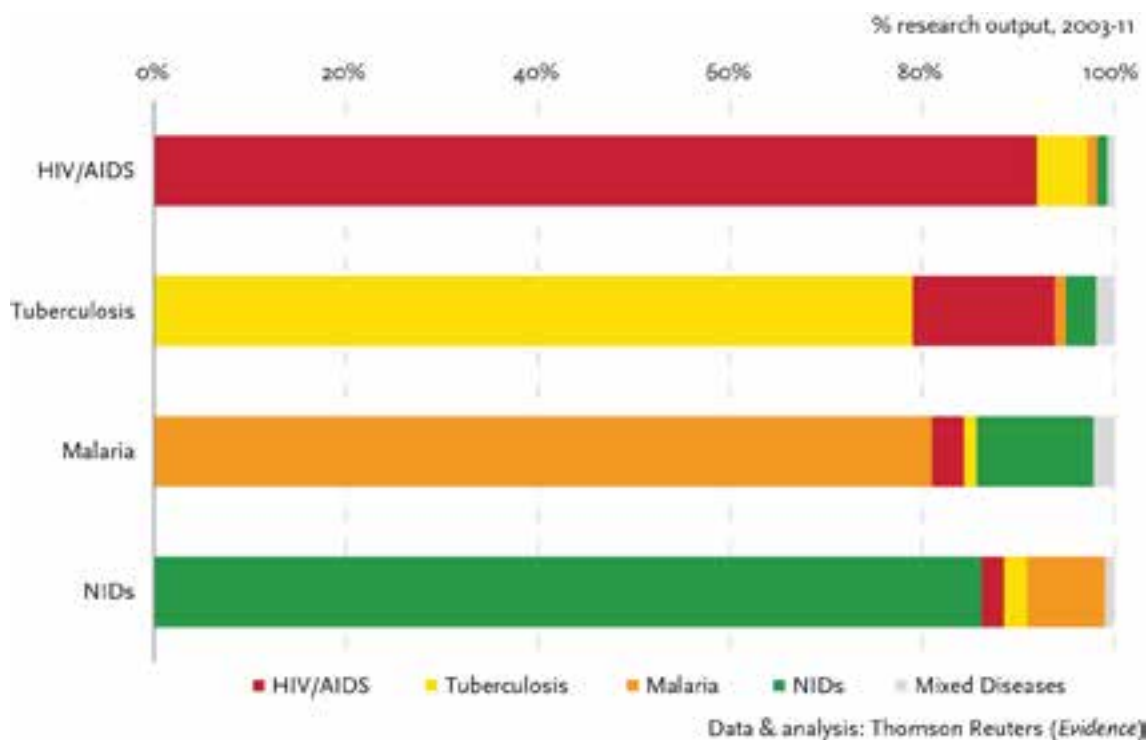


Figure 3.6.2 Overlap between disease areas

Two main overlaps are evident:

- Tuberculosis and HIV/AIDS - 14.8% of tuberculosis research papers are also in the HIV/AIDS dataset. The HIV/AIDS dataset is larger and so these papers represent a smaller part of these data (5.3% of the research in HIV/AIDS relates to research in tuberculosis).
- Malaria and NIDs - 12.2% of malaria research papers are also in the NIDs dataset. 8.2% of the research in NIDs relates to research in malaria.

Very few (71) papers relate to two or more other diseases (Mixed Diseases).

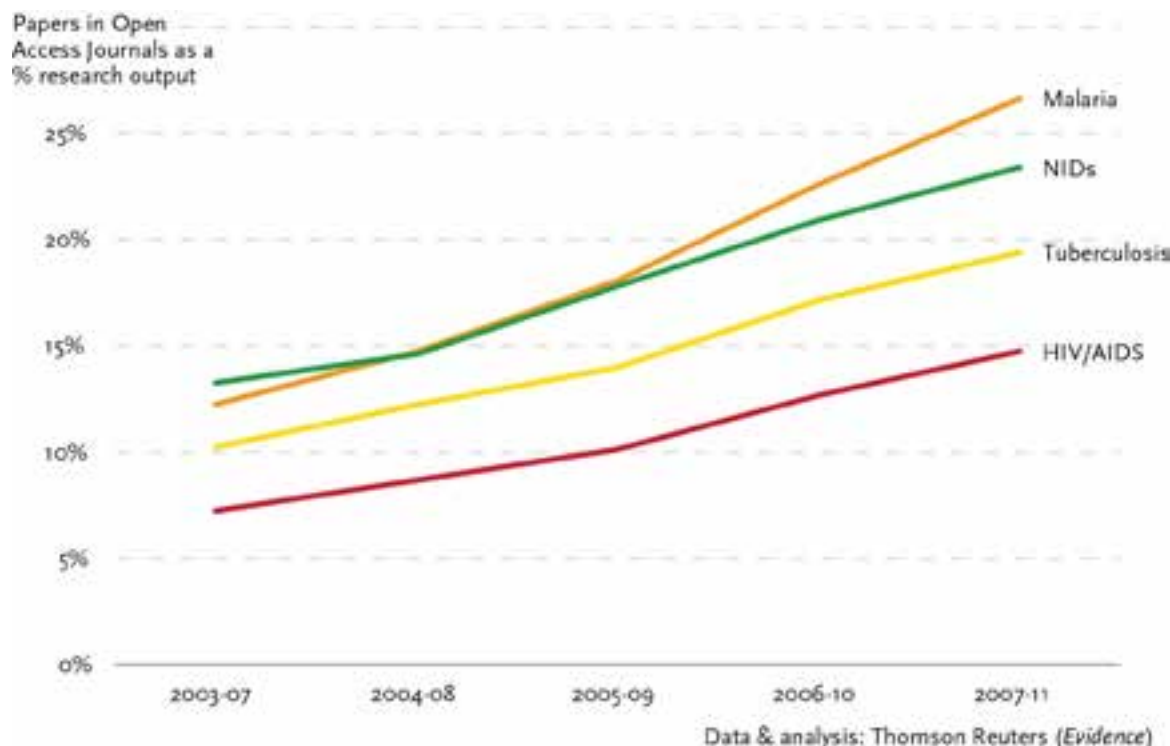


Figure 3.6.3 Papers in Open Access Journals

Across the four disease areas, Open Access journals are used increasingly frequently by researchers as a mode of communication (figure 3.6.3). Although these data are currently in development by Thomson Reuters (*Evidence*), and should be used with caution, the trends are clear.

In HIV/AIDS research, the use of Open Access journals is the lowest amongst the disease areas, but it has risen from 7.2% of research output (2003-07) to 14.7% by 2007-11. Nearly a fifth of tuberculosis research was published in Open Access journals by 2007-11, up from 10.2%. By 2007-11, over a quarter of malaria research was published in Open Access journals, and just under a quarter in NIDs research.

Clinical trials and epidemiology research

The publications that were used in the bibliometric analysis were classified by disease area and type of research (i.e., clinical and epidemiological). Epidemiological research includes

non-interventional observational studies that 1) generate important data that may be used to inform the conduct of clinical trials; 2) provide evidence to inform the planning of national disease control programmes, and 3) support the allocation of resources within national health systems. EDCTP currently supports epidemiological research as part of its commitment to capacity building and within the context of preparatory activities for funded clinical trials. Under EDCTP2 the scope of research will extend from Phase II and Phase III clinical trials, to include Phase I to Phase IV, and increased support for epidemiological studies is expected.

Research papers associated with clinical trials and epidemiology were identified using meta data from the US National Library of Medicine database, PubMed.¹⁵ Publications from *Web of Science* in each disease area were matched to

¹⁵ <http://www.ncbi.nlm.nih.gov/pubmed> Whilst Pharmacokinetics publications were not explicitly excluded in the search strategy, no Pharmacokinetics papers are included in the clinical trials and epidemiology datasets used in this report.

the PubMed database (the match rate was greater than 85% across the dataset) and papers associated with clinical trials and epidemiology research in sub-Saharan Africa were identified as follows:

- Epidemiology research was identified using PubMed MeSH Headings (Medical Subject Headings)¹⁶ where the qualifier contained the term 'epidemiology'.
- Clinical trials research was identified where the PubMed publication type¹⁷ was a 'Clinical Trial' (including Phase I-Phase IV), a 'Controlled Clinical Trial' or a 'Randomized Controlled Trial'.
 - Publications with a PubMed MeSH Heading containing either 'Clinical

Trial' or 'Controlled Trial' were also included.

The figures below show that in each disease area, epidemiology research is the focus of a much higher percentage of research outputs from sub-Saharan Africa than it is globally. The percentage of papers that report clinical trials research in the output of sub-Saharan African is also much higher than that of publications globally. However, it should be noted that with the exception of HIV/AIDS, the absolute numbers of papers referring to clinical trials are small and analysis will therefore be limited.

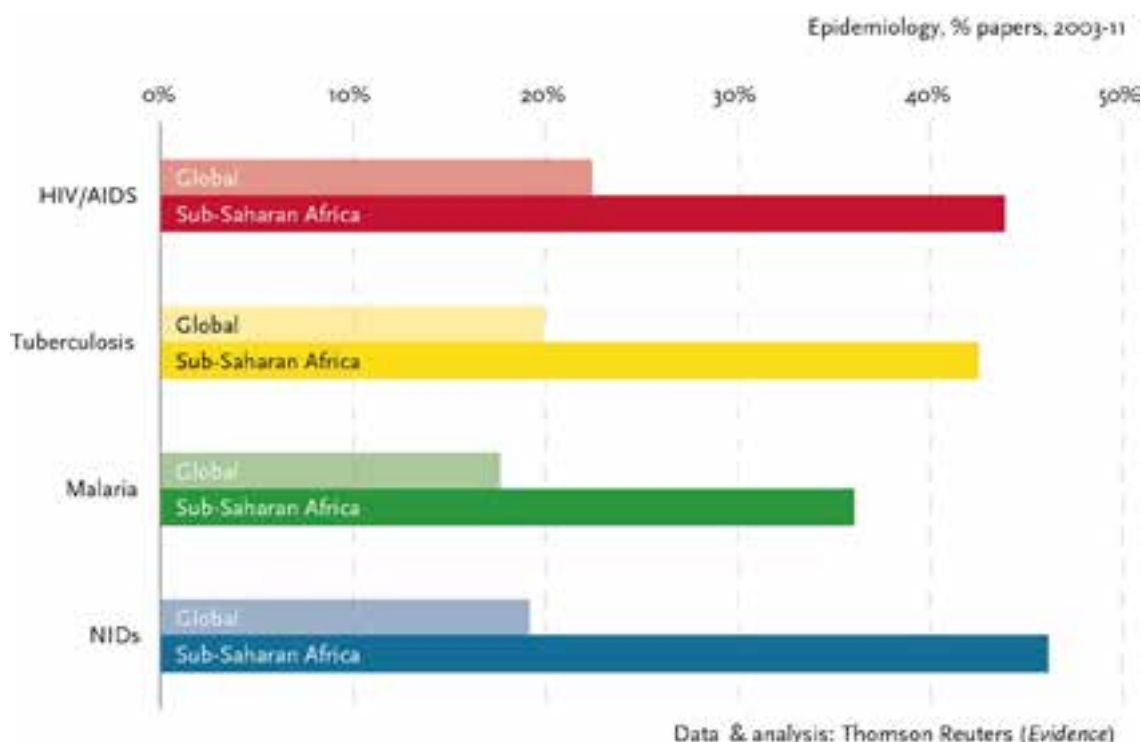


Figure 3.6.4 Relative frequency of epidemiology research papers for global data and for sub-Saharan Africa, analysed by disease area

Data are shown as % of papers with PubMed meta data available (sub-Saharan Africa: HIV/AIDS, 3,934 papers; tuberculosis, 1,206 papers; malaria, 2,047 papers; NIDs, 1,332 papers).

¹⁶ <http://www.nlm.nih.gov/mesh/>

¹⁷ <http://www.nlm.nih.gov/mesh/pubtypes2006.html>

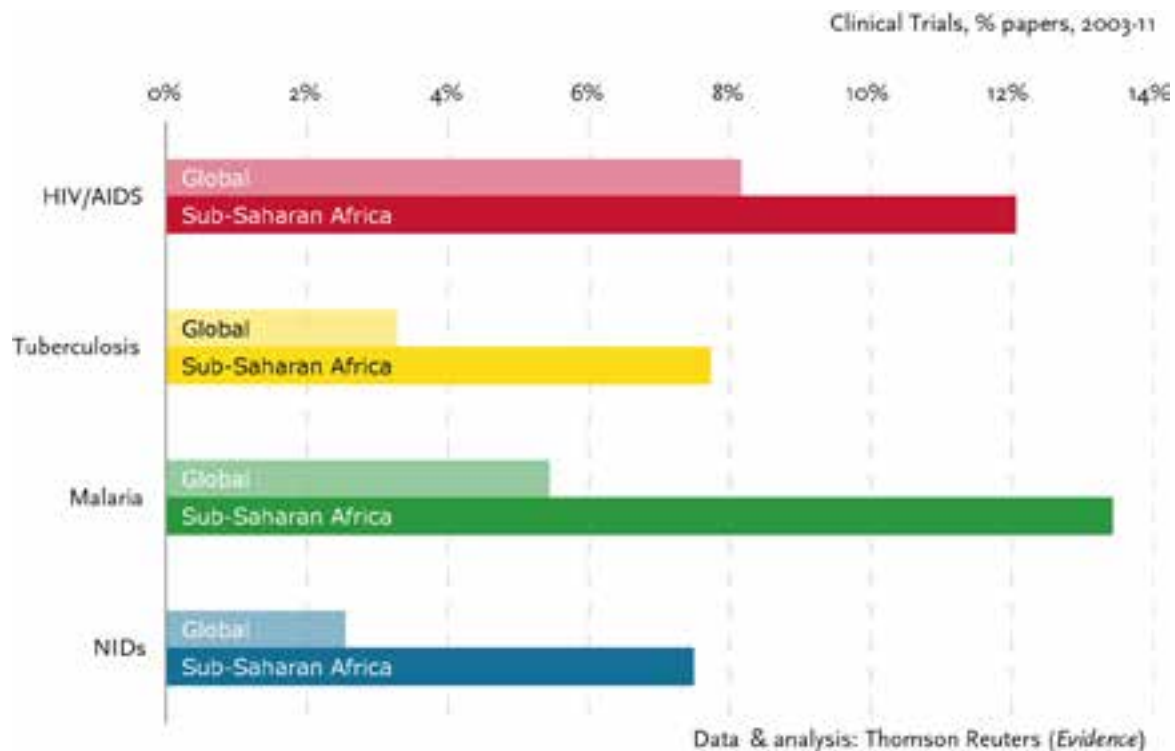


Figure 3.6.5 Relative frequency of clinical trials research papers for global data and for sub-Saharan Africa, analysed by disease area

Data are shown as % of papers with PubMed meta data available (sub-Saharan Africa: HIV/AIDS, 1,080 papers; tuberculosis, 219 papers; malaria, 762 papers; NIDs, 216 papers).

3.7. Data presentation

Each section of the report contains the following:

Summary to highlight the key findings in each of the disease areas.

Disease burden data from WHO on DALYs for sub-Saharan Africa overviews in each disease area (*Mortality and burden of disease estimates for WHO Member States in 2004*).¹⁸ There is no direct mapping between the NIDs covered in this report and WHO burden estimates. As a proxy, data are shown for ‘Tropical-Cluster Infections’ which includes trypanosomiasis, Chagas Disease, schistosomiasis, leishmaniasis, lymphatic filariasis, and onchocerciasis.

¹⁸ http://www.who.int/healthinfo/global_burden_disease/en/

Bubble charts visualise four key indicators for sub-Saharan African countries:

- Horizontal x-axis: DALYs per 100,000 population (2004). This is a measure of relative disease burden (prevalence) in a given country. Data are divided through gridlines indicating either 500, 1000 or 2000 DALYs per 100,000 population.
- Vertical y-axis: number of papers in a disease area, 2003-11, as a measure of research output.
- Bubble size: absolute DALYs (2004). This is a measure of the absolute disease burden (prevalence) in a given country.
- Bubble colour: this relates to the four regions of sub-Saharan Africa: yellow for Southern

Africa, green for East Africa, orange for West Africa, and blue for Central Africa.

Clinical trials and epidemiology research

is shown in as a percentage of the *Web of Science* papers that were matched to records in PubMed. The percentage of global research papers associated with clinical trials and epidemiology is compared with papers from sub-Saharan Africa, and figures also show regional data as a proportion of sub-Saharan Africa. Tables list the leading European and sub-Saharan African institutions involved in clinical trials research in sub-Saharan Africa and the citation impact of their research output.

Maps for each disease area visualise:

- sub-Saharan Africa burden of disease (green) with a scale for DALYs per 100,000 population;
- European research output (blue) with a scale for number of papers, 2003-11;
- The citation impact of the research where European-sub-Saharan African (North-South) research is coloured in red; and intra-sub-Saharan African research (South-South) research is coloured in orange.

Collaboration cartwheels show other funding agencies acknowledged on EDCTP-associated papers across sub-Saharan Africa for 2008-11. A line represents at least one paper between two funding agencies, thicker lines represent more papers. They are ordered by geographical region. Text highlights the main funding partners of EDCTP-associated research.

For each disease area:

- Research in Europe is grouped by
 - EDCTP Member Countries
 - EDCTP Prospective Member Countries.
- Analysis of and commentary on sub-Saharan Partner Countries is ordered uniformly

by region. It is ordered by Southern Africa, East Africa, West Africa and Central Africa.

- Commentary highlights the most relevant findings.

Trend charts show research output, global share and citation impact by disease area. Data for research output and global share are plotted on secondary axes if some data cannot be conveniently displayed on a primary axis (e.g. when comparing research output of EDCTP Member Countries to Prospective Member Countries).

Data tables accompany bubble charts and detail the following for each country:

- National research in disease area
 - Papers in disease area
 - Citation impact of papers in a disease area
 - Papers in disease area as a percentage of national research
- Collaborative research in disease area
 - Collaborative papers
 - Citation impact of collaborative papers
 - Collaborative papers in disease area as a percentage of national research in disease area

Data are greyed out when numbers of papers are <20 for a given aggregation and are not included in figures. This is because citation analyses based on <20 papers at any particular aggregation should not be considered reliable evidence on their own.

Institutional tables show the institutions in either Europe or sub-Saharan Africa, collaborating with either sub-Saharan Africa or Europe respectively. For each institution, it shows the number of collaborative papers and the citation impact of these papers.

Funding agencies in each region of sub-Saharan Africa are listed by number of papers and the

citation impact of these papers in 2008-11. Data are grouped as follows:

- Europe (EUR)
- Africa (AFR)
- Inter-Governmental Organisation (IGO)
- Non-Governmental Organisation (NGO)
- Corporate (COR)
- Rest of World (ROW)

Data for EDCTP-associated papers are highlighted in red.

4. HIV/AIDS research

This section of the report provides a comprehensive bibliometric analysis of European and sub-Saharan African research in HIV/AIDS focussing on research output and citation impact (as an indicator of research quality in the context of disease burden). Country and institutional analyses show where leading collaborative research between Europe and sub-Saharan Africa is being undertaken. From these publication data, the principal agencies funding sub-Saharan African research in HIV/AIDS have been identified – this is based on research volume not investment. This section also provides analyses showing how much global HIV/AIDS research is associated with clinical trials and the main research organisations participating in this in sub-Saharan Africa. The network of funding agencies with which EDCTP cooperates is visualised.

4.1. Summary

Globally, around 95,000 papers have been published in HIV/AIDS research between 2003 and 2011.

More than one-third of HIV/AIDS research conducted globally has been published by European-based researchers in the last decade. In absolute terms, the numbers of European papers published in this disease has increased since 2003 but the share of global research has dropped due to the rapid growth in the research output of developing economies such as China and Brazil. European research in HIV/AIDS is increasingly well-cited and, on average, is above the global average (1.22 compared to 1.14).

Sub-Saharan African research in HIV/AIDS has tripled over the last decade. In 2003, 521 HIV/AIDS research papers were published by researchers from sub-Saharan Africa (6.1% of global research). By 2011, this had risen to 1,912 research papers (15.1% of global research).

Sub-Saharan African research in HIV/AIDS is, on average, better cited than European research with an average citation impact of 1.30 (this is influenced by papers with international co-authors from, not just Europe, but the USA, South America and Asia). Sub-Saharan African research in HIV/AIDS, both in terms of volume and citation impact, is led by Southern Africa and East Africa. Research from West Africa and Central Africa represents a smaller part of the region's total (13.9% and 4.3% respectively) and is not well-cited. Broadly speaking, sub-Saharan African countries with the greatest burden of disease have published the most research, especially South Africa, Uganda and Kenya.

Collaboration between Europe and sub-Saharan Africa in HIV/AIDS research is strong – it has doubled since 2003 and, overall, two-fifths of sub-Saharan African research papers have at least one European address. This collaborative research has a citation impact higher than for either Europe or sub-Saharan Africa. The UK and France are the leading European collaborating partners with sub-Saharan Africa in HIV/AIDS research and this research is well-cited by the community. The main European research organisations collaborating in this research are universities, including the London School of Hygiene & Tropical Medicine and the University of Bordeaux 2 (Victor Segalen). French public sector research is also represented by INSERM (>330 research units mostly embedded in research hospitals associated with French universities) and IRD, a French public science and technology research institute under the joint authority of the French ministries in charge of research and overseas development. In addition, there is some well-cited collaborative research involving researchers from the Netherlands and Belgium. In sub-Saharan Africa, the main research organisations are the universities of Cape Town and Kwa-Zulu Natal in South Africa, the MRC Virus Research Institute and Makerere University in Uganda

and the national universities of Malawi, Zimbabwe and Zambia.

Relatively more papers associated with clinical trials and epidemiology in HIV/AIDS are published in sub-Saharan Africa than globally.

Clinical trials research accounted for 12.1% of sub-Saharan African research in HIV/AIDS compared to 8.2% of global research. Similarly, the percentage of sub-Saharan African research associated with epidemiology was double the global percentage (43.9% compared to 22.5%). Research associated with clinical trials has a higher citation impact than global research in HIV/AIDS (1.58 compared to 1.14, 6,757 papers). Clinical trials research activity in HIV/AIDS is highest in Southern and East Africa. The principal institutions conducting this research include the University of Witwatersrand, the London School of Hygiene & Tropical Medicine and Makerere University.

EDCTP is part of the funding network active in HIV/AIDS research. National agencies in the United States including the National Institutes of Health and the US Agency for International Development and in Europe the European Commission and UK DfID are frequently acknowledged by HIV/AIDS research papers published in sub-Saharan Africa. The Medical Research Councils (MRCs) of both South Africa and the UK also are associated with funding HIV/AIDS research as are the charitable foundations, Bill & Melinda Gates Foundation and the Wellcome Trust. All these agencies have cofunded with EDCTP-associated papers and this is visualised at the end of this section. The corporate sector is active in funding HIV/AIDS research with >35 companies acknowledged on these papers – EDCTP-associated papers acknowledge just two of these, GlaxoSmithKline and Novartis.

National disease burden for HIV/AIDS

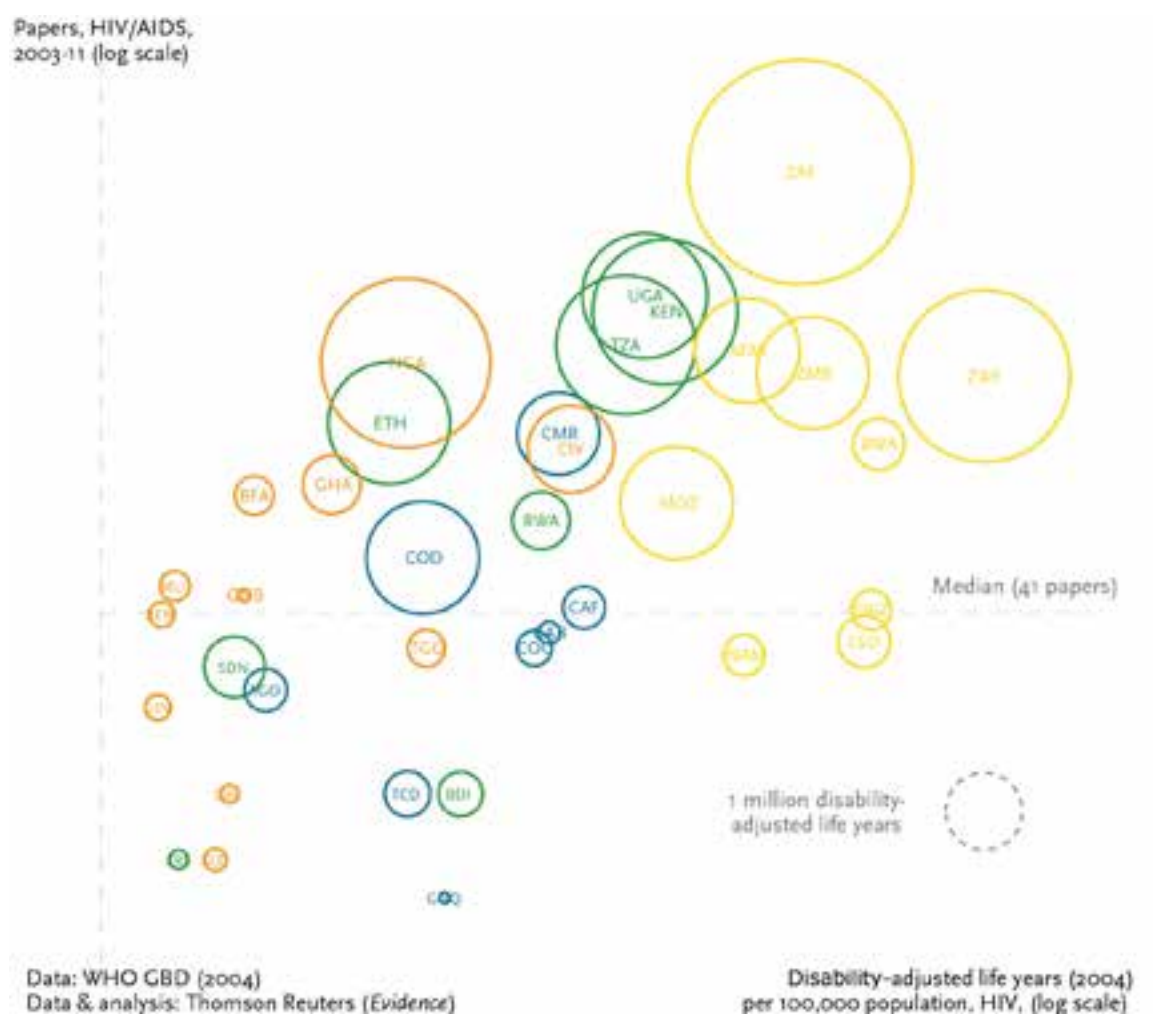


Figure 4.1.1 National disease burden and research output, HIV/AIDS

EXAMPLE (data for Zimbabwe, ZWE): Bubble size - 5,009,570 DALYs lost to HIV/AIDS; x-axis - 38,461 DALYs per 100,000 (population = 13,025,230); y-axis - 497 papers published in HIV/AIDS research.

Clinical trials and epidemiology research

Of the 8,955 sub-Saharan African HIV/AIDS research papers for which PubMed meta data was available, 1,080 (12.1%) were identified as clinical trials research and 3,934 (43.9%) were identified as epidemiology research. This research was mostly published by researchers in Southern and East Africa. Institutions conducting this research include the University of Witwatersrand, the London School of Hygiene & Tropical Medicine and Makerere University. Clinical trials research published by the University of Cape Town is particularly highly-cited (average citation impact 5.36, 89 papers). There are a number of very highly-cited papers, one of which has citation impact more than 130 times the world average.¹⁹ This is a highly collaborative paper involving researchers from

South America, Thailand and the United States as well as the University of Cape Town.

The University of Witwatersrand and the London School of Hygiene & Tropical Medicine are major partners in HIV/AIDS clinical trials research in a collaborative network that extends across Southern and East Africa. This multi-authored highly-cited paper²⁰ includes researchers from the Botswana–Harvard AIDS Institute Partnership; KEMRI, Moi University, the University of Nairobi and Kenyatta National Hospital in Kenya; Kilimanjaro Christian Medical Centre, Tanzania; Makerere University, Uganda and the University of Cape Town, South Africa.

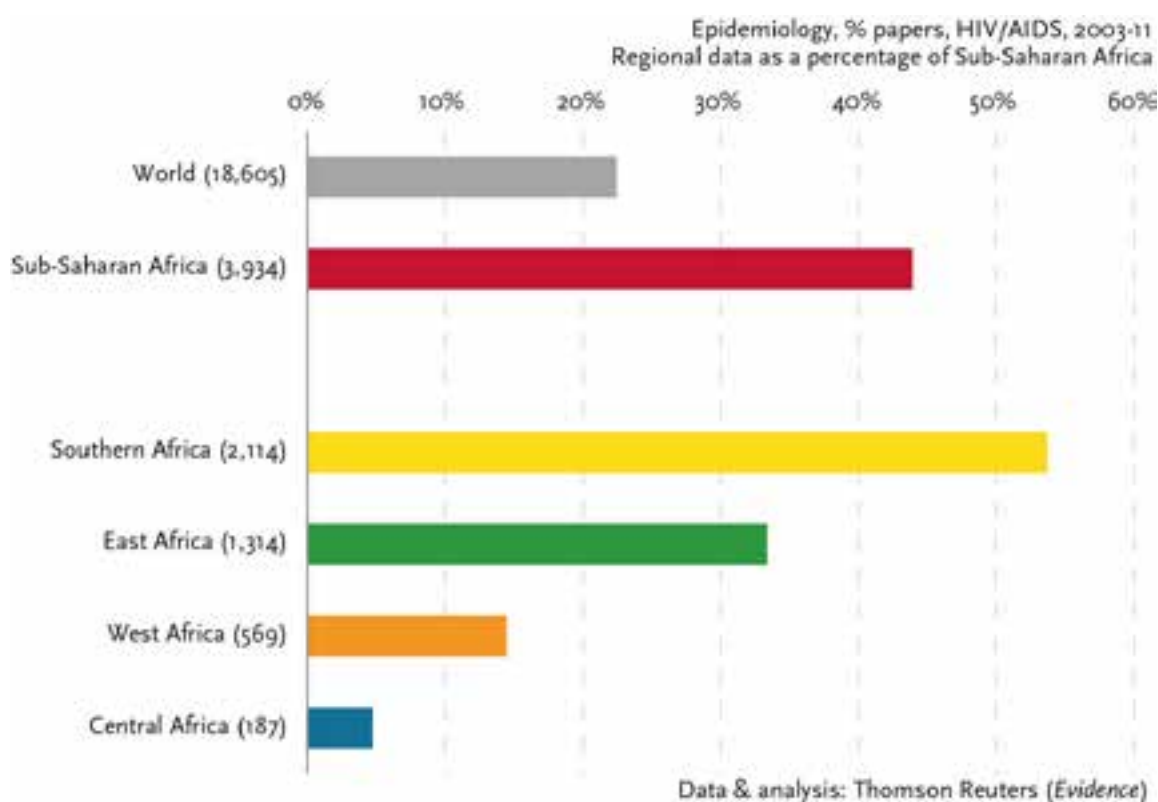


Figure 4.1.2 Epidemiology research, HIV/AIDS, sub-Saharan Africa and world

¹⁹ Grant, RM et al. (2010) Preexposure Chemoprophylaxis for HIV Prevention in Men Who Have Sex with Men. *New England Journal of Medicine*, 363: 2587-2599

²⁰ Celum, C. et al. (2010) Acyclovir and Transmission of HIV-1 from Persons Infected with HIV-1 and HSV-2. *New England Journal of Medicine*, 362: 427-439

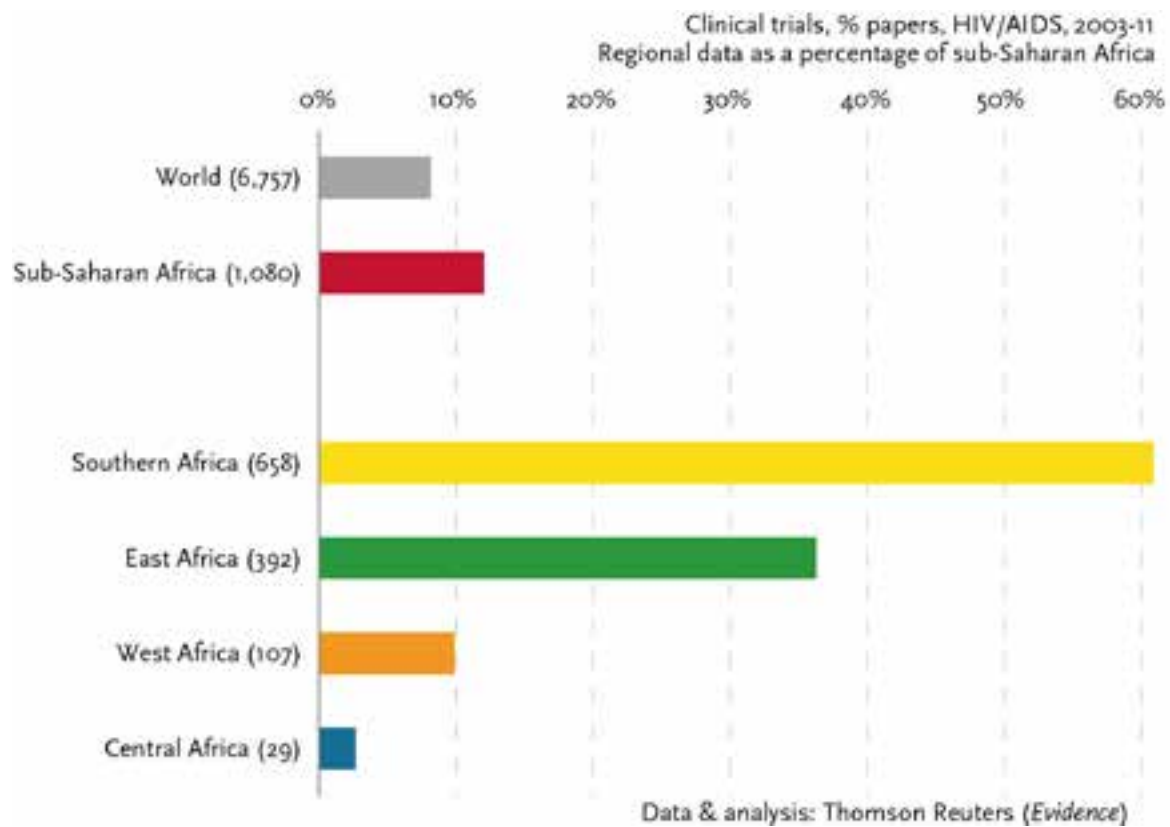


Figure 4.1.3 Clinical trials research, HIV/AIDS, sub-Saharan Africa and world

Table 4.1.1 Institutions involved in sub-Saharan African clinical trials research, HIV/AIDS, by absolute number of papers

Institution	Country	Papers (N)	Citation impact
University of Witwatersrand	ZAF	145	3.24
London School of Hygiene & Tropical Medicine	UK	129	2.43
Makerere University	UGA	99	3.02
University of Cape Town	ZAF	89	5.36
University of Zimbabwe	ZWE	75	2.29
Muhimbili University of Health and Allied Sciences	TZA	74	1.61
MRC of South Africa	ZAF	72	2.97
University of KwaZulu-Natal	ZAF	69	2.20
MRC Uganda Virus Research Institute	UGA	68	1.73
University of Nairobi	KEN	60	2.87
University of Malawi	MWI	49	2.43
University Teaching Hospital, Lusaka	ZMB	46	1.22
Stellenbosch University	ZAF	42	2.50
University College London	UK	39	1.77
Imperial College London	UK	36	2.00
MRC Clinical Trials Unit	UK	36	1.86
National Institute for Medical Research	TZA	32	2.21
Centre for Infectious Disease Research in Zambia	ZMB	31	1.77
University of Zambia	ZMB	30	0.91
Mulago Hospital	UGA	26	3.65
Joint Clinical Research Centre, Kampala	UGA	25	1.66
National Institute for Communicable Diseases	ZAF	25	3.59
University of Liverpool	UK	25	1.82
University of North Carolina	MWI	25	3.60
Botswana–Harvard AIDS Institute Partnership	BWA	23	6.30
INSERM	FRA	23	3.45
University of Bordeaux 2 (Victor Segalen)	FRA	23	1.73
Ministry of Health	ZMB	22	1.33
ANRS	CIV	21	1.68
Human Sciences Research Council of South Africa	ZAF	20	1.85

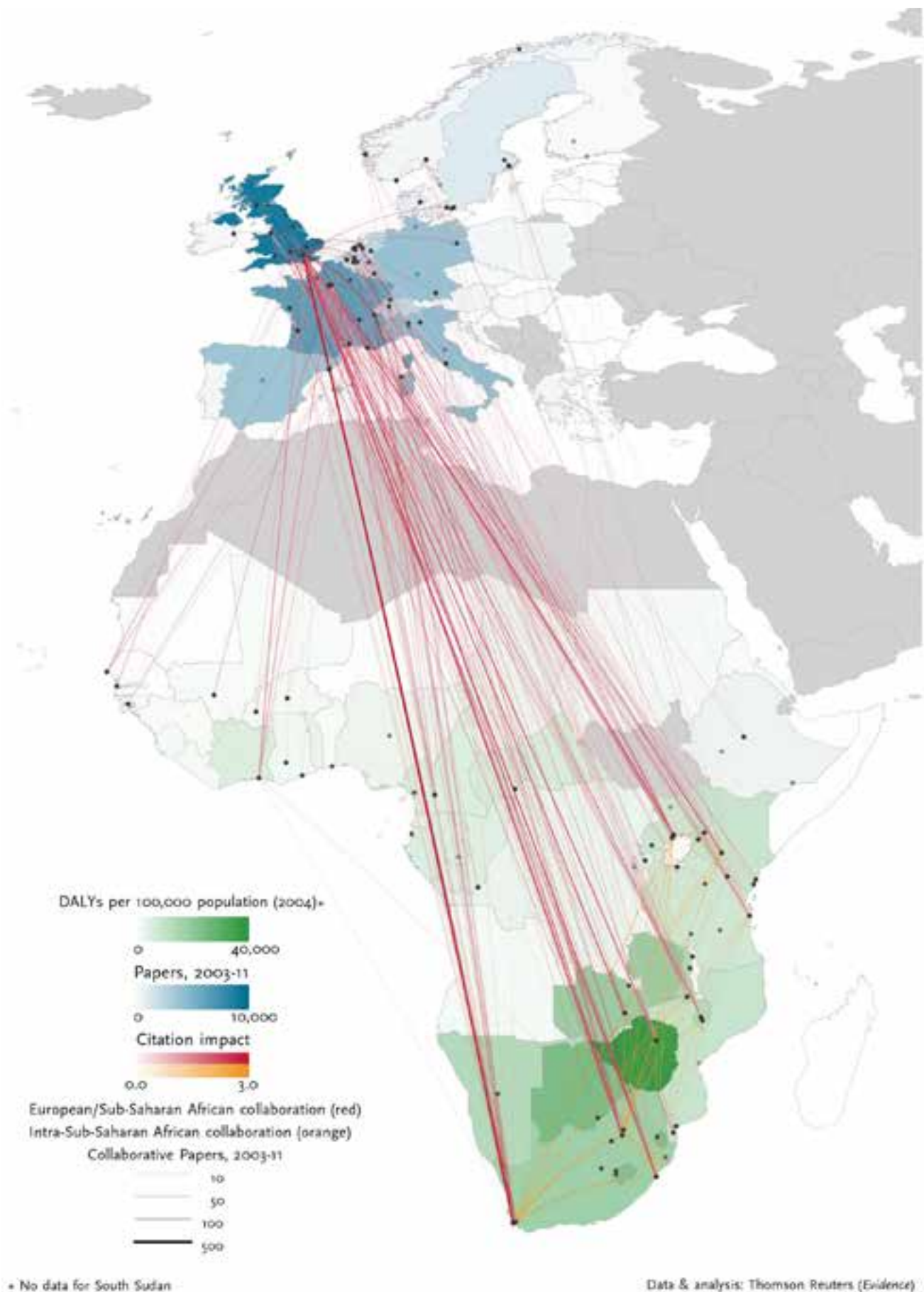


Figure 4.1.4 Disease burden in Sub-Saharan Africa, research output in Europe and their collaborative links in HIV

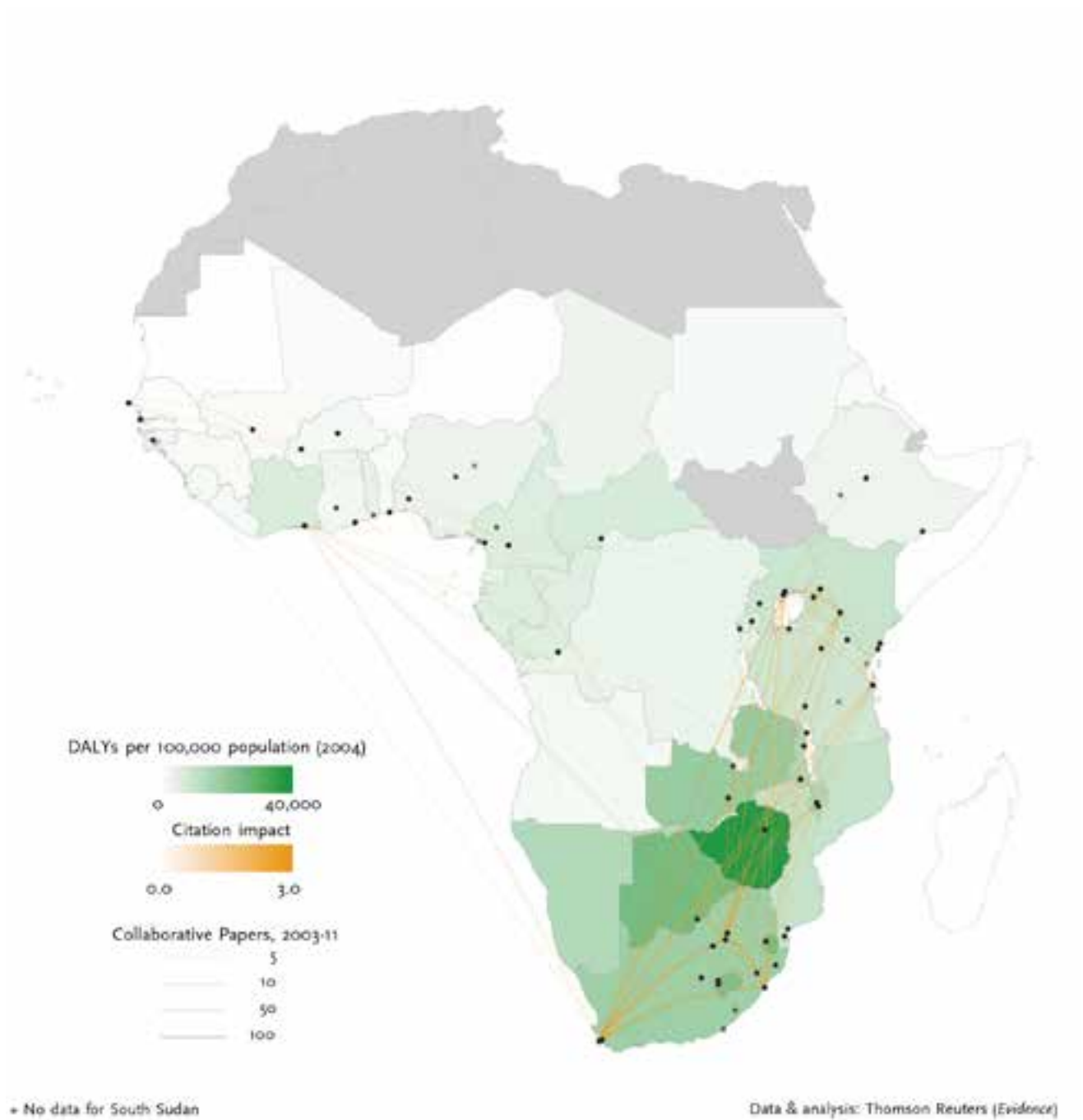


Figure 4.1.5 Disease burden and collaborative research links within Sub-Saharan Africa in HIV

EDCTP-associated funding collaboration

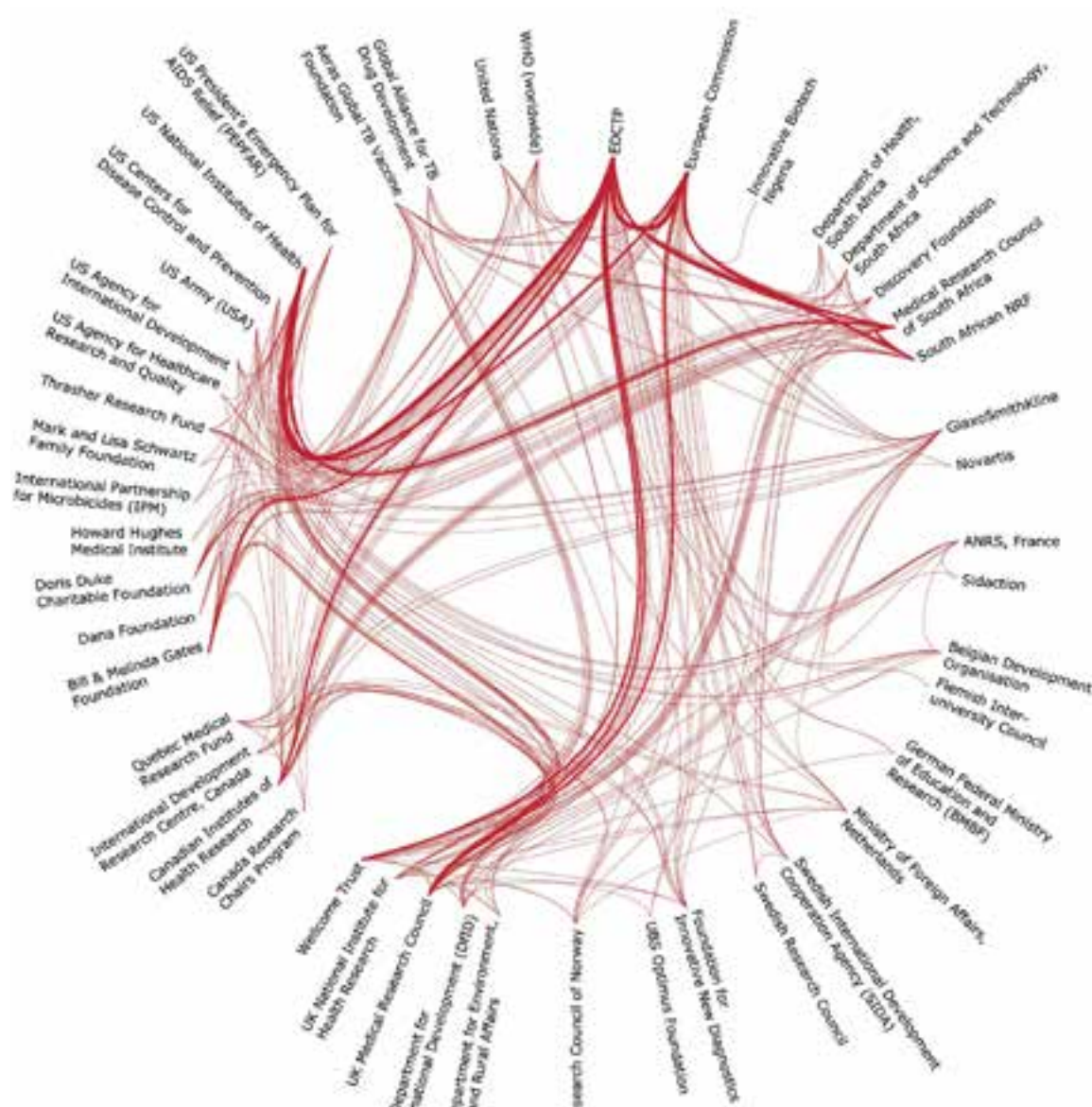


Figure 4.1.6 Collaboration between EDCTP-associated papers and other funding agencies, HIV/AIDS, sub-Saharan Africa (2008-11)

A line between two funding agencies represents at least one paper, thicker lines represent more co-funded papers.

Agencies acknowledged on EDCTP-associated papers across sub-Saharan Africa in HIV/AIDS research include: in the UK, MRC UK (14 papers) and the Wellcome Trust (12 papers); in Africa, the MRC of South Africa

(15 papers) and the South African National Research Foundation (15 papers); worldwide, the US National Institutes of Health (28 papers) and the Bill & Melinda Gates Foundation (10 papers).

4.2. European research in HIV/AIDS

EDCTP Member Countries have published more than one-third of global HIV/AIDS research output, and this research is very highly-cited.

Research output by EDCTP Member Countries has increased but has not kept pace with global growth in HIV/AIDS research and share of global research has fallen. This trend (shown in figure 4.3.1 and figure 4.3.2) has been observed widely and is due to the rapid growth in the research output of developing economies such as China and Brazil.²¹

Collaboration between EDCTP Member Countries and sub-Saharan Africa has doubled and is now 5.2% of global HIV/AIDS research output (figure 4.3.2).

Citation impact of HIV/AIDS research from EDCTP Member Countries is higher than the global average. Collaborative HIV/AIDS research between EDCTP Member Countries and sub-Saharan Africa is very highly-cited and rising rapidly, which indicates that this research is well regarded internationally (figure 4.3.3).

Key findings by country (section 4.4 and section 4.5) are:

- The UK is the leading European collaborating partner of sub-Saharan Africa in HIV/AIDS research. It published nearly half of the research output of European countries that is collaborative with sub-Saharan Africa. The citation impact of UK HIV/AIDS collaborative research is 1.83, close to twice the world average. The UK institutions particularly involved are the London School of Hygiene & Tropical Medicine, University College London, Imperial College London, the University of Oxford and the University of Liverpool.

- France is the second most frequent European collaborating partner of sub-Saharan Africa. Collaborative HIV/AIDS research with sub-Saharan Africa is a smaller percentage of French HIV/AIDS research output (10.6%) than for the European average (12.2%). The French institutions particularly involved are University of Bordeaux 2 (Victor Segalen), INSERM, IRD and the University of Montpellier 1.
- The high citation impact of Swiss HIV/AIDS research is driven by the location of the WHO.²² Similarly, the high percentage of Luxembourg's research output focussed on HIV/AIDS research is driven by the Operational Headquarters of *Médecins sans Frontières* for reasons described in section 3.4.3.²³
- Some European HIV/AIDS research is both highly-cited and highly-collaborative with sub-Saharan Africa. This is concentrated in the Netherlands and Belgium and in institutions such as the Netherlands' University Medical Centres of Amsterdam and Radboud Nijmegen and the Institute of Tropical Medical Medicine, Antwerp. It also includes Sweden and Denmark where it is led by the Karolinska Institutet and University of Copenhagen associated hospitals.

²¹ <http://sciencewatch.com/grr/building-bricks>

²² WHO accounts for 21.3% of the HIV/AIDS research of Switzerland; it accounts for 52.6% of the research which is collaborative with sub-Saharan Africa.

²³ *Médecins sans Frontières* accounts for 41.7% of the HIV/AIDS research of Luxembourg; it accounts for 71.7% of the research which is collaborative with sub-Saharan Africa.

4.3. European research trends

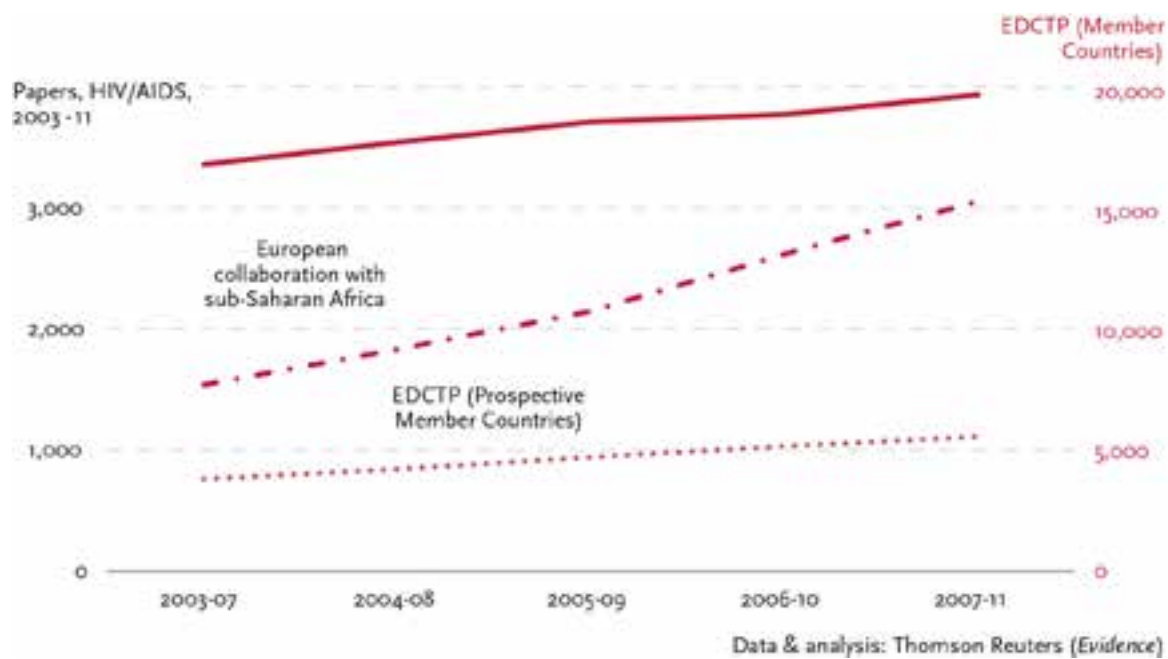


Figure 4.3.1 Trends in HIV/AIDS research output in Europe

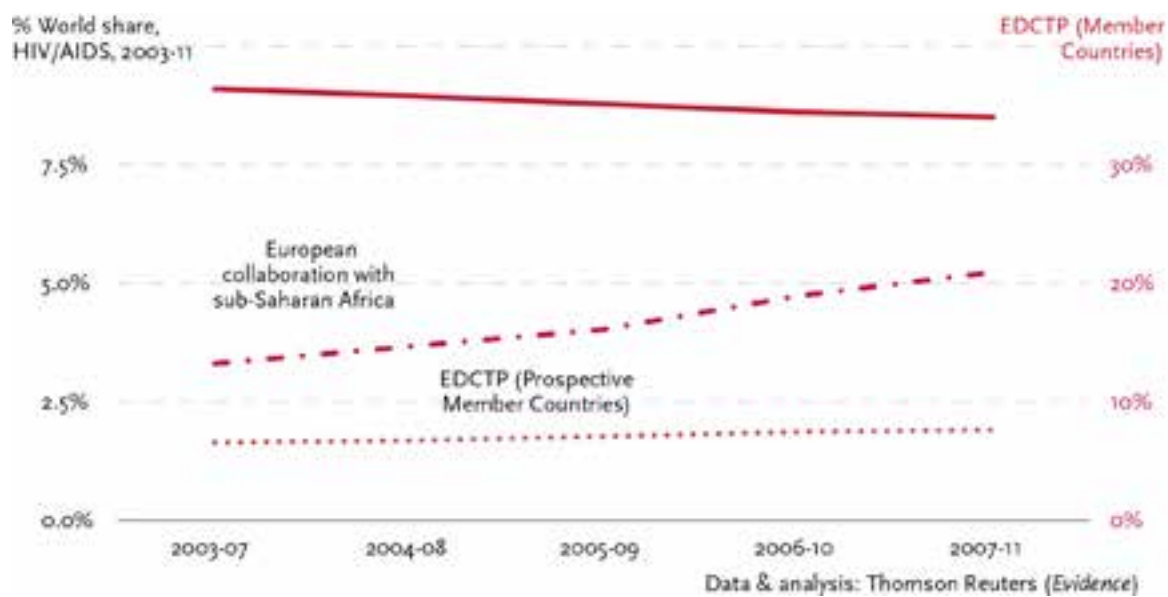


Figure 4.3.2 Trends in world share of HIV/AIDS research, Europe

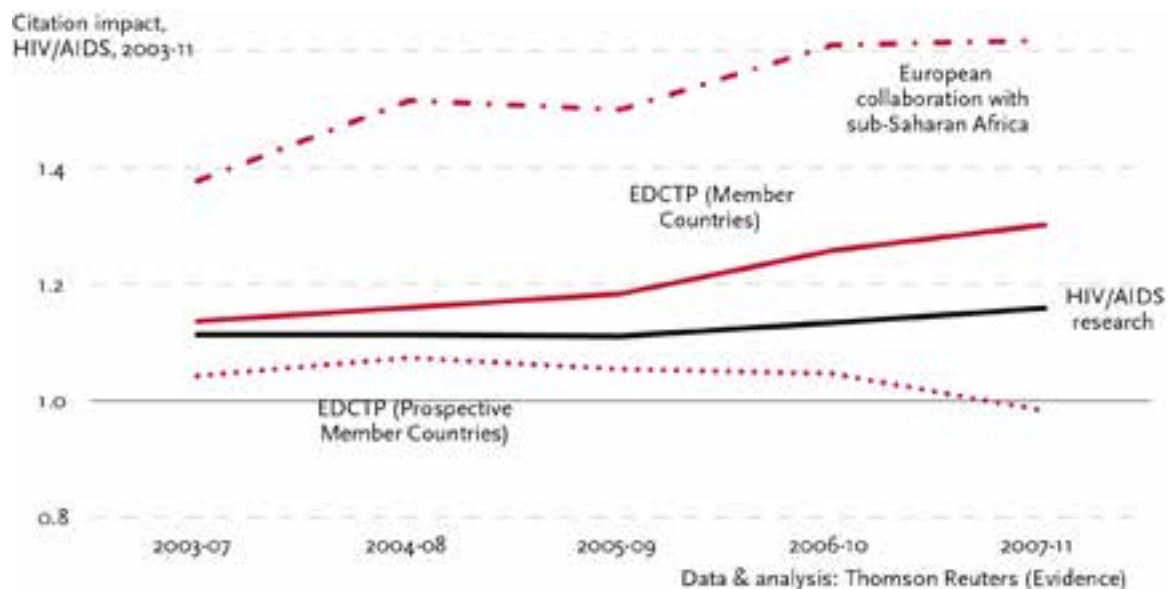


Figure 4.3.3 Trends in citation impact of HIV/AIDS research, Europe

4.4. EDCTP Member Countries

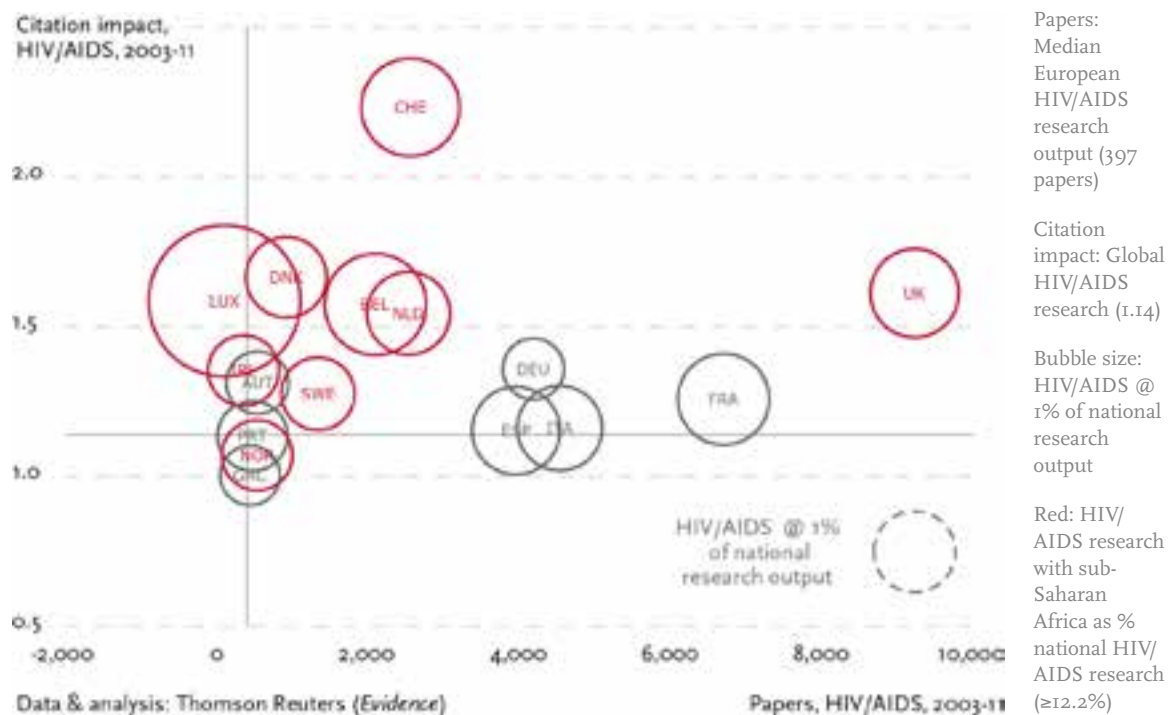


Figure 4.4.1 Country quadrant for HIV/AIDS research in EDCTP Member Countries

Table 4.4.1 Country data for HIV/AIDS research in EDCTP Member Countries

UN Short Code	National HIV/AIDS research			Collaborative HIV/AIDS research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
AUT	540	1.31	0.6%	19	0.61	3.5%
BEL	2,095	1.57	1.6%	389	1.51	18.6%
CHE	2,558	2.23	1.5%	388	2.96	15.2%
DEU	4,182	1.36	0.6%	227	1.54	5.4%
DNK	917	1.67	1.0%	114	1.44	12.4%
ESP	3,952	1.15	1.2%	105	1.95	2.7%
FRA	6,691	1.26	1.3%	706	1.64	10.6%
GRC	439	1.00	0.5%	6	1.01	1.4%
IRL	355	1.35	0.8%	45	1.96	12.7%
ITA	4,529	1.16	1.1%	163	1.28	3.6%
LUX	103	1.59	3.5%	53	1.82	51.5%
NLD	2,530	1.55	1.0%	448	1.48	17.7%
NOR	535	1.07	0.8%	240	0.95	44.9%
PRT	473	1.14	0.7%	23	2.52	4.9%
SWE	1,337	1.28	0.8%	291	1.08	21.8%
UK	9,214	1.61	1.2%	2,080	1.83	22.6%

Table 4.4.2 Institutions in Europe collaborating on HIV/AIDS research with sub-Saharan Africa

Institution	Country	Papers (N)	Citation impact
London School of Hygiene & Tropical Medicine	UK	824	1.97
University College London	UK	294	2.18
Imperial College London	UK	265	2.19
University of Oxford	UK	253	2.13
University of Liverpool	UK	229	1.25
WHO	CHE	204	3.22
Institute of Tropical Medicine Antwerp	BEL	157	1.44
University of Bordeaux 2 (Victor Segalen)	FRA	154	1.82
Karolinska Institutet	SWE	145	0.99
University of Bergen	NOR	134	0.93
UMC Amsterdam	NLD	129	2.01
INSERM	FRA	122	2.08
IRD (Institut de recherche pour le developpement)	FRA	94	1.67
University of Montpellier 1	FRA	91	1.21
University of Antwerp	BEL	79	1.13
University of Ghent	BEL	79	1.17
Institut Pasteur	FRA	73	0.79

MRC Clinical Trials Unit	UK	71	2.09
University of Oslo	NOR	69	0.90
University of Copenhagen	DNK	67	1.13
International Union Against Tuberculosis and Lung Disease	FRA	61	3.03
Karolinska University Hospital	SWE	59	0.87
University of Paris 5 (Descartes)	FRA	58	1.49
UMC Radboud Nijmegen	NLD	53	1.29
CHU Montpellier	FRA	52	1.31
King's College London	UK	50	1.03

4.5. EDCTP Prospective Member Countries

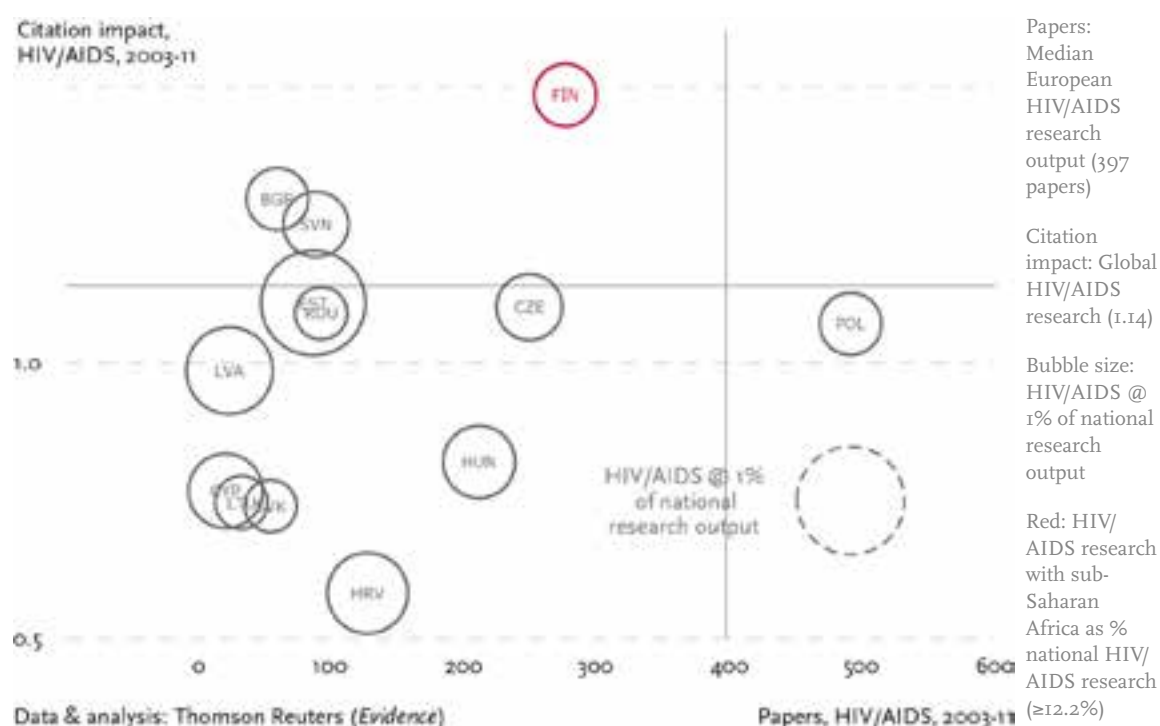


Figure 4.5.1 Country quadrant for HIV/AIDS research in EDCTP Prospective Member Countries

Table 4.5.1 Country data for HIV/AIDS research in EDCTP Prospective Member Countries

UN Short Code	National HIV/AIDS research			Collaborative HIV/AIDS research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
BGR	59	1.30	0.3%	1	0.49	1.7%
CYP	20	0.77	0.5%	0	0.00	0.0%
CZE	249	1.10	0.4%	13	1.30	5.2%
EST	86	1.11	0.9%	4	1.33	4.7%
FIN	276	1.49	0.3%	37	2.03	13.4%
HRV	127	0.58	0.6%	5	1.63	3.9%
HUN	211	0.82	0.4%	0	0.00	0.0%
LTU	32	0.75	0.2%	0	0.00	0.0%
LVA	23	0.99	0.6%	3	0.76	13.0%
MLT	8	0.22	0.9%	0	0.00	0.0%
POL	491	1.07	0.3%	10	4.51	2.0%
ROU	92	1.09	0.2%	3	0.45	3.3%
SVK	54	0.74	0.2%	2	0.04	3.7%
SVN	88	1.25	0.4%	1	0.00	1.1%

No institution from these countries has 20 or more collaborative papers with sub-Saharan Africa in HIV/AIDS research. No data are displayed.

4.6. Sub-Saharan African research in HIV/AIDS

HIV/AIDS research output from sub-Saharan Africa doubled from 2003-7 to 2007-11 and increased to 13.2% share of global research in the most recent 5-year period. The citation impact of HIV/AIDS research from sub-Saharan Africa is higher than the global average (however, many of these papers will have international co-authors). Collaborative research with Europe accounted for two-fifths of HIV/AIDS research across sub-Saharan Africa (40.1%) and the citation impact of this collaborative is high and rising.

Growth in HIV/AIDS research in sub-Saharan Africa is led by Southern Africa, and East Africa, whereas research output and citation impact is less in West Africa and Central Africa. This reflects the relative burden of disease as, broadly

speaking, those countries with the greatest burden of disease also are the most research-active.

Southern Africa

Growth in sub-Saharan Africa in HIV/AIDS research is driven by Southern Africa. The citation impact of this research is high (average citation impact 1.51) and rising (section 4.8).

- South Africa published 41.1% of sub-Saharan Africa's research output on HIV/AIDS. It is the country most frequently collaborating with Europe, producing over a third of collaborative research in the area. The difference between total and collaborative research reflects South Africa's substantial domestic activity. The citation impact of its collaborative research is more than twice the global average (2.34). South African institutions collaborating most frequently with Europe are the University of Cape Town, the University of KwaZulu-Natal, the University of Witwatersrand, Stellenbosch University and the MRC of South Africa.
- In Malawi, Zambia and Zimbabwe, HIV/AIDS research is highly-cited and a major part of these countries' national research output. Collaborative research with Europe

accounted for 40% or more of their output. Collaborative HIV/AIDS research is primarily led through national universities and Ministries of Health.

- In Botswana, HIV/AIDS research is highly-cited, despite fewer European research links, due to the Botswana-Harvard AIDS Institute Partnership.
- In Swaziland and Lesotho, the burden of HIV/AIDS is high but research output is negligible and there are few collaborative links with Europe.

The US National Institutes of Health was the most significant funding agency in HIV/AIDS research in Southern Africa between 2008-11 (672 papers). US agencies active in this area included the US Agency for International Development, the US Centres for Disease Control and Prevention and the US President's Emergency Plan for AIDS Relief. The Bill & Melinda Gates Foundation ranks fourth. The South African National Research Foundation and the MRC of South Africa are the most frequent African partners in this research effort. Within Europe, the Wellcome Trust, European Commission, UK DfID and the UK MRC are active.

EDCTP is one of the top 20 funding agencies of HIV/AIDS research in Southern Africa in terms of research output and the research it is associated with is extremely highly-cited (5.51, the highest within the top 20 funding organisations). There is one very highly-cited EDCTP-associated paper (cited more than 30 times the world average) related to HIV/AIDS and tuberculosis co-infection.²⁴

East Africa

HIV/AIDS research output has more than doubled in East Africa (section 4.9) and the citation

impact of this research is high (average citation impact 1.35) and rising.

- Uganda is a major player in size, in focus and in collaboration. One-third of its national research output is focussed on HIV/AIDS, and 43.5% of this was collaborative with Europe and highly-cited (1.70). MRC Uganda Virus Research Institute and Makerere University are key collaborating partners.
- In Kenya, HIV/AIDS research accounted for 12.9% of research output and more than one-third of this research was collaborative with Europe. The research output of the KEMRI has been disaggregated by site, but if it were considered as a single entity, it would contribute significantly to HIV/AIDS research alongside the University of Nairobi.
- In Tanzania, HIV/AIDS research output accounted for nearly 17.5% of national research effort and 59.2% was collaborative with Europe. Lead institutions include the National Institute for Medical Research and Muhimbili University of Health and Allied Sciences.
- Rwanda's research output was small (108 papers) but HIV/AIDS research represents a major area of national research focus (29.1% of total research output). European collaboration was involved in over half this research and has a high citation impact (average citation impact 1.83).
- Ethiopia's research output in HIV/AIDS is poorly-cited (average citation impact 0.75) despite being highly-collaborative. 2,530,280 DALYs are lost to HIV/AIDS (3,286 per 100,000 population) which is a lower burden of disease than for its neighbours but is still absolutely high in terms of disease burden.

Various US government agencies, but particularly the US National Institutes of Health have been active in HIV/AIDS research in East Africa. The Bill & Melinda Gates Foundation ranked second overall. Within Europe, the UK

²⁴ Boehme, CC et al. (2011) Feasibility, diagnostic accuracy, and effectiveness of decentralised use of the Xpert MTB/RIF test for diagnosis of tuberculosis and multidrug resistance: a multicentre implementation study. *Lancet*, 377: 1495-150

MRC, the European Commission, Wellcome Trust, and UK DfID are also active. Amongst the African agencies, KEMRI has been acknowledged on 20 papers.

EDCTP-associated research in HIV/AIDS in East Africa is the most highly-cited (average citation impact 4.33) among the top 20 group of funding agencies including this very highly-cited paper.²⁵

West Africa

Research in HIV/AIDS in West Africa has almost doubled to 1.8% of global research output in the most recent five-year window (2007-11). The citation impact of this output is below the global average (0.91) and unchanged over the period. With the exception of Nigeria and Togo, collaboration with Europe accounted for a significant percentage of these countries' national research output in HIV/AIDS (section 4.10).

- Nigeria has a high burden of HIV/AIDS (4,860,250 DALYs 3,522 per 100,000 population) but its research output in HIV/AIDS has been neither significant nationally (4.0% of research output) nor particularly collaborative with Europe (13.0%). The citation impact of this research (average citation impact 0.54) is below the global average.
- Data for other countries are split between those that have above the global average citation impact (Côte d'Ivoire and Mali in particular, but also The Gambia and Ghana), and those that do not (Senegal, Burkina Faso, Gabon and Benin). Côte d'Ivoire has a very high burden of HIV/AIDS (6,971 DALYs per 100,000 population) and 80.4% of its research is collaborative with Europe. The French ANRS is a major partner.
- The relative burden of HIV/AIDS in The Gambia is lower than elsewhere in West

Africa but the MRC Unit, The Gambia is a major European collaborating partner.

There are fewer funding agencies of HIV/AIDS research in West Africa. Whilst the US National Institutes of Health is the largest funding agency in HIV/AIDS research in West Africa, the French ANRS is active.

EDCTP-associated HIV/AIDS research in West Africa is highly-cited (average citation impact 3.59) but is based on a small number of papers (11) including the Kesho Bora study mentioned in section 4.6.2.

Central Africa

Central African HIV/AIDS research output is very small: 448 papers, or 0.5% of world. The citation impact of this research is below the global average (0.82) despite a rise in the middle of the last decade. Most countries have a HIV/AIDS disease burden greater than 2,000 DALYs per 100,000 population. The research of these countries is highly-collaborative with Europe.

- From a regional perspective at institution-level, the few major, active collaborating partners in HIV/AIDS research in Central Africa are in Yaoundé, Cameroon.
- The research output of the Democratic Republic of Congo in HIV/AIDS research is around the global average (average citation impact 1.14). For all other countries, it is well below 1.0. For the Central African Republic, the 43 papers it has published in HIV/AIDS research accounted for just under a quarter of its total national research output for 2003-11.

There are few funding agencies of HIV/AIDS research in Central Africa, compared to Southern or East Africa, owing to the relative burden of HIV/AIDS across sub-Saharan Africa, but the ANRS is the most active (31 papers). This research is cited less well than for other regions of Africa.

²⁵ Meda, N et al. (2011) Triple antiretroviral compared with zidovudine and single-dose nevirapine prophylaxis during pregnancy and breastfeeding for prevention of mother-to-child transmission of HIV-1 (Kesho Bora study): a randomised controlled trial. *Lancet Infectious Diseases*, 11: 171-180

4.7. Sub-Saharan African research trends

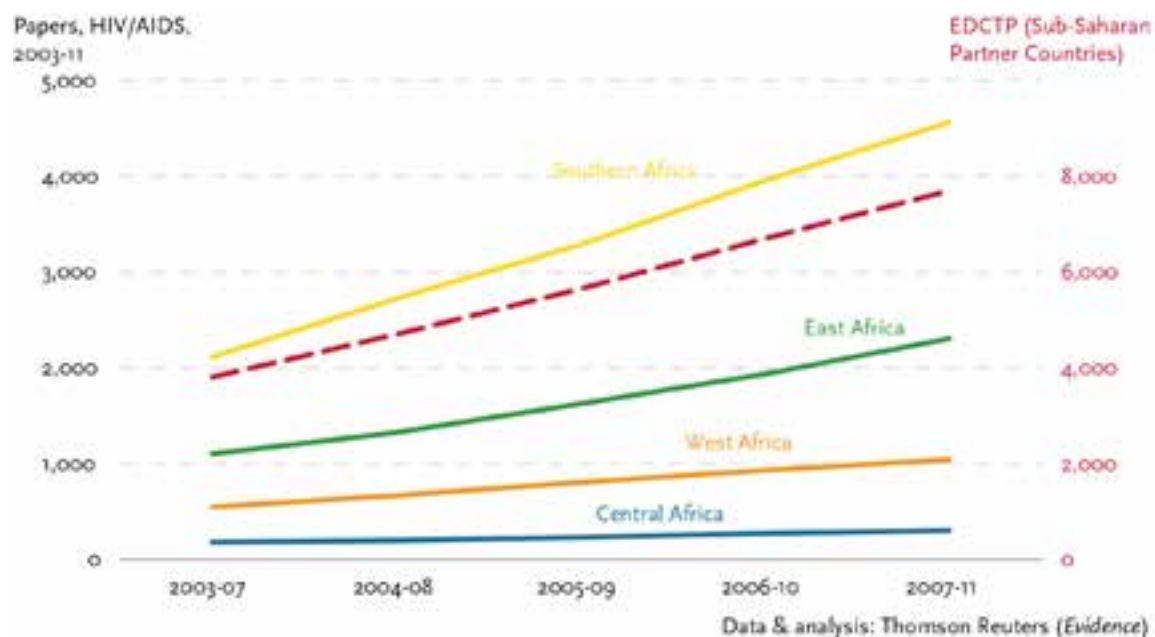


Figure 4.7.1 Trends in HIV/AIDS research output in sub-Saharan Africa

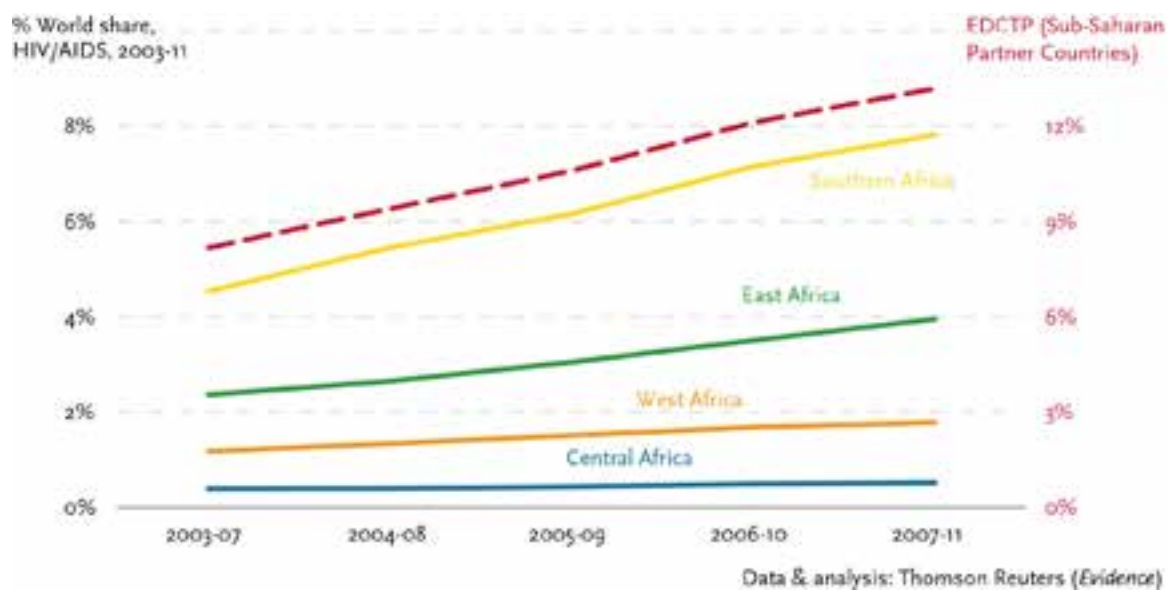


Figure 4.7.2 Trends in world share of HIV/AIDS research, sub-Saharan Africa

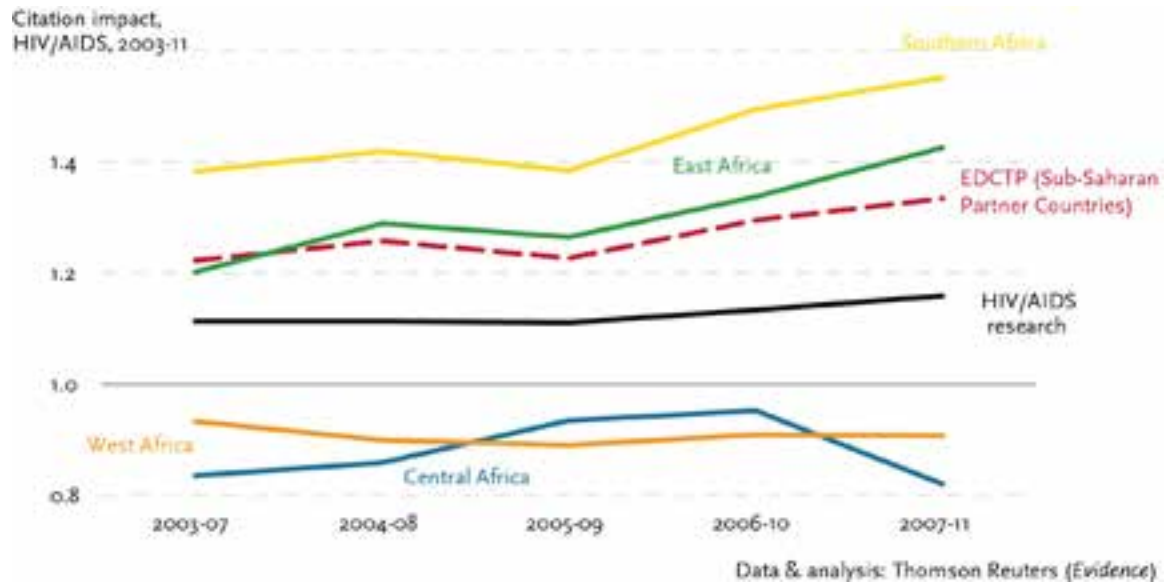


Figure 4.7.3 Trends in citation impact of HIV/AIDS research, sub-Saharan Africa

4.8. Southern Africa

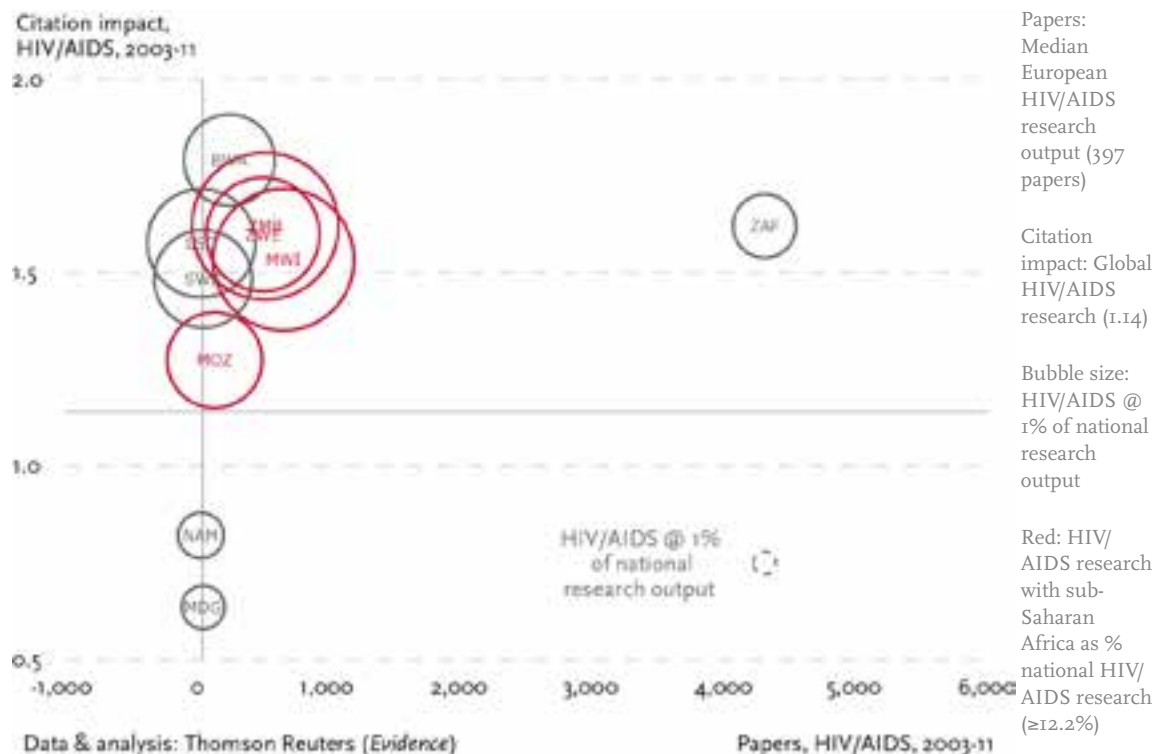


Figure 4.8.1 Country quadrant for HIV/AIDS research, Southern Africa

Table 4.8.1 Country data for HIV/AIDS research in Southern Africa

UN Short Code	National HIV/AIDS research			Collaborative HIV/AIDS research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
BWA	242	1.79	16.0%	31	4.07	12.8%
COM	1	0.06	3.4%	0	0.00	0.0%
LSO	30	1.58	22.6%	7	1.39	23.3%
MDG	43	0.64	3.6%	11	0.70	25.6%
MOZ	130	1.27	17.4%	70	1.49	53.8%
MUS	7	0.30	1.4%	3	0.70	42.9%
MWI	653	1.53	38.5%	367	1.65	56.2%
NAM	26	0.82	4.0%	7	0.34	26.9%
SWZ	42	1.48	18.4%	11	0.47	26.2%
SYC	1	0.06	0.6%	0	0.00	0.0%
ZAF	4,303	1.62	7.7%	1,422	2.34	33.0%
ZMB	514	1.62	41.5%	215	1.91	41.8%
ZWE	497	1.60	24.8%	260	1.59	52.3%

Table 4.8.2 Institutions in Southern Africa collaborating on HIV/AIDS research with Europe

Institution	Country	Papers (N)	Citation impact
University of Cape Town	ZAF	396	3.29
University of KwaZulu-Natal	ZAF	356	2.09
University of Witwatersrand	ZAF	300	1.99
Stellenbosch University	ZAF	187	2.84
University of Malawi	MWI	152	1.54
University of Zimbabwe	ZWE	143	1.50
MRC of South Africa	ZAF	139	2.92
Ministry of Health	MWI	91	1.58
Biomedical Research and Training Institute	ZWE	89	1.71
University of Zambia	ZMB	86	2.18
Malawi-Liverpool-Wellcome Trust Clinical Research Programme	MWI	76	1.71
University Teaching Hospital, Lusaka	ZMB	71	1.57
National Institute for Communicable Diseases	ZAF	63	2.15
Aurum Institute for Health Research	ZAF	57	2.76
Karonga Prevention Study	MWI	51	1.34
University of Pretoria	ZAF	47	2.14
University of the Free State	ZAF	42	1.58
University of the Western Cape	ZAF	39	2.73
Groote Schuur Hospital, Cape Town	ZAF	36	4.20

Kamuzu Central Hospital	MWI	36	2.40
National Health Laboratory Service South Africa	ZAF	36	2.73
GF Jooste Hospital, Cape Town	ZAF	34	2.03
Human Sciences Research Council of South Africa	ZAF	34	1.38
University of Limpopo	ZAF	34	0.98
Tygerberg Hospital, Cape Town	ZAF	32	1.32
Ministry of Health	MOZ	31	1.44
Médecins sans Frontières	ZAF	29	4.45
Ministry of Health	ZMB	29	2.03
Ministry of Health	ZWE	29	1.71
Ministry of Health	ZAF	25	3.40
Medecins Sans Frontieres	MWI	22	2.33
National Institute of Health Research	ZWE	22	1.43
Manhiça Health Research Centre	MOZ	21	1.92
Tropical Diseases Research Centre	ZMB	21	1.41

Table 4.8.3 Agencies funding Southern African HIV/AIDS research, 2008-11

Institution	Region	Papers (N)	Citation impact
US National Institutes of Health	ROW	672	2.65
Wellcome Trust	EUR	323	2.44
South African National Research Foundation	AFR	172	1.05
Bill & Melinda Gates Foundation	ROW	170	4.59
MRC of South Africa	AFR	162	1.99
US Agency for International Development	ROW	138	2.48
US Centers for Disease Control and Prevention	ROW	114	1.67
European Commission	EUR	104	2.85
US President's Emergency Plan for AIDS Relief	ROW	94	1.85
UK DfID	EUR	86	2.26
UK MRC	EUR	85	2.72
Doris Duke Charitable Foundation	ROW	79	2.32
Department of Science and Technology, South Africa	AFR	66	2.52
European & Developing Countries Clinical Trials Partnership	EUR	58	5.51
Bristol-Myers Squibb	COR	53	5.30
US Department of Health and Human Services	ROW	51	1.39
GlaxoSmithKline	COR	50	4.78
WHO	IGO	45	2.24
Canadian Institutes of Health Research	ROW	40	3.58
Elizabeth Glaser Pediatric AIDS Foundation	ROW	39	1.99
Department of Health, South Africa	AFR	34	1.05
United Nations	IGO	34	2.37

University of North Carolina	ROW	32	1.49
ANRS	EUR	30	3.95
Gilead Sciences	COR	30	8.88
Merck & Co (Merck, Sharp & Dohme)	COR	29	10.11
University of Cape Town	AFR	29	1.60
Abbott Laboratories	COR	28	4.66
Pfizer	COR	28	3.33
Rockefeller Foundation	ROW	28	1.94
National Health Laboratory Service South Africa	AFR	27	0.73
University of KwaZulu-Natal	AFR	26	0.85
International AIDS Vaccine Initiative	NGO	25	2.17

4.9. East Africa

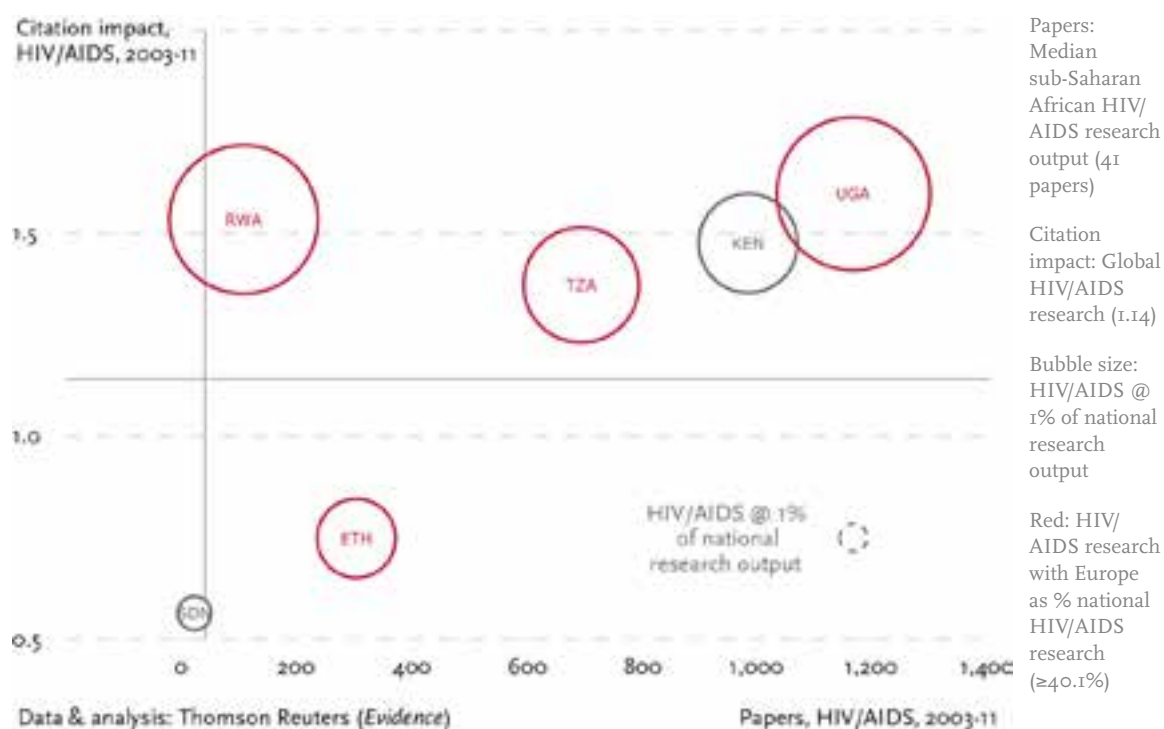


Figure 4.9.1 Country quadrant for HIV/AIDS research in East Africa

Table 4.9.1 Country data for HIV/AIDS research in East Africa

UN Short Code	National HIV/AIDS research			Collaborative HIV/AIDS research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
BDI	6	0.27	5.6%	6	0.27	100.0%
ERI	3	0.05	1.5%	2	0.08	66.7%
ETH	303	0.75	8.1%	164	0.67	54.1%
KEN	981	1.48	12.9%	366	1.75	37.3%
RWA	108	1.53	29.1%	56	1.83	51.9%
SDN	23	0.56	1.9%	11	0.65	47.8%
SOM	1	0.25	7.1%	1	0.25	100.0%
SSD	2	0.86	7.1%	0	0.00	0.0%
TZA	692	1.37	17.5%	410	1.49	59.2%
UGA	1,163	1.60	31.0%	506	1.70	43.5%

Table 4.9.2 Institutions in East Africa collaborating on HIV/AIDS research with Europe

Institution	Country	Papers (N)	Citation impact
MRC Uganda Virus Research Institute	UGA	209	1.59
Makerere University	UGA	201	2.13
National Institute for Medical Research	TZA	152	1.57
Muhimbili University of Health and Allied Sciences	TZA	127	1.21
University of Nairobi	KEN	86	1.97
Addis Ababa University	ETH	68	0.73
Ministry of Health	UGA	55	2.18
KEMRI, Nairobi	KEN	52	2.53
KEMRI, Kilifi	KEN	49	1.57
Ministry of Health	KEN	49	1.73
Kilimanjaro Christian Medical Centre	TZA	48	2.47
Mulago Hospital	UGA	43	1.75
Ethiopian Health and Nutrition Research Institute	ETH	42	0.41
Ministry of Health	TZA	41	1.41
KEMRI, Kisumu	KEN	40	1.31
African Medical and Research Foundation	TZA	39	1.94
Joint Clinical Research Centre, Kampala	UGA	32	1.96
International Centre for Reproductive Health	KEN	30	1.80
US Centers for Disease Control and Prevention	KEN	30	2.41
Ministry of Health	ETH	29	0.72
Coast Province General Hospital	KEN	26	1.18
Armauer Hansen Research Institute	ETH	21	0.91

Table 4.9.3 Agencies funding East African HIV/AIDS research, 2008-11

Institution	Region	Papers (N)	Citation impact
US National Institutes of Health	ROW	418	2.06
Bill & Melinda Gates Foundation	ROW	108	3.31
US Centers for Disease Control and Prevention	ROW	82	1.57
US Agency for International Development	ROW	79	1.47
UK MRC	EUR	65	1.82
US President's Emergency Plan for AIDS Relief	ROW	57	1.58
European Commission	EUR	56	1.45
Wellcome Trust	EUR	56	2.69
UK DfID	EUR	55	2.67
Canadian Institutes of Health Research	ROW	52	1.51
Swedish International Development Cooperation Agency	EUR	47	1.03
Rockefeller Foundation	ROW	31	1.80
University of Washington, Seattle	ROW	28	2.25
International AIDS Vaccine Initiative	NGO	27	1.97
WHO	IGO	27	1.80
European & Developing Countries Clinical Trials Partnership	EUR	26	4.33
Doris Duke Charitable Foundation	ROW	20	1.16
Harvard University	ROW	20	1.50
KEMRI	AFR	20	1.88

4.10. West Africa

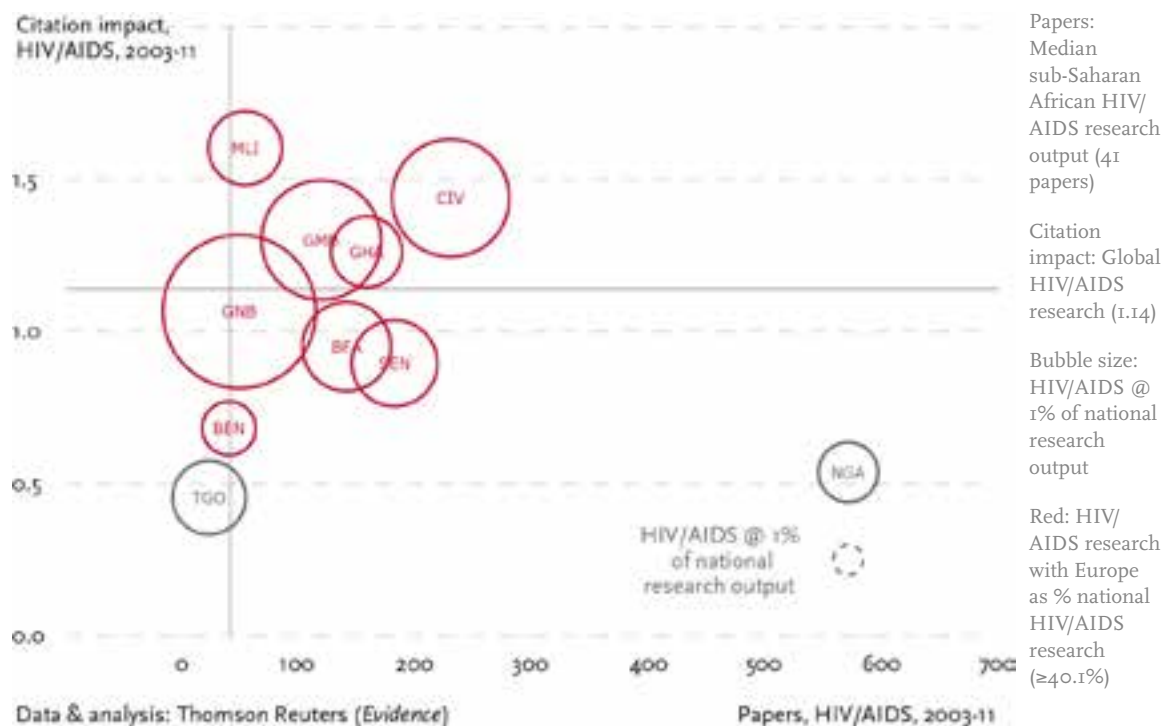


Figure 4.10.1 Country quadrant for HIV/AIDS research in West Africa

Table 4.10.1 Country data for HIV/AIDS research in West Africa

UN Short Code	National HIV/AIDS research			Collaborative HIV/AIDS research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
BEN	40	0.68	3.2%	27	0.73	67.5%
BFA	141	0.95	8.8%	109	1.07	77.3%
CIV	230	1.44	15.5%	185	1.68	80.4%
CPV	1	0.00	2.4%	0	0.00	0.0%
GHA	158	1.26	5.6%	75	1.56	47.5%
GIN	15	0.98	8.1%	9	1.26	60.0%
GMB	119	1.30	16.1%	92	1.31	77.3%
GNB	49	1.07	26.3%	48	1.07	98.0%
LBR	6	0.21	15.0%	0	0.00	0.0%
MLI	54	1.60	6.1%	29	2.35	53.7%
MRT	2	0.38	1.2%	1	0.76	50.0%
NER	12	0.37	2.2%	6	0.46	50.0%
NGA	571	0.54	4.0%	74	1.12	13.0%
SEN	182	0.90	8.3%	98	1.16	53.8%
SLE	3	0.25	2.7%	0	0.00	0.0%
TGO	23	0.45	6.0%	11	0.60	39.3%

Table 4.10.2 Institutions in West Africa collaborating on HIV/AIDS research with Europe

Institution	Country	Papers (N)	Citation impact
MRC Unit, The Gambia	GMB	88	1.36
ANRS	CIV	86	1.62
Treichville University Hospital Centre	CIV	73	1.39
Centre MURAZ	BFA	57	1.45
Aristide Le Dantec University Hospital Centre	SEN	35	1.06
Fann University Hospital Centre	SEN	27	1.45
Yopougon University Hospital Centre	CIV	26	1.47
ACONDA-VS	CIV	24	1.57
Komfo Anokye Teaching Hospital	GHA	22	0.72
Ministry of Health	SEN	22	1.06
Project RETRO-C1	CIV	22	1.18
Ministry of Health	BFA	20	0.76

Figure 4.10.3 Agencies funding West African HIV/AIDS research, 2008-11

Institution	Region	Papers (N)	Citation impact
US National Institutes of Health	ROW	67	2.38
ANRS	EUR	64	1.89
Bill & Melinda Gates Foundation	ROW	19	2.98
European Commission	EUR	19	3.50
US Agency for International Development	ROW	19	3.39
UK MRC	EUR	17	2.22
WHO	IGO	16	2.28
US Centers for Disease Control and Prevention	ROW	15	2.53
Wellcome Trust	EUR	15	3.95
United Nations	IGO	13	2.12
European & Developing Countries Clinical Trials Partnership	EUR	11	3.59
US President's Emergency Plan for AIDS Relief	ROW	10	0.83

4.11. Central Africa



Figure 4.11.1 Country quadrant for HIV/AIDS research in Central Africa

Table 4.11.1 Country data for HIV/AIDS research in Central Africa

UN Short Code	National HIV/AIDS research			Collaborative HIV/AIDS research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
AGO	18	0.47	11.1%	11	0.57	61.1%
CAF	43	0.58	24.4%	36	0.60	83.7%
CMR	271	0.94	7.0%	163	1.15	60.1%
COD	73	1.14	18.0%	39	1.54	53.4%
COG	28	0.73	4.4%	21	0.86	75.0%
GAB	33	0.81	4.5%	31	0.77	93.9%
GNQ	2	0.73	6.9%	2	0.73	100.0%
STP	1	0.00	5.6%	0	0.00	0.0%
TCD	6	0.46	4.3%	5	0.55	83.3%

Table 4.11.2 Institutions in Central Africa collaborating on HIV/AIDS research with Europe

Institution	Country	Papers (N)	Citation impact
University of Yaoundé I	CMR	41	0.75
Ministry of Health	CMR	35	1.63
Yaoundé Central Hospital	CMR	35	0.80
Institut Pasteur	CMR	32	1.03

Table 4.11.3 Agencies funding Central African HIV/AIDS research, 2008-11

Institution	Region	Papers (N)	Citation impact
ANRS	EUR	31	1.10
US National Institutes of Health	ROW	26	0.90
US Centers for Disease Control and Prevention	ROW	13	1.19
European Commission	EUR	12	0.35
IRD	EUR	12	0.81

5. Tuberculosis research

This section of the report provides a comprehensive bibliometric analysis of European and sub-Saharan research in tuberculosis focussing on research output and citation impact (as an indicator of research quality in the context of disease burden). Country and institutional analyses show where leading collaborative research between Europe and sub-Saharan Africa is being undertaken. From these publication data, the principal agencies funding sub-Saharan African research in tuberculosis have been identified – this is based on research volume not investment. This section also provides analyses showing how much global tuberculosis research is associated with clinical trials and the main research organisations participating in this in sub-Saharan Africa. The network of funding agencies with which EDCTP cooperates is visualised.

5.1. Summary

Globally, around 34,000 papers have been published in tuberculosis research between 2003 and 2011.

The share of world tuberculosis research published by European researchers has fallen in the last decade. In absolute terms, however, the number of European papers published in tuberculosis has increased since 2003, but the share of global research has dropped due to rapid growth in the research output of developing economies. European tuberculosis research is increasingly well-cited and, on average, is above the global average (1.31 compared to 1.05).

Sub-Saharan African research in tuberculosis has increased rapidly since 2003. In 2003, 185 tuberculosis research papers were published by researchers from sub-Saharan Africa (6.8%), and by 2011, this had risen to 614 papers (12.2%). A shift in focus towards HIV/

AIDS-related tuberculosis research may be contributing to the rapid growth recently in this region. Sub-Saharan African tuberculosis research is, on average, better cited than European research with an average citation impact of 1.52 (this will be influenced by papers with international co-authors, not just from Europe, but the USA, South America and Asia). Sub-Saharan African research in tuberculosis, both in terms of volume and citation impact, is led by Southern Africa, and South Africa in particular accounted for over half of sub-Saharan Africa's total research output). The tuberculosis burden of disease in East Africa is relatively high, especially in Kenya and Rwanda. KEMRI actively collaborates with Europe; whereas there are few links between Rwanda and European partners. Djibouti has the highest burden of disease in tuberculosis globally but is not a participating EDCTP member country, and, in West Africa also, countries such as Sierra Leone and Togo have a high burden of disease, but publish little research.

Collaboration between Europe and sub-Saharan Africa in tuberculosis research is important – overall, more than half of sub-Saharan African research papers have at least one European address. This collaborative research has a citation impact that is currently twice the global average and higher than for either Europe or sub-Saharan Africa. The UK and France are the leading European collaborating partners with sub-Saharan Africa in tuberculosis research, and UK research in particular is well-cited by the international research community. Most of this research is university-based; again, the London School of Hygiene & Tropical Medicine is very active. Institut Pasteur is the most research active French organisation, though the International Union against Tuberculosis and Lung Disease is an international organisation based in France. Swiss research is particularly highly-cited, not only because of the WHO, but also the Swiss Tropical & Public Health Institute and the

Foundation for Innovative New Diagnostics. In addition, there is some well-cited collaborative research involving researchers from the Institute of Tropical Medicine, Antwerp and the Royal Netherlands Tuberculosis Association. In sub-Saharan Africa, the main research organisations are in South Africa, such as the University of Cape Town and Stellenbosch University and their collaborative research is very well-cited.

Clinical trials research accounted for a smaller percentage of research in tuberculosis compared to the other disease areas, so data are limited at institutional level. Over two-fifths of research output in sub-Saharan Africa is associated with epidemiology compared to one-fifth worldwide. Sub-Saharan African clinical trials research is very highly-cited (average citation impact 2.82 compared to 1.96 globally) and related to HIV/AIDS and tuberculosis co-infection. The University of Cape Town and the London School of Hygiene & Tropical Medicine participate on around one-quarter of sub-Saharan African clinical trials research.

The principal funding agencies acknowledged by tuberculosis research papers published in sub-Saharan Africa focus their research efforts in Southern Africa. Worldwide, the US National Institutes of Health is the most frequently acknowledged funding agency, followed by the UK's Wellcome Trust. South African funding agencies are important and include the National Research Foundation and the MRC of South Africa. All these agencies have cofunded with EDCTP. From Europe, EDCTP and the European Commission are active and EDCTP-associated papers are the most highly-cited with a citation impact more than five times the global average. EDCTP works with the major multinational pharmaceutical companies such as Bristol-Myers Squibb, Gilead Sciences and GlaxoSmithKline.

National disease burden for tuberculosis

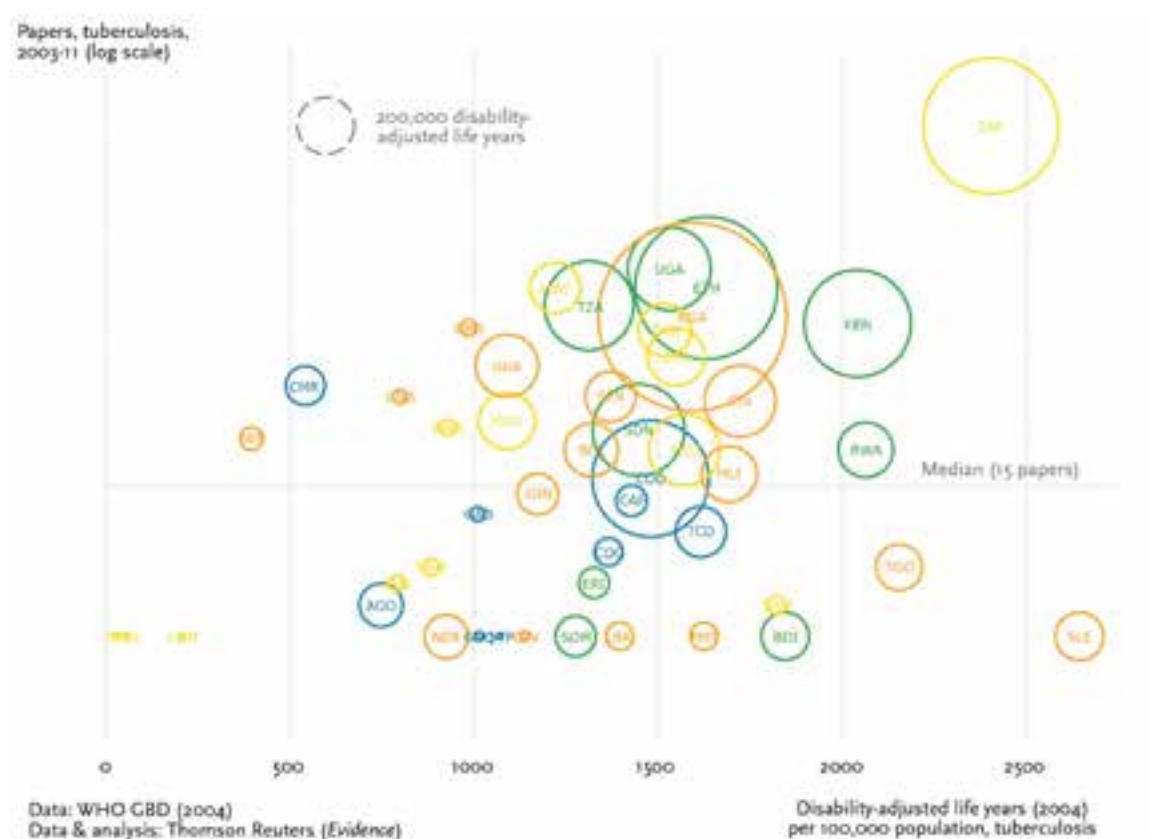


Figure 5.1.1 National disease burden and research output, tuberculosis

EXAMPLE (data for South Africa, ZAF): Bubble size – 1,142,750 DALYs lost to tuberculosis; x-axis – 2,404 per 100,000 (population = 47,540,930); y-axis – 1,597 papers published in tuberculosis research

Clinical trials and epidemiology research

Over two-fifths of the tuberculosis research output in sub-Saharan Africa (1,206 of 2,833 papers) is associated with epidemiology, compared to one fifth globally, and much of this occurs in Southern and East Africa. Clinical trials research forms a much smaller part of the research output in tuberculosis globally (3.3%) and in sub-Saharan Africa (219 papers, 7.7%), so there appear to be few institutions conducting significant clinical trials in the region.

The University of Cape Town has conducted 29.2% of this research. Partners of the University of Cape Town are predominantly from South Africa and the UK, including the MRC of South Africa and Imperial College London. Two particularly well-cited papers arise from this collaboration.^{26,27}

The London School of Hygiene & Tropical Medicine (conducting just 18.7% of sub-Saharan

²⁶ Boehme, CC et al. (2010) Rapid Molecular Detection of Tuberculosis and Rifampin Resistance. *New England Journal of Medicine*, 363: 1005-1015

²⁷ Sester, M et al. (2010) Interferon-gamma release assays for the diagnosis of active tuberculosis: a systematic review and meta-analysis. *European Respiratory Journal*, 37: 100-111

African clinical trials research in tuberculosis) is part of a network - including the Aurum Institute for Health Research and the MRC Uganda Virus Research Institute – that conducts multidisciplinary HIV/AIDS and tuberculosis research including this well-cited paper.²⁸

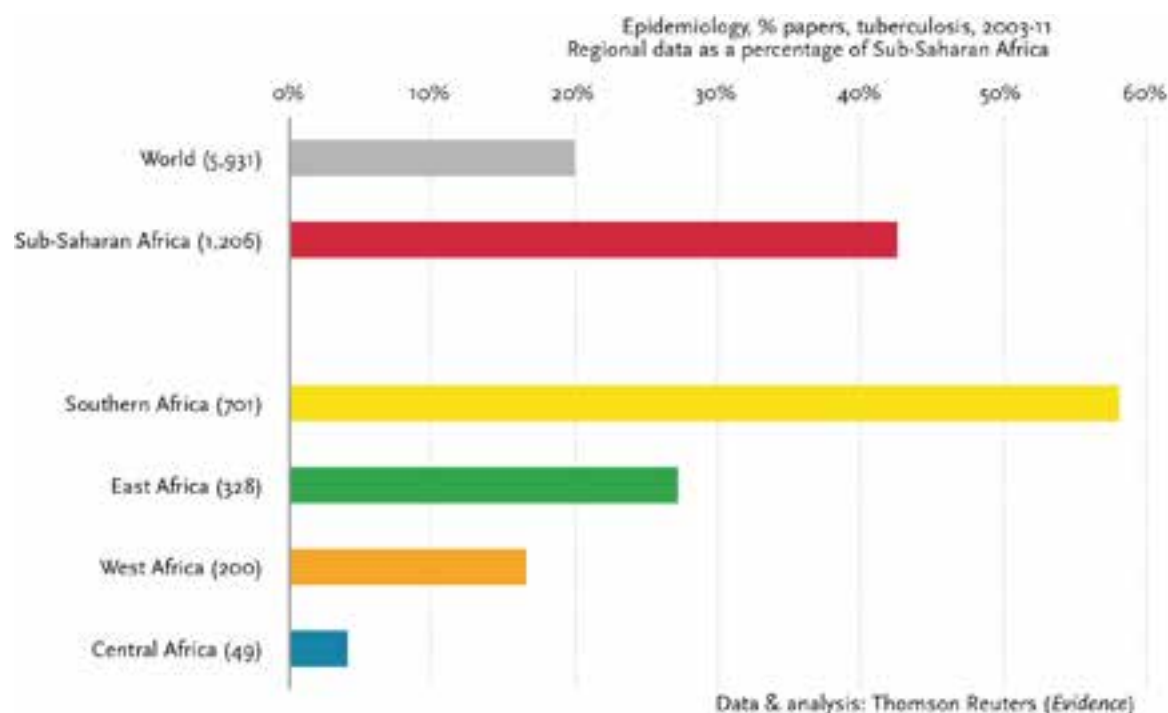


Figure 5.1.2 Epidemiology research, tuberculosis, sub-Saharan Africa and world

²⁸ Lawn, SD et al. (2010) Strategies to reduce early morbidity and mortality in adults receiving antiretroviral therapy in resource-limited settings. *Current Opinion in HIV and AIDS*, 5: 18-26

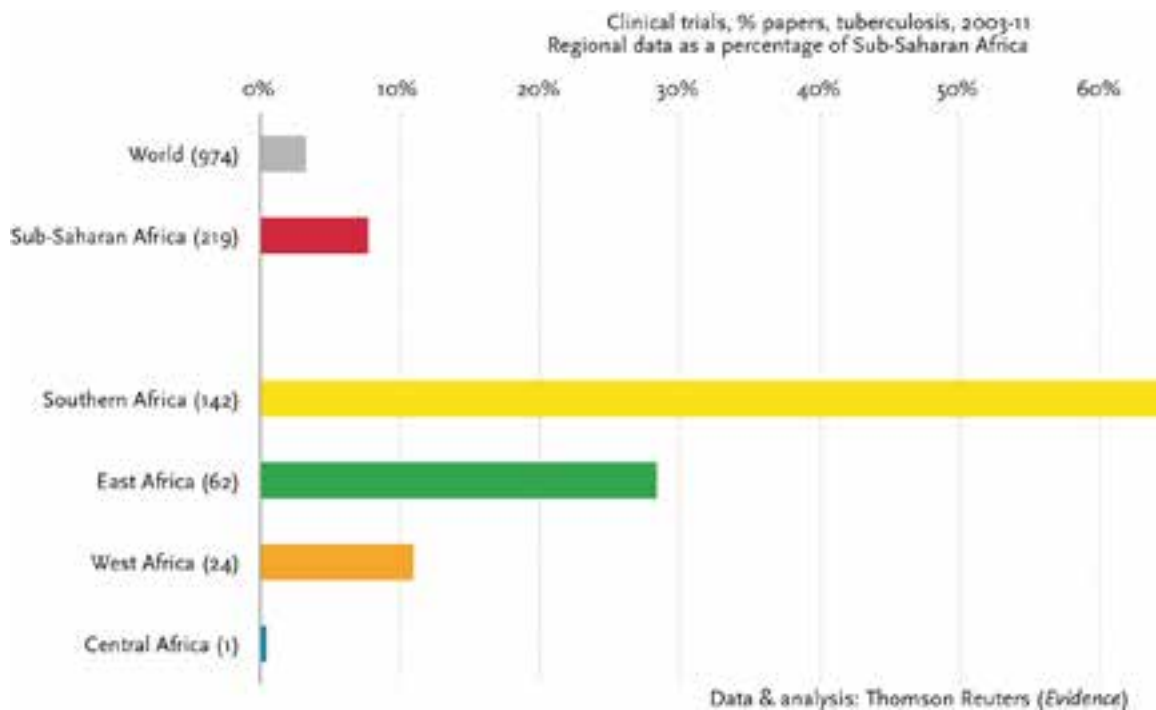


Figure 5.1.3 Clinical trials research, tuberculosis, sub-Saharan Africa and world

Table 5.1.1 Institutions involved in sub-Saharan African clinical trials research, tuberculosis

Institution	Country	Papers (N)	Citation impact
University of Cape Town	ZAF	64	4.36
London School of Hygiene & Tropical Medicine	UK	41	2.23
Stellenbosch University	ZAF	27	3.34
MRC of South Africa	ZAF	21	5.09
Makerere University	UGA	20	2.06

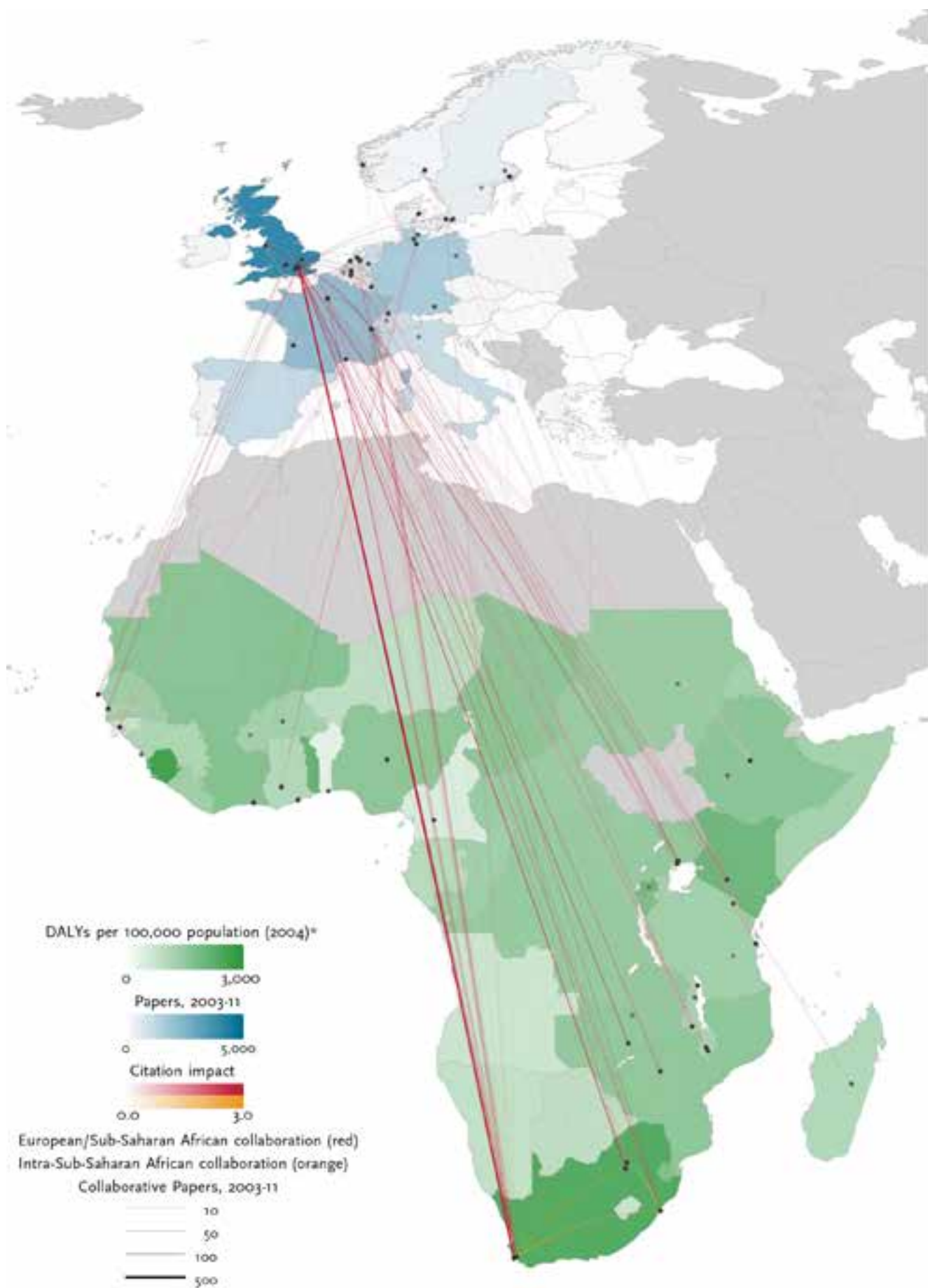


Figure 5.1.4 Disease burden in Sub-Saharan Africa, research output in Europe and their collaborative links in tuberculosis

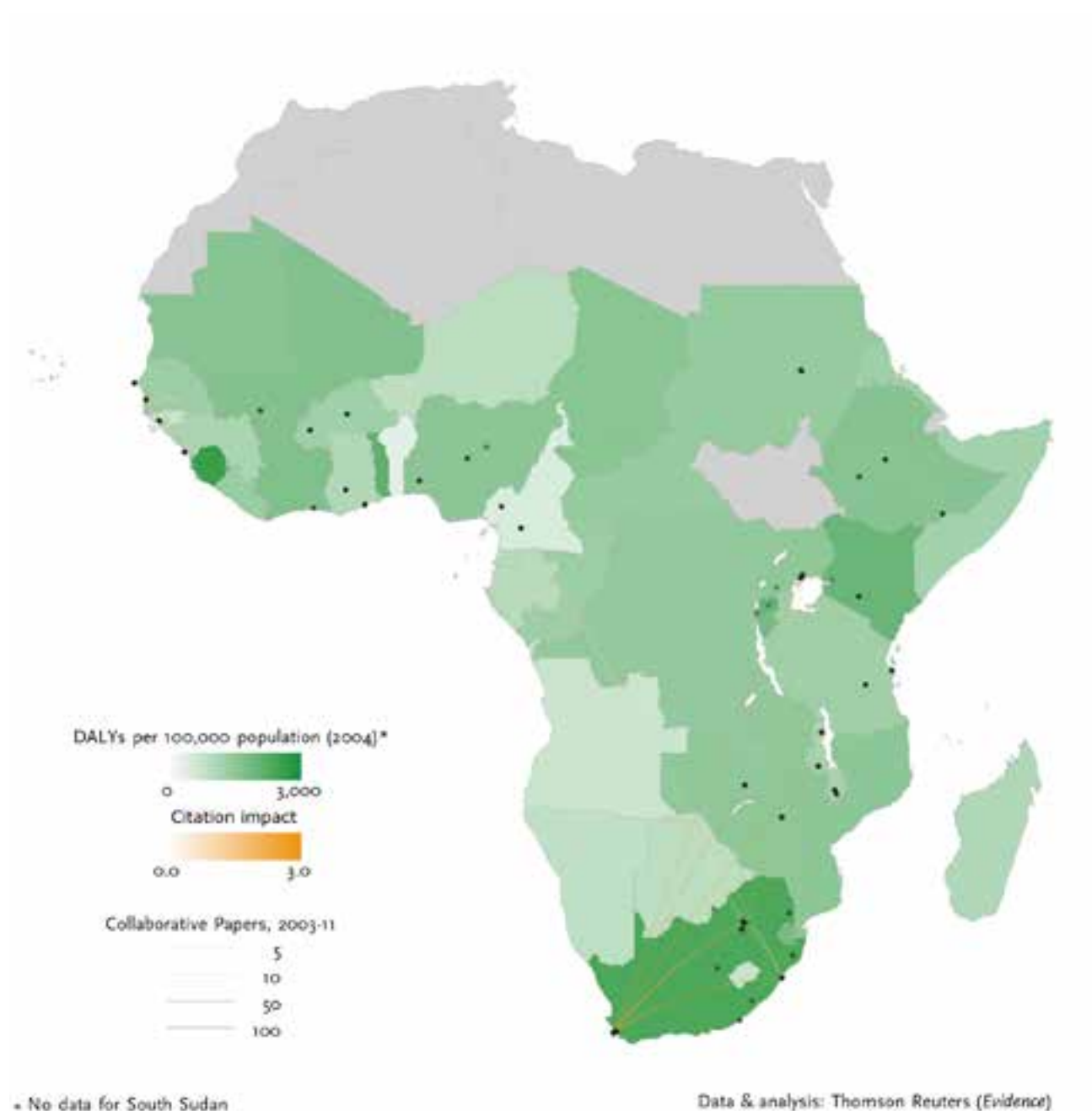


Figure 5.1.5 Disease burden and collaborative research links within Sub-Saharan Africa in tuberculosis

EDCTP-associated funding collaboration

Agencies acknowledged on EDCTP-associated papers across sub-Saharan Africa in tuberculosis research include: in Europe, the European Commission (31 papers), the UK MRC (14 papers), the Wellcome Trust (11 papers); in Africa, the MRC of South Africa (17 papers) and the South African National Research Foundation (17 papers); worldwide, the US National Institutes of Health (23

papers) and the Canadian Institutes of Health Research (11 papers).

EDCTP-associated funding collaboration

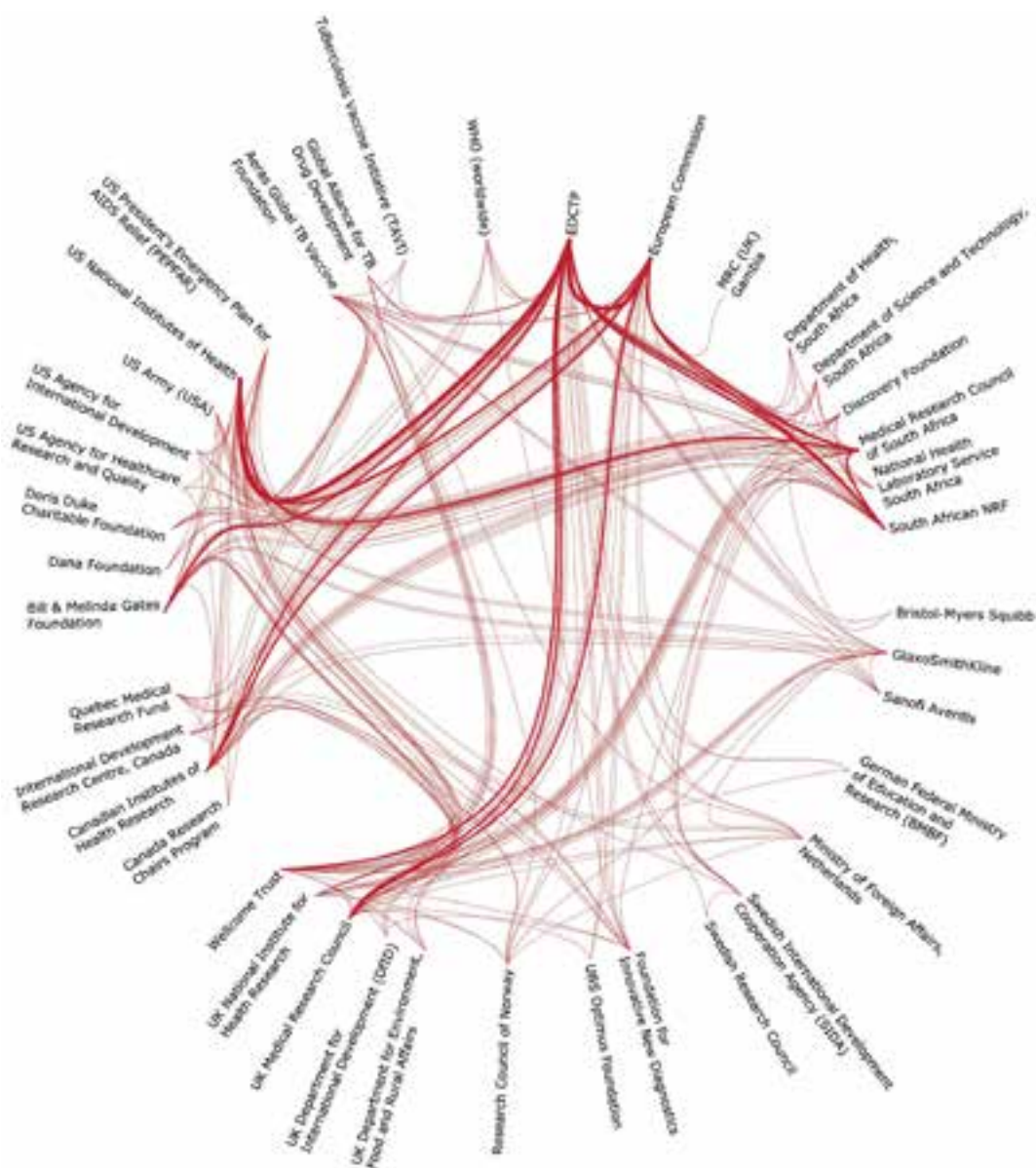


Figure 5.1.6 Collaboration between EDCTP-associated papers and other funding agencies, tuberculosis, sub-Saharan Africa (2008-11)

A line between two funding agencies represents at least one paper, thicker lines represent more co-funded papers.

5.2. European research in tuberculosis

European countries produce well over a third of global research output in tuberculosis (37.1%)

and this research is relatively highly cited (average citation impact 1.31). Collaboration between Europe and sub-Saharan Africa is increasing: there has been a shift in the latter part of the last decade, driven by multidisciplinary HIV/AIDS

and tuberculosis research which tends to be very well-cited – the average citation impact is over twice the global average (2.11) in the most recent five-year period. Worldwide, 14.8% of tuberculosis research relates to HIV/AIDS. Consequently, there are similarities between the key findings of this section of the report, and section 4 on HIV/AIDS due to the overlap between the research agendas (section 3.6).

EDCTP Member Countries have increased the volume of their tuberculosis research, but the growth rate has been lower than global average, so share has fallen from around two-fifths of global research output to 36.1% in the most recent five-year period, 2007-11 (section 5.3). Whilst EDCTP Prospective Member Countries have increased their research output, it is small in volume and there are no institutions with substantial links to sub-Saharan Africa in tuberculosis research (section 5.5).

Collaborative research between Europe and sub-Saharan Africa has increased rapidly in recent years. An analysis of the PubMed Medical Subject Headings (MeSH Headings) suggests that more tuberculosis research was concerned with HIV Infections and AIDS-related opportunistic infections than earlier in the decade. Collaboration between Europe and sub-Saharan Africa has nearly doubled and citation impact has improved.

The key findings by country (section 5.4 and section 5.5) are:

- The UK published the largest volume of tuberculosis research in Europe (4,068 papers) and it is the most collaborative country with sub-Saharan Africa in Europe. This tuberculosis research is highly-cited (average citation impact 1.61) and highly collaborative accounting for around one-fifth of the UK's tuberculosis research. The leading UK institutions working with sub-Saharan Africa are the London School of Hygiene & Tropical Medicine, Imperial College London,

University College London and the University of Liverpool.

- France produced the second largest volume of research in tuberculosis: it is also the second most collaborative country with sub-Saharan Africa in Europe although less of its research output is collaborative with sub-Saharan Africa compared to the UK (11.8%). French institutions working in sub-Saharan Africa include Institut Pasteur, but also the International Union against Tuberculosis & Lung Disease, which is an international organisation based in Paris.²⁹
- Swiss tuberculosis research is highly-cited, partly because of the WHO (104 papers)³⁰ but also because of the Swiss Tropical & Public Health Institute and the Foundation for Innovative New Diagnostics.
- Highly-collaborative research countries include the Netherlands, Belgium and a Scandinavian group (Sweden, Denmark and Norway). Around 20% or more of their research is collaborative with sub-Saharan Africa. Of this group, the Netherlands is by far the largest with the Royal Netherlands tuberculosis Association and UMC Amsterdam active in sub-Saharan Africa. The Institute of Tropical Medicine, Antwerp, is a major collaborating partner. Danish research in tuberculosis is very highly-cited (average citation impact 2.02) and its collaborative research with sub-Saharan Africa even more so (average citation impact 2.74). This is primarily due to the Statens Serum Institut and University Hospitals, Copenhagen.

²⁹ The Union accounts for 10.8% of the tuberculosis research of France; it accounts for 38.6% of the research which is collaborative with sub-Saharan Africa.

³⁰ The WHO accounts for 33.1% of the tuberculosis research of Switzerland; it accounts for 46.4% of the research which is collaborative with sub-Saharan Africa.

5.3. European research trends

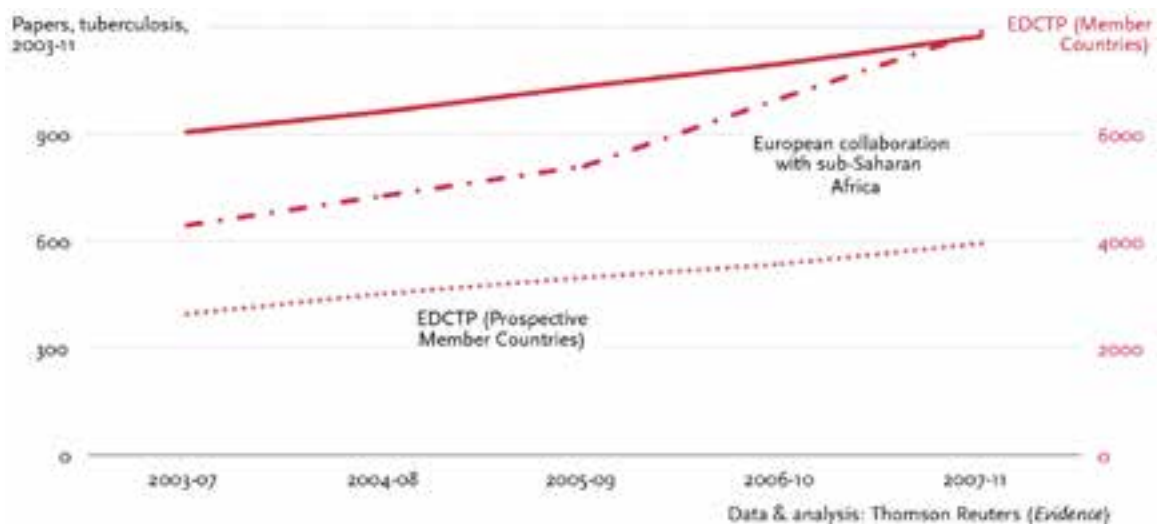


Figure 5.3.1 Trends in tuberculosis research output in Europe

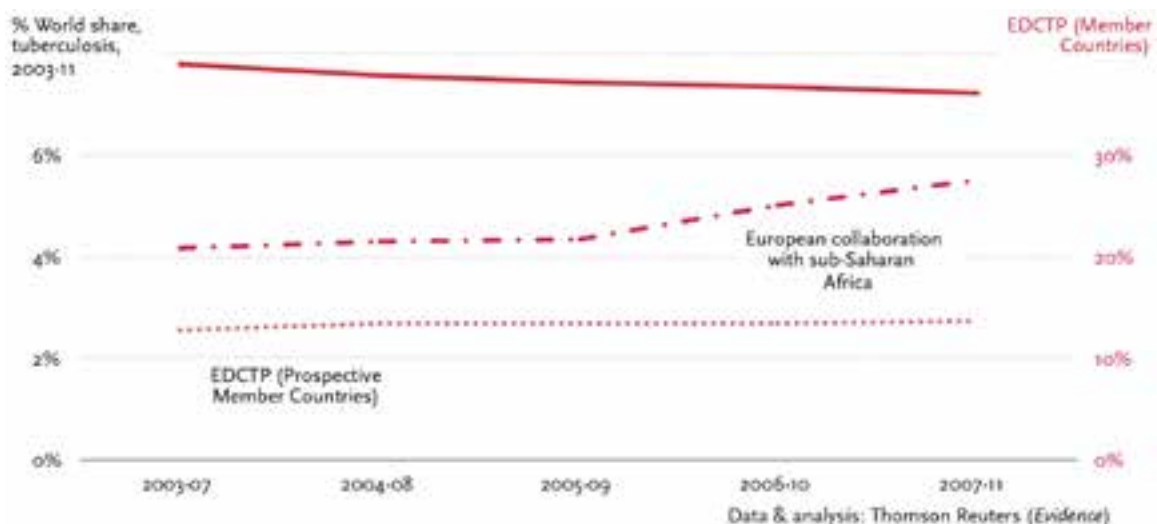


Figure 5.3.2 Trends in world share of tuberculosis research, Europe

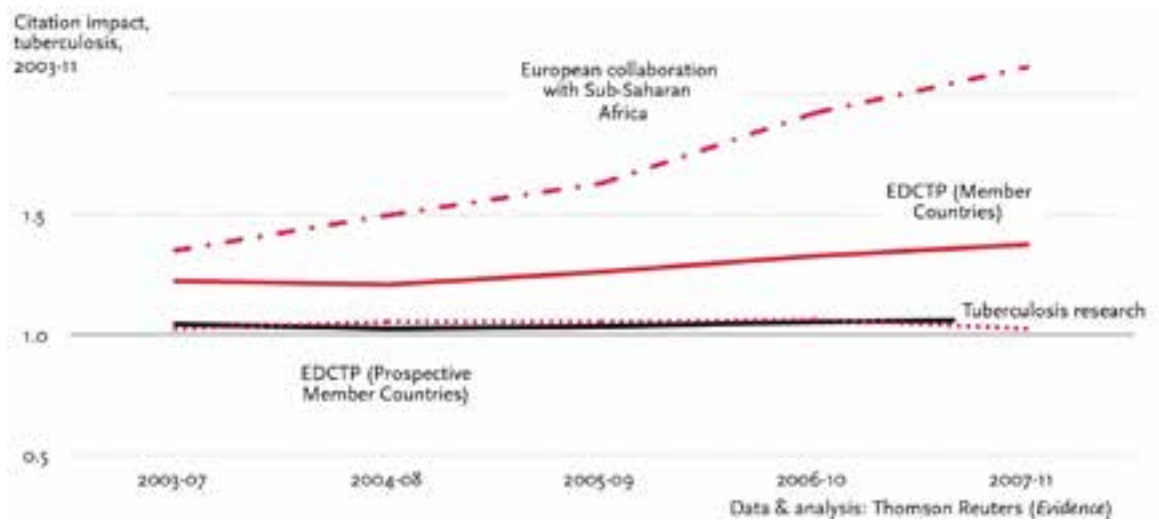


Figure 5.3.3 Trends in citation impact of tuberculosis research, Europe

5.4. EDCTP Member Countries

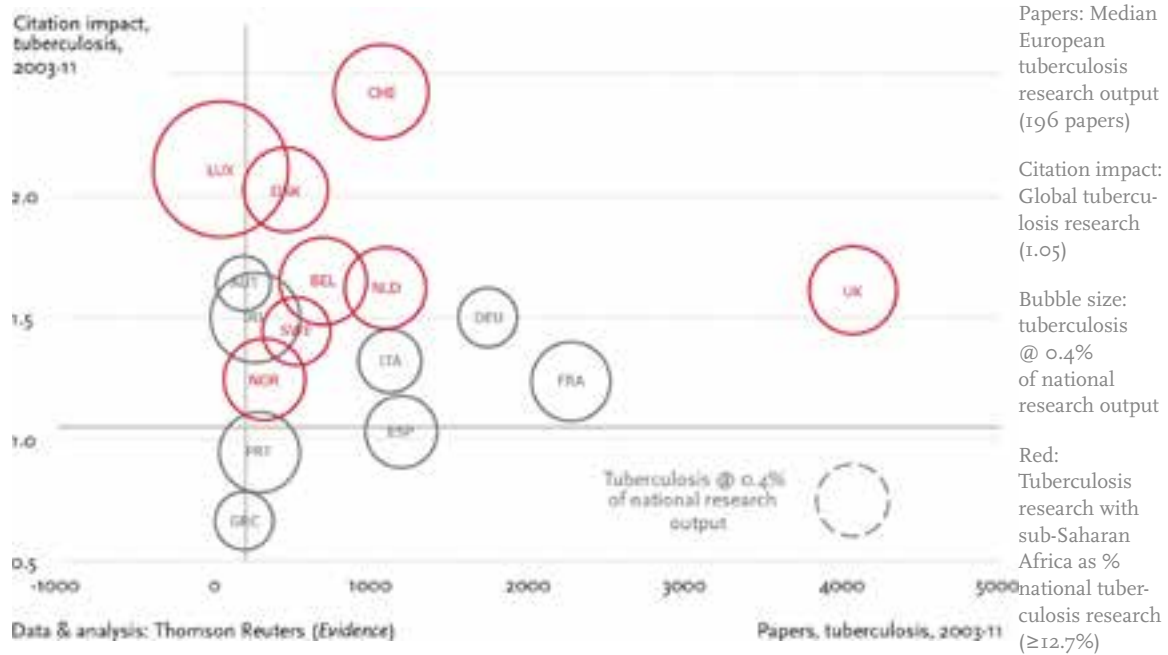


Figure 5.4.1 Country quadrant for tuberculosis research in EDCTP Member Countries

Table 5.4.1 Country data for tuberculosis research in EDCTP Member Countries

UN Short Code	National tuberculosis research			Collaborative tuberculosis research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
AUT	187	1.64	0.2%	10	6.48	5.3%
BEL	697	1.65	0.5%	177	1.56	25.4%
CHE	1,063	2.42	0.6%	224	3.63	21.1%
DEU	1,744	1.50	0.2%	116	2.97	6.7%
DNK	454	2.02	0.5%	88	2.74	19.4%
ESP	1,189	1.04	0.4%	31	2.58	2.6%
FRA	2,270	1.24	0.4%	267	1.80	11.8%
GRC	189	0.67	0.2%	4	1.48	2.1%
IRL	257	1.50	0.5%	18	1.16	7.0%
ITA	1,118	1.32	0.3%	67	2.29	6.0%
LUX	37	2.11	1.2%	28	2.20	75.7%
NLD	1,092	1.62	0.5%	222	1.96	20.3%
NOR	321	1.24	0.5%	105	1.36	32.7%
PRT	284	0.95	0.4%	7	1.58	2.5%
SWE	521	1.45	0.3%	101	1.64	19.4%
UK	4,068	1.61	0.5%	809	2.19	19.9%

Table 5.4.2 Institutions in Europe collaborating on tuberculosis research with sub-Saharan Africa

Institution	Country	Papers (N)	Citation impact
London School of Hygiene & Tropical Medicine	UK	326	2.38
Imperial College London	UK	123	2.53
University College London	UK	105	3.16
WHO	CHE	104	3.77
Institute of Tropical Medicine Antwerp	BEL	103	1.53
International Union Against Tuberculosis and Lung Disease	FRA	103	2.18
University of Liverpool	UK	102	1.50
University of Oxford	UK	68	2.36
Royal Netherlands Tuberculosis Association	NLD	63	1.22
UMC Amsterdam	NLD	57	2.37
Institut Pasteur	FRA	52	1.79
MRC National Institute for Medical Research	UK	49	3.09
University of Bergen	NOR	46	1.48
Karolinska Institutet	SWE	45	1.18
Statens Serum Institut	DNK	43	2.76
Swiss Tropical & Public Health Institute, Basel	CHE	43	1.85
University of Antwerp	BEL	39	1.65

National Institute for Public Health and the Environment	NLD	37	2.72
University Hospitals, Copenhagen	DNK	29	3.31
Foundation for Innovative New Diagnostics	CHE	26	7.79
Medecins Sans Frontieres	LUX	26	2.32
Research Center Borstel	DEU	26	6.06
UMC Radboud Nijmegen	NLD	26	1.17
Norwegian School of Veterinary Science	NOR	25	1.29
Medecins Sans Frontieres	BEL	24	1.90
Veterinary Laboratories Agency	UK	24	1.17
University of Oslo	NOR	23	1.94
Swedish Institute for Infectious Disease Control	SWE	22	1.01
University of Cambridge	UK	22	1.25
Karolinska University Hospital	SWE	21	0.72
University Hospital, Aarhus	DNK	20	1.51
University of Copenhagen	DNK	20	1.44

5.5. EDCTP Prospective Member Countries

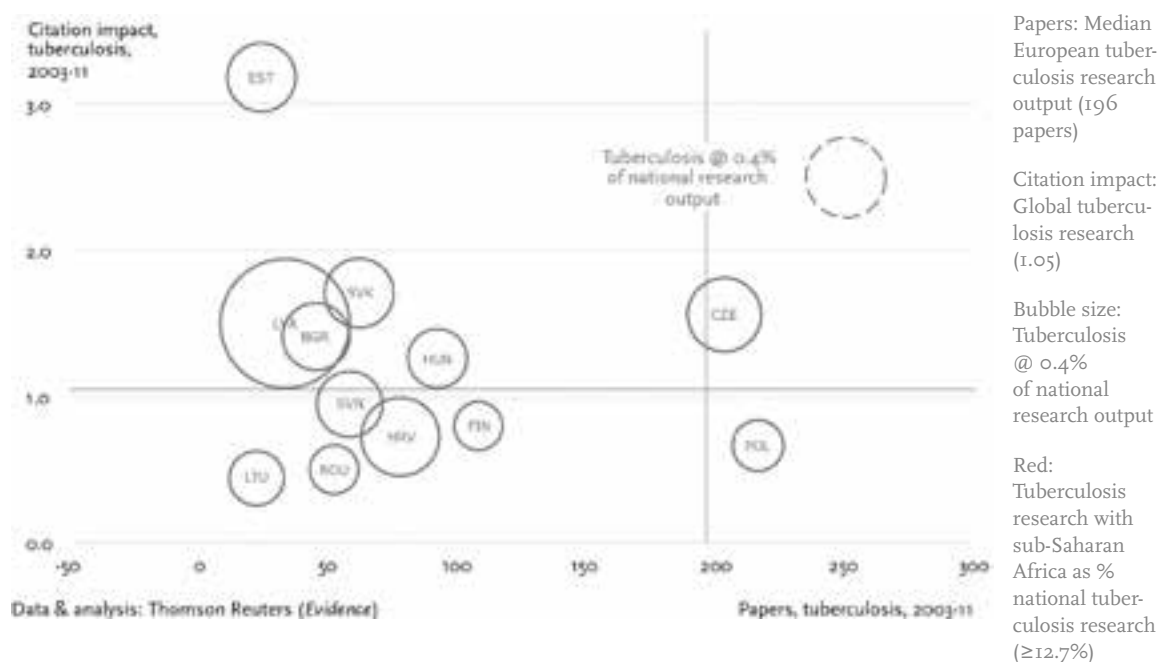


Figure 5.1 Country quadrant for tuberculosis research in EDCTP Prospective Member Countries

Table 5.5.1 Country data for tuberculosis research in EDCTP Prospective Member Countries

UN Short Code	National tuberculosis research			Collaborative tuberculosis research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
BGR	45	1.41	0.3%	0	0.00	0.0%
CYP	1	1.07	0.0%	0	0.00	0.0%
CZE	203	1.56	0.3%	5	3.60	2.5%
EST	24	3.18	0.3%	0	0.00	0.0%
FIN	108	0.80	0.1%	10	1.61	9.3%
HRV	78	0.73	0.3%	2	2.08	2.6%
HUN	92	1.26	0.2%	2	9.78	2.2%
LTU	22	0.45	0.2%	1	1.20	4.5%
LVA	33	1.50	0.9%	8	2.61	24.2%
MLT	1	1.72	0.1%	1	1.72	100.0%
POL	216	0.66	0.1%	3	5.33	1.4%
ROU	52	0.50	0.1%	1	3.71	1.9%
SVK	62	1.71	0.3%	0	0.00	0.0%
SVN	58	0.96	0.2%	0	0.00	0.0%

No institution from these countries has 20 or more collaborative papers with sub-Saharan Africa in tuberculosis research. No data are displayed.

not well-cited with an average citation impact below the global average at 0.86.

Southern Africa

The burden of tuberculosis in South Africa relates to research output in this disease as this country published the major part of the research output of Southern Africa (80.7%) and in turn, sub-Saharan Africa (50.6%).

5.6. Sub-Saharan African research in tuberculosis

Tuberculosis research from sub-Saharan Africa has doubled from 1,235 papers in 2003-07 to 2,235 papers in 2007-11. Its share of global research output has risen to 10.3% by 2007-11 (section 5.7). The average citation impact of this research has increased from 1.18 (2003-07) to 1.67 (2007-11), but the citation impact of research that is collaborative between sub-Saharan Africa and Europe is higher still.

Southern Africa (1,978 papers) is the most active region in sub-Saharan Africa followed by East Africa (738 papers). Tuberculosis research from both regions is highly-cited. The research output of West Africa and Central Africa in tuberculosis research is considerably smaller and, in the case of Central Africa is

- South African tuberculosis research is very highly-cited (average citation impact 1.95) and the citation impact of tuberculosis research collaborative with Europe is higher still (average citation impact 2.74). The University of Cape Town and Stellenbosch University are the most frequent collaborating partners of European research institutions, with the MRC of South Africa to a lesser extent. The citation impact of University of Cape Town's 313 collaborative research papers with European partners at 3.59 is exceptional.
- In Malawi, collaborative research with Europe in tuberculosis accounted for 74.3% of its total national research output in this disease area, and tuberculosis research accounted for 11.3% of its national research

output overall. It is very highly-cited (average citation impact 1.60). Much of this is published by the Community Health Sciences Unit of the Ministry of Health, Malawi which manages the National Tuberculosis Control Programme.

- In Zambia, 70.9% of its tuberculosis research is collaborative with Europe, and the citation impact of this research is 2.21. The main links are through the University of Zambia and the Zambia AIDS Related Tuberculosis project with the London School of Hygiene & Tropical Medicine.
- In Zimbabwe, 61.5% of its research output in tuberculosis is collaborative with Europe. Botswana's output is small (31 papers) but citation impact is high (average citation impact 3.12) through BOTUSA (Botswana-USA Partnership). Swaziland has the second highest burden of tuberculosis in Southern Africa (1,823 per 100,000 population) but only 3 papers have been published.

The US National Institutes of Health and the Wellcome Trust have been the most significant funding agencies in tuberculosis research in Southern Africa. The South African National Research Foundation and the MRC of South Africa are important funding agencies within Southern Africa.

The European Commission and EDCTP are within the top 10 research funding agencies in tuberculosis research, and EDCTP-associated research is the most highly-cited (average citation impact 5.63) within this group. Both agencies are associated with these papers relating to HIV/AIDS and tuberculosis co-infection.^{31, 32}

East Africa

Tuberculosis disease burden is very high in this region in terms of absolute DALYs, but

research output is lower than in Southern Africa (738 papers). The citation impact of this research is below the average for sub-Saharan Africa (1.42).

- The burden of tuberculosis in Rwanda and Kenya is very high (over 2,000 DALYs per 100,000 population). Research from Kenya is very highly-cited (average citation impact 2.11) and much of this is due to KEMRI. In Rwanda, research output is low (23 papers) and there are no major links to European organisations conducting tuberculosis research.
- In Ethiopia, the absolute burden of DALYs lost to tuberculosis is very high (1,255,720). Three quarters of its research is collaborative with Europe but citation impact (average citation impact 0.87) is below the global average. Collaborative links with Europe are through the Armauer Hansen Research Institute and Addis Ababa University.
- Uganda has been the largest producer of tuberculosis research in the East African region (248 papers). The citation impact of this research is high as is the citation impact of collaborative research (average citation impact 1.78 and 2.28 respectively). There is sizable collaboration between Makerere University, the Institute of Tropical Medicine and the University of Antwerp.
- Tanzania published 151 papers in tuberculosis research. Three quarters of its research is collaborative with Europe for which the National Institute for Medical Research, Tanzania is the most frequent collaborating partner. Collaboration with the University of Copenhagen and Associated Hospitals is significant.

The most prominent of a small number of funding agencies in tuberculosis research in East Africa are the US National Institutes of Health and the Wellcome Trust.

³¹ Boehme, CC et al. (2011) Feasibility, diagnostic accuracy, and effectiveness of decentralised use of the Xpert MTB/RIF test for diagnosis of tuberculosis and multidrug resistance: a multicentre implementation study. *Lancet*, 377: 1495-1505

³² Wallis, RS et al. (2010) Tuberculosis 4 Biomarkers and diagnostics for tuberculosis: progress, needs, and translation into practice. *Lancet*, 375: 1920-1937

West Africa

Tuberculosis research output in this region (481 papers) is smaller than in Southern Africa or East Africa. This does not reflect the high burden of disease in Sierra Leone, Togo, Mali or Mauritania, nor the scale of DALYs lost to tuberculosis in Nigeria.

- Nigeria is the largest research producer (132 papers) in the region but citation impact of this research is below the global average (0.54) and collaboration with Europe is a smaller percentage of its national research output in tuberculosis compared to other countries in West Africa.
- For these other countries, most research output is collaborative with Europe and is highly-cited relative to the global average for tuberculosis research. The Gambia (113 papers) has high citation impact (1.78) which can be attributed to the MRC Unit, The Gambia. In Côte d'Ivoire, the citation impact of collaborative research (2.14) is due to collaboration with both France and Switzerland.
- In Guinea-Bissau, tuberculosis research accounted for nearly a quarter of total national research output, almost all of which is collaborative with Europe. The table features institutional data but at the core of this research is a collaboration via the INDEPTH Network, Statens Serum Institut (Denmark), and the Bandim Health Project.

There are fewer funding agencies in tuberculosis research in West Africa compared to Southern Africa, of which the European Commission and the US National Institutes of Health are the most prominent, though paper numbers are relatively low (just over 20).

Central Africa

For the 2003-11 period, there were 109 tuberculosis research papers published in Central Africa and the citation impact of this research is below the global average (0.86). In Chad, the Democratic Republic of Congo and the Central African Republic, the burden is higher (circa 1,500 DALYs per 100,000 population) but none of these countries publish much research. Cameroon has published 53 papers, cited on average less than the global average (citation impact 0.84) no institutions have strong collaboration with European partners in tuberculosis research (section 5.11).

No funding agencies have funded 10 or more papers in tuberculosis research in Central Africa between 2008 and 2011.

5.7. Sub-Saharan African research trends

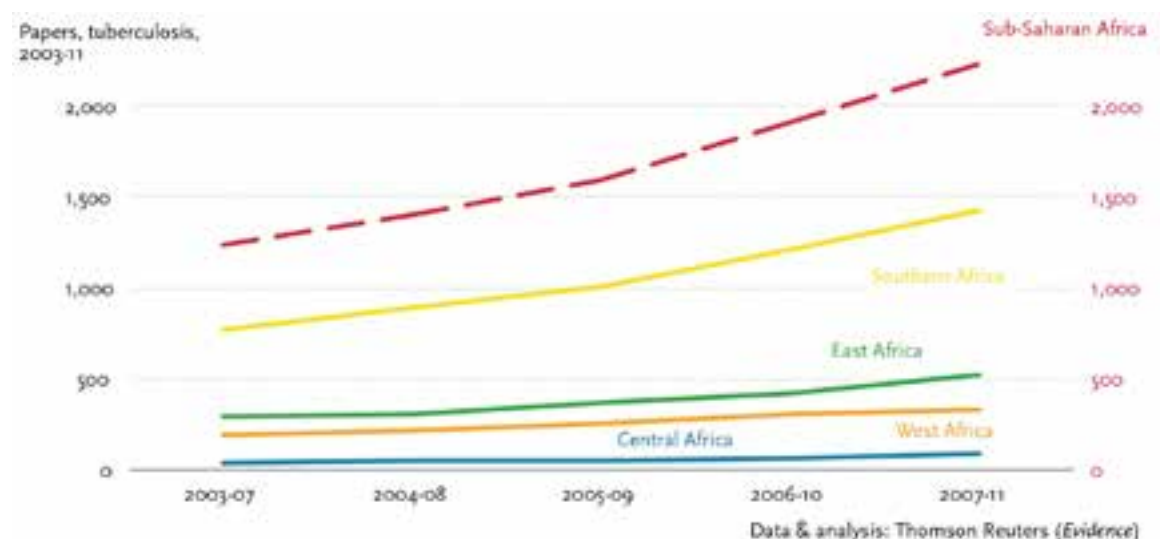


Figure 5.7.1 Trends in tuberculosis research output in sub-Saharan Africa

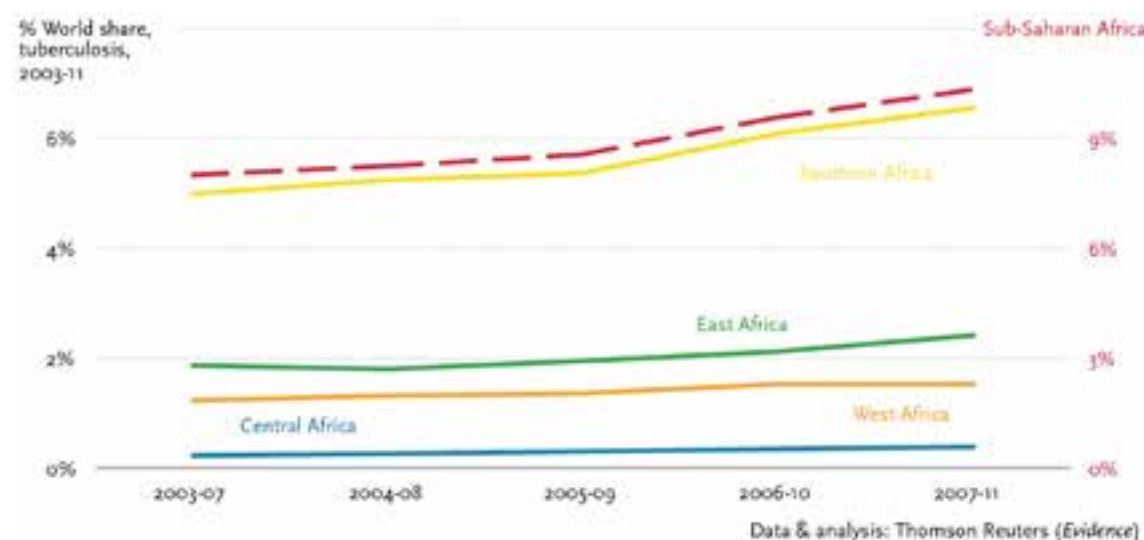


Figure 5.7.2 Trends in world share of tuberculosis research, sub-Saharan Africa

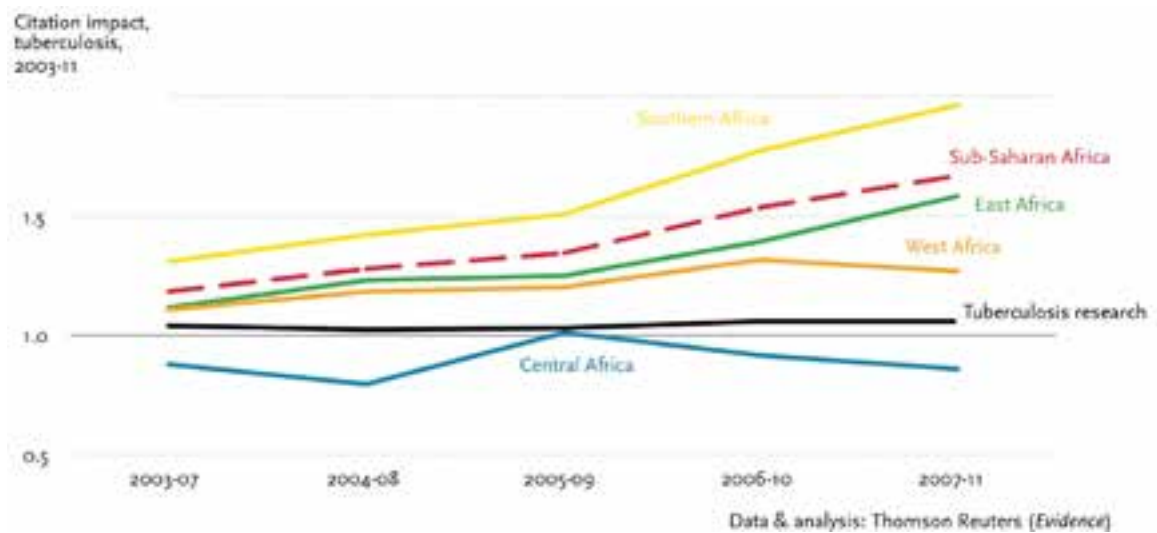


Figure 5.7.3 Trends in citation impact of tuberculosis research, sub-Saharan Africa

5.8. Southern Africa

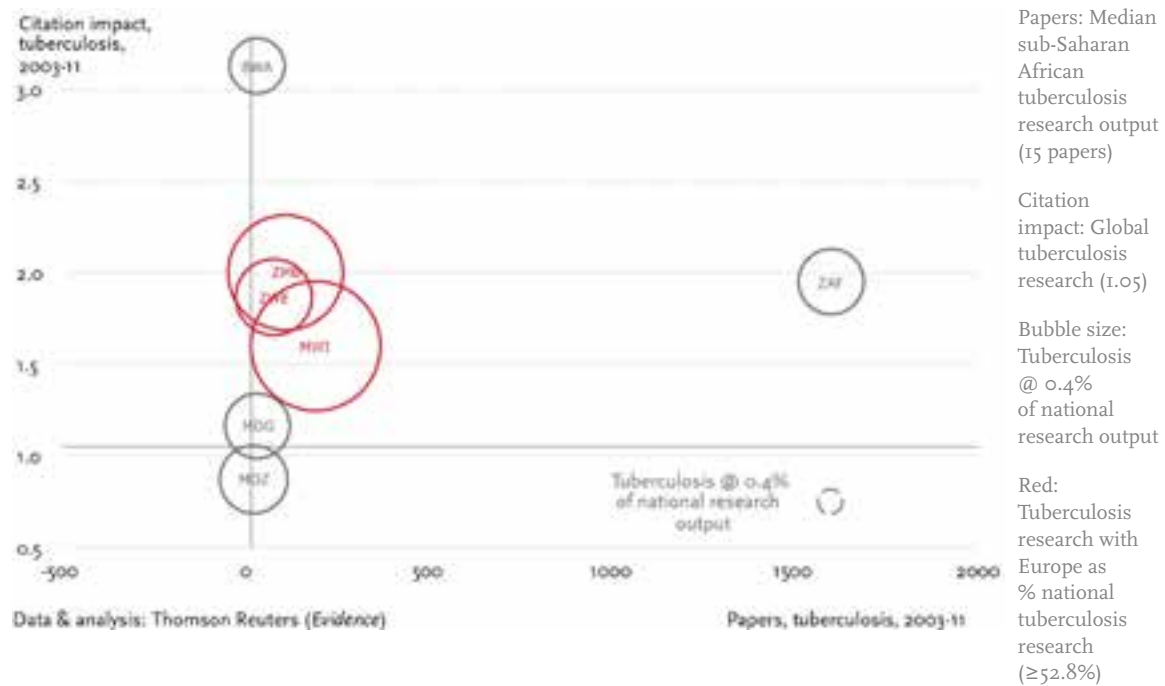


Figure 5.8.1 Country quadrant for tuberculosis research in Southern Africa

Table 5.8.1 Country data for tuberculosis research in Southern Africa

UN Short Code	National tuberculosis research			Collaborative tuberculosis research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
BWA	31	3.12	2.0%	4	2.18	12.9%
COM	0	0.00	0.0%	0	0.00	0.0%
LSO	4	1.19	3.0%	3	1.01	75.0%
MDG	34	1.17	2.8%	16	2.21	47.1%
MOZ	23	0.88	3.1%	15	0.28	65.2%
MUS	0	0.00	0.0%	0	0.00	0.0%
MWI	191	1.60	11.3%	142	1.53	74.3%
NAM	5	1.72	0.8%	1	1.44	20.0%
SWZ	3	1.12	1.3%	2	0.59	66.7%
SYC	0	0.00	0.0%	0	0.00	0.0%
ZAF	1,597	1.95	2.9%	715	2.74	44.8%
ZMB	110	2.00	8.9%	78	2.21	70.9%
ZWE	78	1.87	3.9%	48	1.67	61.5%

Table 5.8.2 Institutions in Southern Africa collaborating on tuberculosis research with Europe

Institution	Country	Papers (N)	Citation impact
University of Cape Town	ZAF	313	3.59
Stellenbosch University	ZAF	215	2.91
MRC of South Africa	ZAF	88	2.98
University of Witwatersrand	ZAF	71	2.20
Ministry of Health	MWI	63	1.04
University of KwaZulu-Natal	ZAF	62	1.85
University of Pretoria	ZAF	51	1.16
University of Zambia	ZMB	50	2.67
Aurum Institute for Health Research	ZAF	42	3.71
National Health Laboratory Service South Africa	ZAF	38	3.02
Groote Schuur Hospital, Cape Town	ZAF	36	4.06
Karonga Prevention Study	MWI	31	1.43
University of Malawi	MWI	28	1.20
University of Zimbabwe	ZWE	28	1.79
Malawi-Liverpool-Wellcome Trust Clinical Research Programme	MWI	23	1.96
GF Jooste Hospital, Cape Town	ZAF	22	2.28
Ministry of Health	ZAF	21	3.23
University Teaching Hospital, Lusaka	ZMB	20	2.49

Table 5.8.3 Agencies funding Southern African tuberculosis research, 2008-11

Institution	Region	Papers (N)	Citation impact
US National Institutes of Health	ROW	201	3.04
Wellcome Trust	EUR	165	3.18
South African National Research Foundation	AFR	109	1.71
MRC of South Africa	AFR	87	2.65
European Commission	EUR	81	3.67
Bill & Melinda Gates Foundation	ROW	62	5.10
European & Developing Countries Clinical Trials Partnership	EUR	51	5.63
US Agency for International Development	ROW	45	3.25
US President's Emergency Plan for AIDS Relief	ROW	40	2.94
UK MRC	EUR	36	4.12
Canadian Institutes of Health Research	ROW	26	4.34
Stellenbosch University	AFR	26	1.57
UK DfID	EUR	26	2.79
Aeras Global TB Vaccine Foundation	NGO	25	4.26
Doris Duke Charitable Foundation	ROW	25	3.36
Department of Science and Technology, South Africa	AFR	23	3.31
US Centers for Disease Control and Prevention	ROW	23	2.09
University of Cape Town	AFR	22	2.02
Foundation for Innovative New Diagnostics	EUR	21	5.96
WHO	IGO	19	3.40
Bristol-Myers Squibb	COR	16	5.49
Howard Hughes Medical Institute	ROW	15	1.71
Department of Health, South Africa	AFR	14	1.69
Gilead Sciences	COR	14	5.21
University of KwaZulu-Natal	AFR	14	0.72
GlaxoSmithKline	COR	13	9.22
Government of South Africa	AFR	13	1.70
National Health Laboratory Service South Africa	AFR	12	1.57
UK Department of Health	EUR	12	1.56
US Department of Health and Human Services	ROW	11	0.86
International Development Research Centre, Canada	ROW	10	1.50
Irene Diamond Fund	ROW	10	2.18
Swiss National Science Foundation	EUR	10	0.60

5.9. East Africa

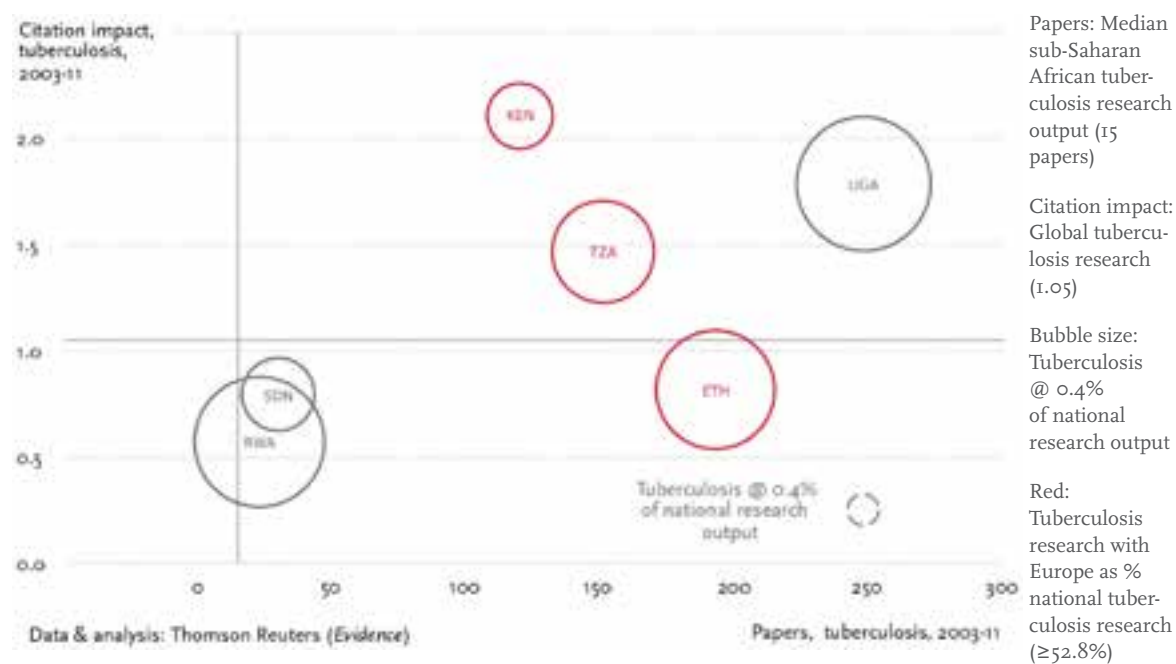


Figure 5.9.1 Country quadrant for tuberculosis research in East Africa

Table 5.9.1 Country data for tuberculosis research in East Africa

UN Short Code	National tuberculosis research			Collaborative tuberculosis research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
BDI	2	0.37	1.9%	2	0.37	100.0%
ERI	4	0.23	2.0%	3	0.30	75.0%
ETH	193	0.81	5.2%	143	0.87	74.1%
KEN	120	2.11	1.6%	71	2.37	59.2%
RWA	23	0.57	6.2%	15	0.71	65.2%
SDN	30	0.79	1.9%	16	1.10	53.3%
SOM	0	0.00	0.0%	0	0.00	0.0%
SSD	1	1.44	1.0%	0	0.00	0.0%
TZA	151	1.47	3.8%	112	1.63	74.2%
UGA	248	1.78	6.6%	126	2.28	50.8%

Table 5.9.2 Institutions in East Africa collaborating on tuberculosis research with Europe

Institution	Country	Papers (N)	Citation impact
Makerere University	UGA	81	2.49
Armauer Hansen Research Institute	ETH	61	1.02
National Institute for Medical Research	TZA	41	1.64
Addis Ababa University	ETH	39	1.03
Ministry of Health	ETH	34	0.78
KEMRI, Nairobi	KEN	31	2.53
Ministry of Health	TZA	24	1.63
MRC Uganda Virus Research Institute	UGA	22	3.10
Ministry of Health	KEN	21	2.13
Ministry of Health	UGA	20	3.76
Muhimbili University of Health and Allied Sciences	TZA	20	1.24

Table 5.9.3 Agencies funding East African tuberculosis research, 2008-11

Institution	Region	Papers (N)	Citation impact
US National Institutes of Health	ROW	87	2.29
Wellcome Trust	EUR	33	3.78
European Commission	EUR	18	1.97
Swedish International Development Cooperation Agency	EUR	15	0.77
US Agency for International Development	ROW	13	2.57
Foundation for Innovative New Diagnostics	EUR	11	7.69
Norwegian Council of Universities	EUR	10	0.82
US Centers for Disease Control and Prevention	ROW	10	1.61

5.10. West Africa

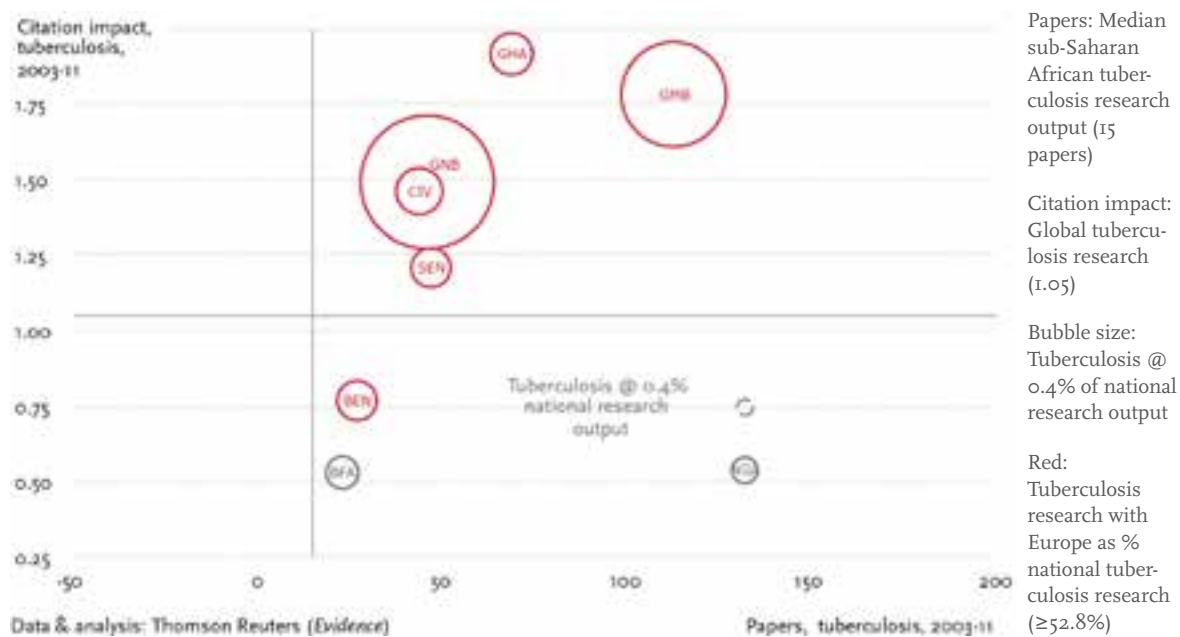


Figure 5.10.1 Country quadrant for tuberculosis research in West Africa

Table 5.10.1 Country data for tuberculosis research in West Africa

UN Short Code	National tuberculosis research			Collaborative tuberculosis research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
BEN	27	0.77	2.2%	26	0.80	96.3%
BFA	23	0.53	1.4%	18	0.64	78.3%
CIV	44	1.46	3.0%	29	2.14	65.9%
CPV	1	0.00	2.4%	0	0.00	0.0%
GHA	69	1.92	2.5%	53	1.86	76.8%
GIN	13	2.17	7.0%	12	2.33	92.3%
GMB	113	1.78	15.2%	73	1.89	64.6%
GNB	46	1.49	24.7%	45	1.51	97.8%
LBR	1	2.91	2.5%	1	2.91	100.0%
MLI	17	1.41	1.9%	9	2.44	52.9%
MRT	1	0.09	0.6%	0	0.00	0.0%

NER	1	0.00	0.2%	1	0.00	100.0%
NGA	132	0.54	0.9%	34	1.01	25.8%
SEN	47	1.21	2.1%	30	1.74	63.8%
SLE	1	0.63	0.9%	1	0.63	100.0%
TGO	5	0.14	1.3%	1	0.00	20.0%

Table 5.10.2 Institutions in West Africa collaborating on tuberculosis research with Europe

Institution	Country	Papers (N)	Citation impact
MRC Unit, The Gambia	GMB	72	1.92
Ministry of Health	GHA	23	1.70
Ministry of Health	BEN	20	0.79

Figure 5.10.3 Agencies funding West African tuberculosis research, 2008-11

Institution	Region	Papers (N)	Citation impact
European Commission	EUR	22	3.65
US National Institutes of Health	ROW	21	2.36
UK MRC	EUR	13	2.77
Wellcome Trust	EUR	12	4.29
Bill & Melinda Gates Foundation	ROW	11	4.20

5.11. Central Africa

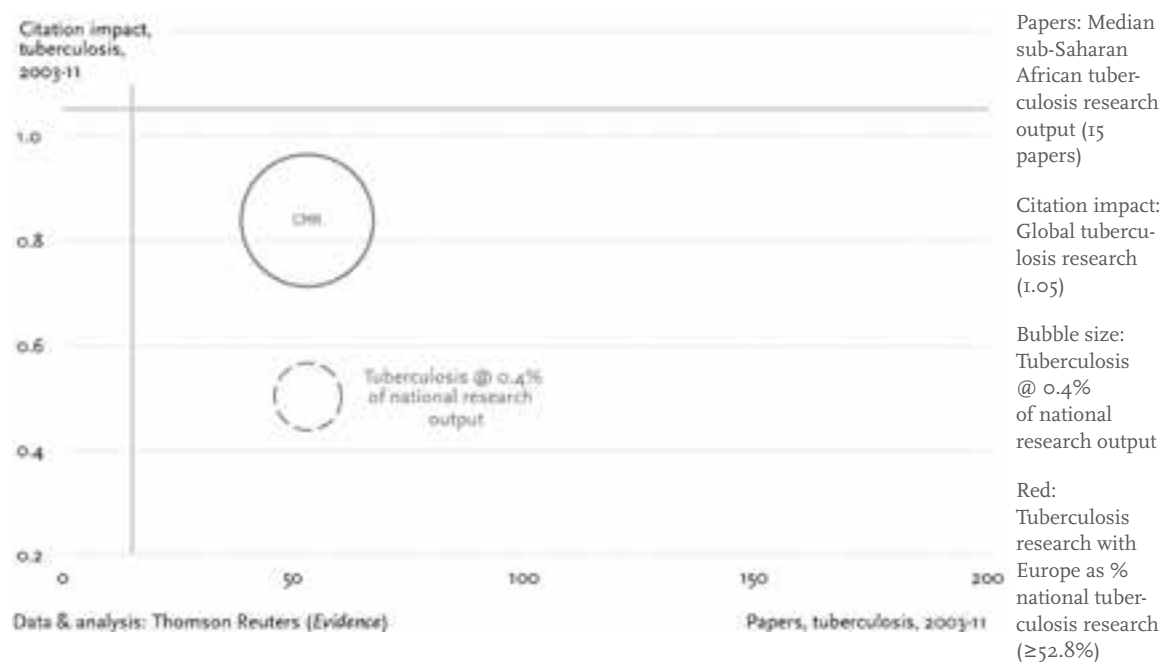


Figure 5.11.1 Country quadrant for tuberculosis research in Central Africa

Table 5.11.1 Country data for tuberculosis research in Central Africa

UN Short Code	National tuberculosis research			Collaborative tuberculosis research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
AGO	3	0.00	1.9%	3	0.00	100.0%
CAF	12	0.75	6.8%	8	1.02	66.7%
CMR	53	0.84	1.4%	27	0.89	50.9%
COD	16	0.93	4.0%	8	1.05	50.0%
COG	6	0.30	0.9%	3	0.10	50.0%
GAB	10	1.41	1.4%	10	1.41	100.0%
GNQ	2	0.45	6.9%	2	0.45	100.0%
STP	0	0.00	0.0%	0	0.00	0.0%
TCD	8	1.26	5.8%	8	1.26	100.0%

No institution from these countries has 20 or more collaborative papers with Europe in tuberculosis research. No data are displayed.

There is no funding agency that has been acknowledged on at least 10 papers between 2008 and 2011.

6. Malaria research

This section of the report provides a comprehensive bibliometric analysis of European and sub-Saharan African research in malaria focusing on research output and citation impact (as an indicator of research quality in the context of disease burden). Country and institutional analyses show where leading collaborative research between Europe and sub-Saharan Africa is being undertaken. From these publication data, the principal agencies funding sub-Saharan African research in malaria have been identified – this is based on research volume not investment. This section also provides analyses showing how much global malaria research is associated with clinical trials and the main research organisations participating in this in sub-Saharan Africa. The network of funding agencies with which EDCTP cooperates is visualised.

6.1. Summary

Globally, around 30,000 papers have been published in malaria research between 2003 and 2011. This is similar to the global research output in tuberculosis.

Over two-fifths of malaria research has been published by European-based researchers in the last decade. In absolute terms, the numbers of European papers published in this disease area has increased since 2003 but the share of global research has dropped due to the rapid growth in the research output of developing economies such as China and Brazil. The citation impact of European research in malaria is, on average, above the global average (1.48 compared to 1.24) and has not changed over this period.

Sub-Saharan African research in malaria has doubled over the last decade. In 2003, the number of malaria research papers published by researchers from sub-Saharan Africa was

similar to that in HIV/AIDS (474 compared to 521) but growth has been less than in HIV/AIDS research, with research output rising to just over 1,000 papers in 2011. However, this represents a larger percentage of global malaria research – in 2011, one-quarter of malaria research papers included a sub-Saharan African author address. The citation impact of sub-Saharan African³³ research in malaria is, on average, similar to European research. Within sub-Saharan Africa, the most research-active regions in malaria are East Africa and West Africa. The citation impact of research from East Africa is high (average 1.72) whereas the citation impact of West African research is below the global average despite growing output. Unlike HIV/AIDS research, there is little correlation between burden of disease and research output in sub-Saharan Africa. For example, Niger has the highest burden of disease and has published just 43 papers in malaria between 2003 and 2011.

Collaboration between Europe and sub-Saharan Africa in malaria research is good.

Collaborative research as a share of global malaria research has not changed over the last decade. 61% of sub-Saharan African research papers have at least one European address. This collaborative research has a citation impact higher than for either Europe or sub-Saharan Africa. The UK is the leading European collaborating partner with sub-Saharan Africa in malaria research and this research is very well-cited by the community. The principal European research organisations collaborating in this research are mostly universities and research institutes, including the London School of Hygiene & Tropical Medicine and universities in Tübingen, Copenhagen and Barcelona. The IRD, a French public science and technology research institute, has published more than 200 papers. Also notable is the Swiss Tropical & Public Health Institute,

³³ NB: Sub-Saharan Africa research will include papers with international co-authors from, not just Europe, but the USA, South America and Asia.

which is one of the most prolific research organisations in malaria research which is very well-cited. In sub-Saharan Africa, the main research organisations are research institutes in both Kenya and Tanzania, the MRC Unit, The Gambia and the University of Bamako in Mali.

Relatively more papers associated with clinical trials and epidemiology in malaria are published in sub-Saharan Africa than globally.

Research associated with clinical trials has a much higher citation impact than global research in malaria (1.93 compared to 1.24, 1,397 papers). Clinical trials research activity in malaria is highest in East and West Africa, which correlates to burden of disease and overall malaria research. The principal institutions conducting clinical trials research include the London School of Hygiene & Tropical Medicine with more than twice as many papers as the top three sub-Saharan African institutions of Makerere University, KEMRI at Kisumu and University of Bamako.

EDCTP is part of the funding network active in malaria research and also cofunds with specialist international agencies. National agencies from the United States, Europe and the UK are most frequently acknowledged in funding text of malaria research papers. In addition to these agencies, and charities such as the Bill & Melinda Gates Foundation and the Wellcome Trust, EDCTP has cofunded malaria research with the Multilateral Initiative on malaria and UNICEF. The corporate sector is active in funding malaria research with more than 25 companies acknowledged on these papers – EDCTP is associated with just two of these, Novartis and Pfizer.

National disease burden and research output, malaria

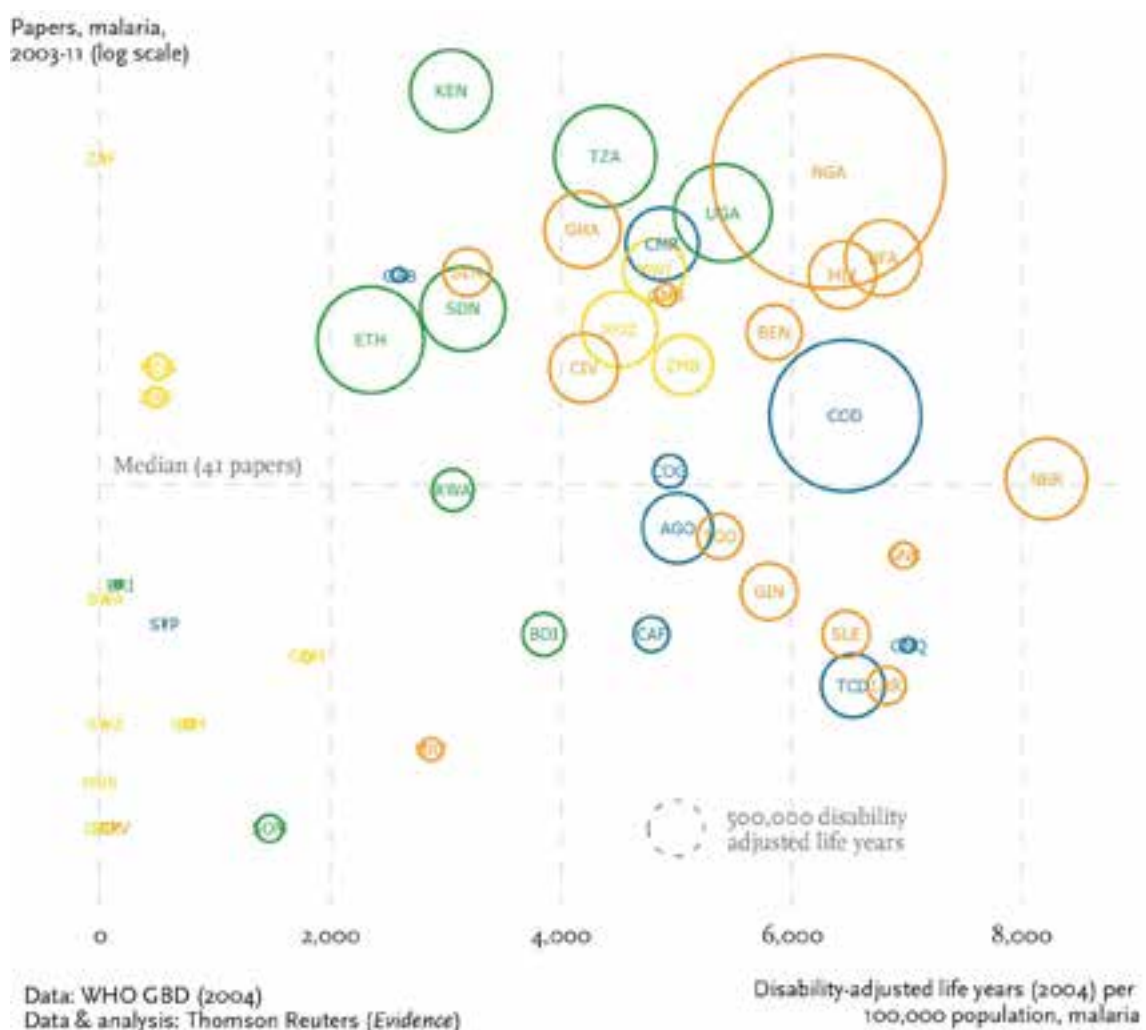


Figure 6.1.1 National disease burden and research output, malaria

EXAMPLE (data for Niger, NER): Bubble size – 1,051,760 DALYs lost to malaria; x-axis – 8,212 DALYs per 100,000 (population = 12,807,900); y-axis – 43 papers published in malaria research.

Clinical trials and epidemiology research

Epidemiology-related research accounted for 17.7% of global malaria research but twice that percentage for sub-Saharan Africa's output (36.1%). Around half of this is conducted in East Africa and just under a third in West Africa. Clinical trials research accounted for 5.4% of global malaria research, but 13.4% of the malaria research conducted in sub-Saharan Africa. However, over 40% of clinical trials research is conducted in East Africa (45.9%) and West Africa (40.8%) and only 10.9% (83 papers) in Central Africa. This research is, however, highly-cited.

The London School of Hygiene & Tropical Medicine is associated with many malaria clinical trials research papers in sub-Saharan Africa (137 papers). Makerere University and KEMRI are active in East Africa. The University of Bamako, the University of Ibadan (and associated University Hospital) and MRC Unit, The Gambia are active in malaria clinical trials research in West Africa. In Central Africa, the Albert Schweitzer Hospital has conducted around half the malaria clinical trials research and its main partners are the University of Tübingen (Eberhard Karl) and Medical University of Vienna. Well-cited papers are footnoted.^{34,35} The latter paper involves researchers from the London School of Hygiene & Tropical Medicine, the University of Oxford, the University of Copenhagen, Kilimanjaro Christian Medical Centre, KEMRI and GlaxoSmithKline.

34 Olotu, A et al. (2011) Efficacy of RTS,S/AS01E malaria vaccine and exploratory analysis on anti-circumsporozoite antibody titres and protection in children aged 5-17 months in Kenya and Tanzania: a randomised controlled trial. *Lancet Infectious Diseases*, 11: 102-109

35 Bejon, P et al. (2008) Efficacy of RTS,S/AS01E Vaccine against Malaria in Children 5 to 17 Months of Age. *New England Journal of Medicine*, 359: 2521-2532

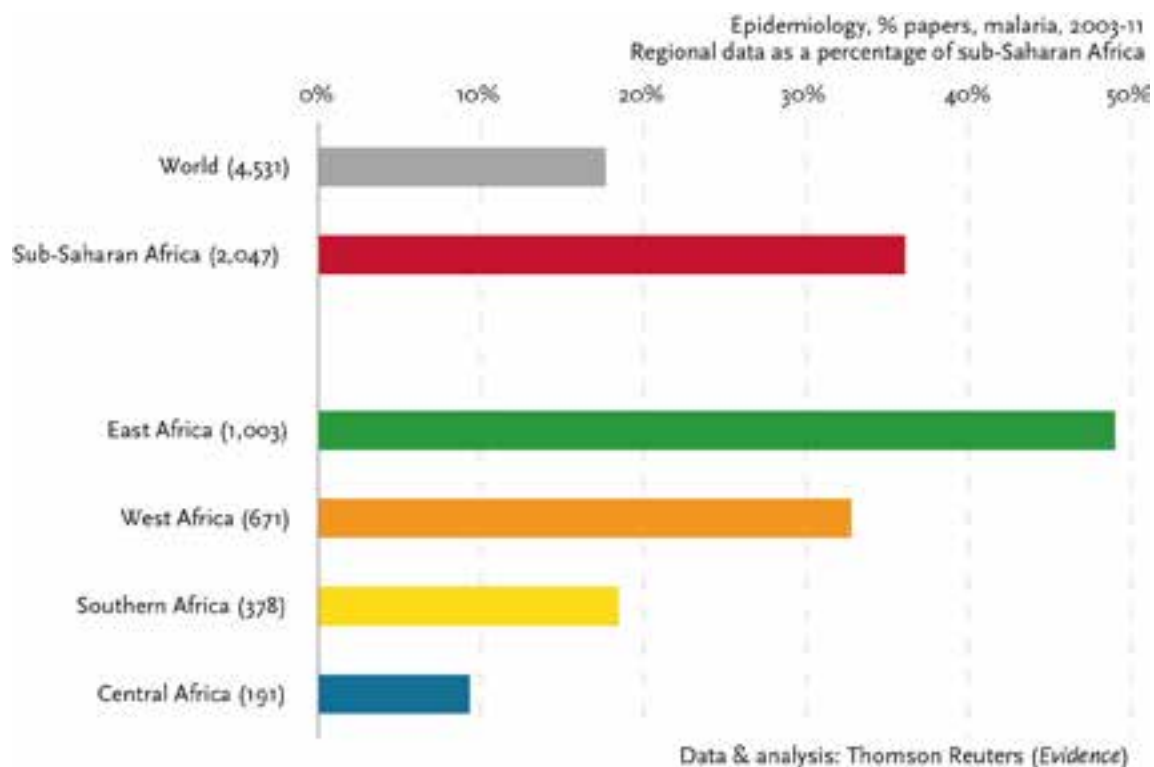


Figure 6.1.2 Epidemiology research, malaria, sub-Saharan Africa and world

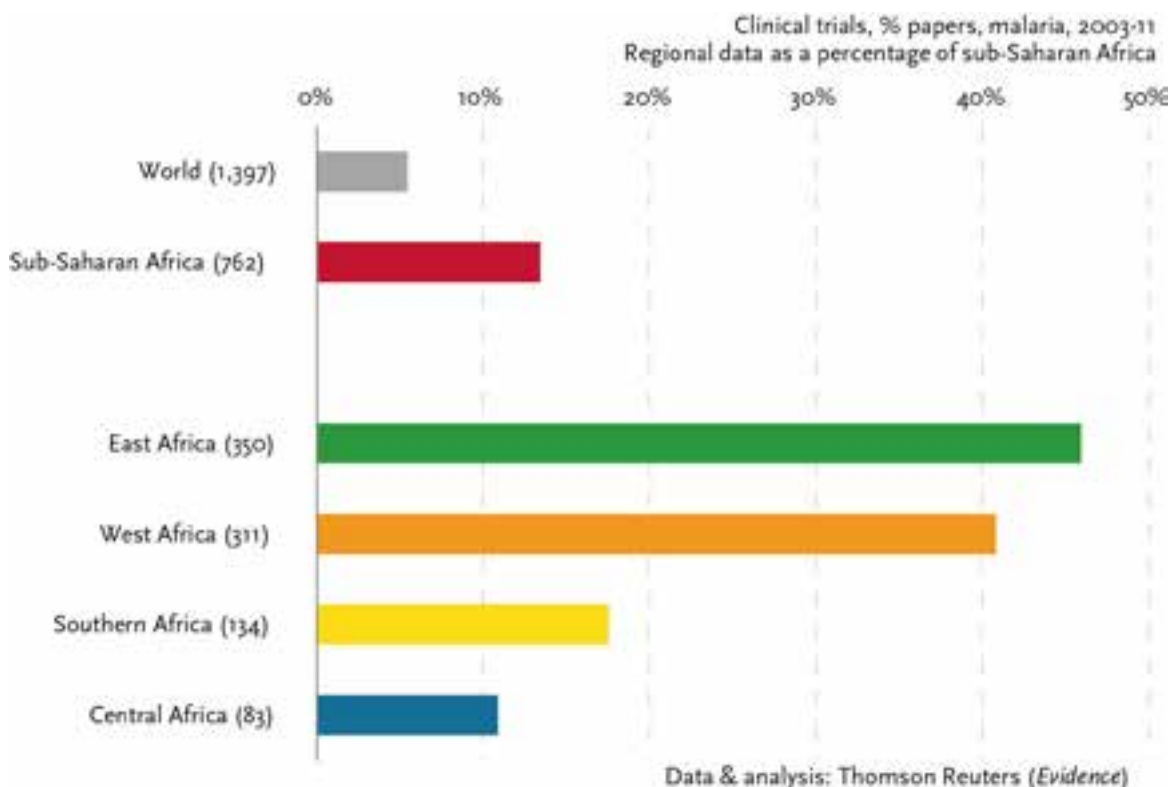


Figure 6.1.3 Clinical trials research, malaria, sub-Saharan Africa and world

Table 6.1.1 Institutions involved in sub-Saharan African clinical trials research, malaria

Institution	Country	Papers (N)	Citation impact
London School of Hygiene & Tropical Medicine	UK	137	3.38
Makerere University	UGA	58	2.46
KEMRI, Kisumu	KEN	54	2.33
University of Bamako	MLI	50	2.57
University of Oxford	UK	49	3.65
WHO	CHE	46	2.31
Albert Schweitzer Hospital	GAB	42	1.98
KEMRI, Kilifi	KEN	42	3.39
University of Tübingen (Eberhard Karl)	DEU	41	1.84
University of Ibadan	NGA	38	1.52
KEMRI, Nairobi	KEN	37	2.16
MRC Unit, The Gambia	GMB	37	2.99
Ifakara Health Institute	TZA	34	2.98
UMC Amsterdam	NLD	34	1.72
GlaxoSmithKline	BEL	33	5.27
University of Barcelona	ESP	32	3.30
National Institute for Medical Research	TZA	30	3.77
Swiss Tropical & Public Health Institute, Basel	CHE	30	3.31
University of Liverpool	UK	29	1.67
Institute of Tropical Medicine Antwerp	BEL	28	1.96
Manhica Health Research Centre	MOZ	28	2.96
Muhimbili University of Health and Allied Sciences	TZA	28	2.52
University College Hospital, Ibadan	NGA	28	1.12
Karolinska University Hospital	SWE	26	1.67
Ministry of Health	MOZ	26	3.36
Cheikh Anta Diop University	SEN	24	2.10
University of Copenhagen	DNK	24	3.36
Ministry of Health	UGA	22	1.70
University of Khartoum	SDN	21	1.05
Epicentre	FRA	20	1.94
Karolinska Institutet	SWE	20	1.44
Ministry of Health	GHA	20	3.29

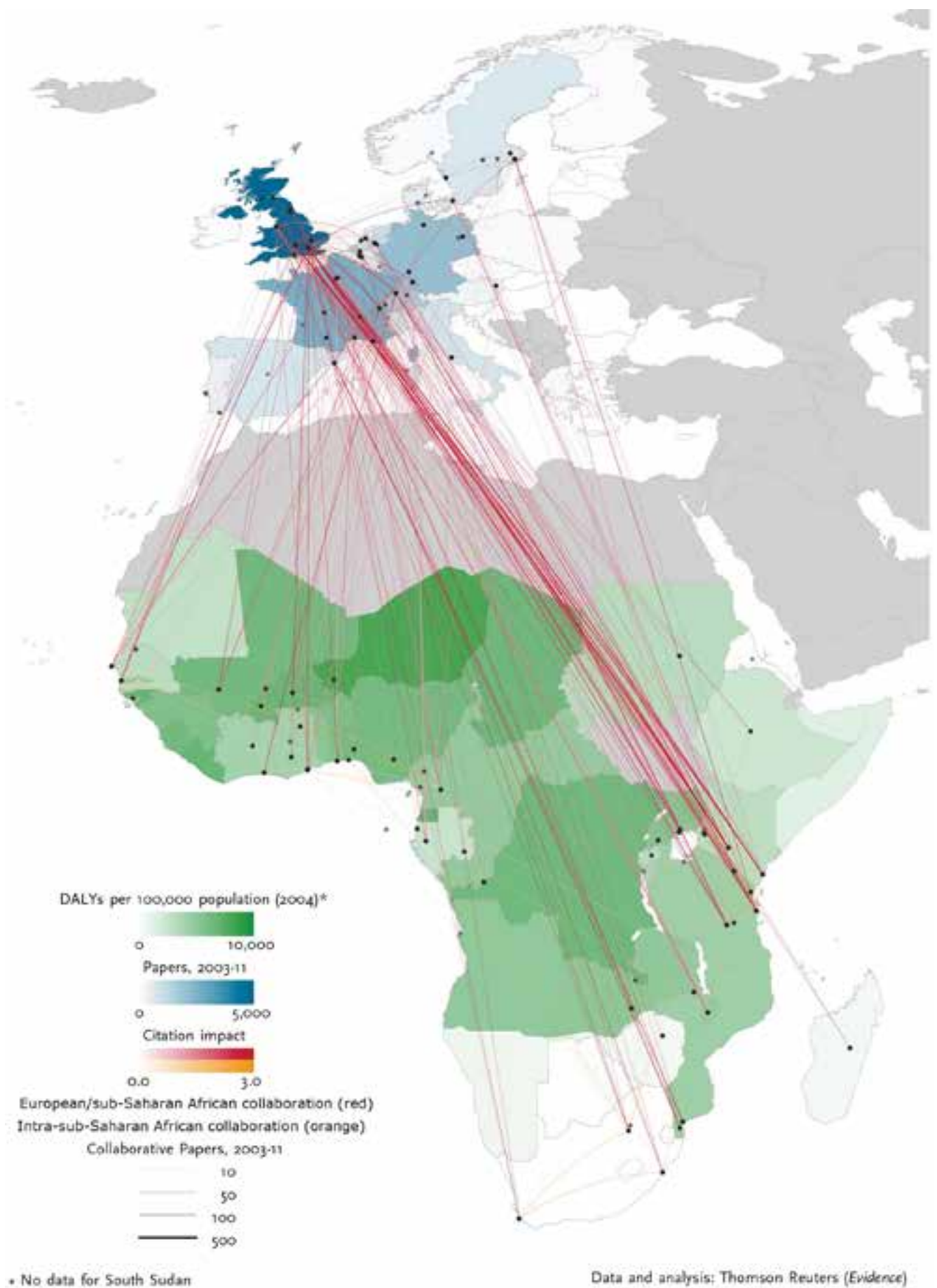


Figure 6.1.4 Disease burden in sub-Saharan Africa, research output in Europe and their collaborative links in malaria

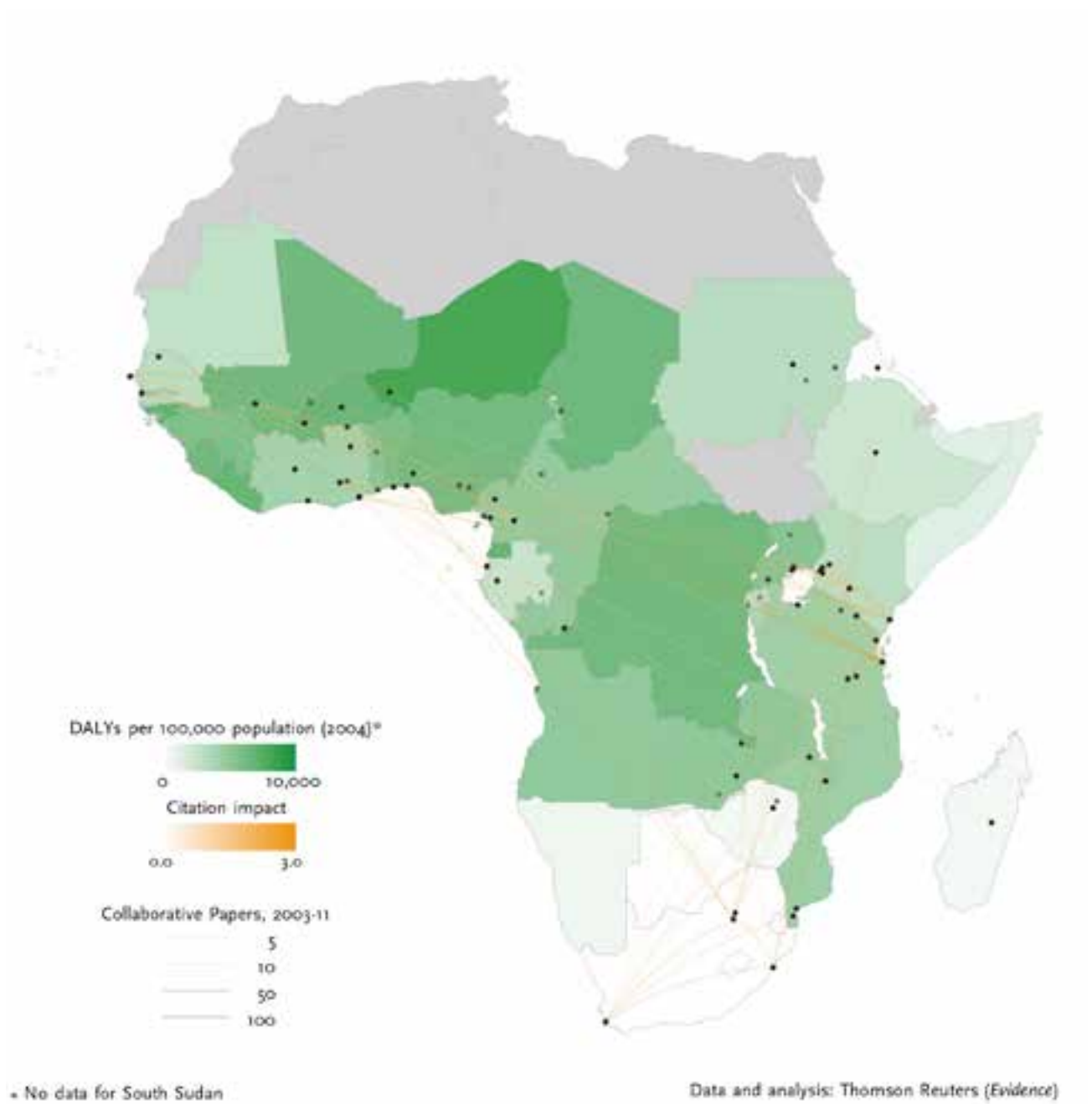


Figure 6.1.5 Disease burden and collaborative research links within sub-Saharan Africa in malaria

EDCTP-associated funding collaboration

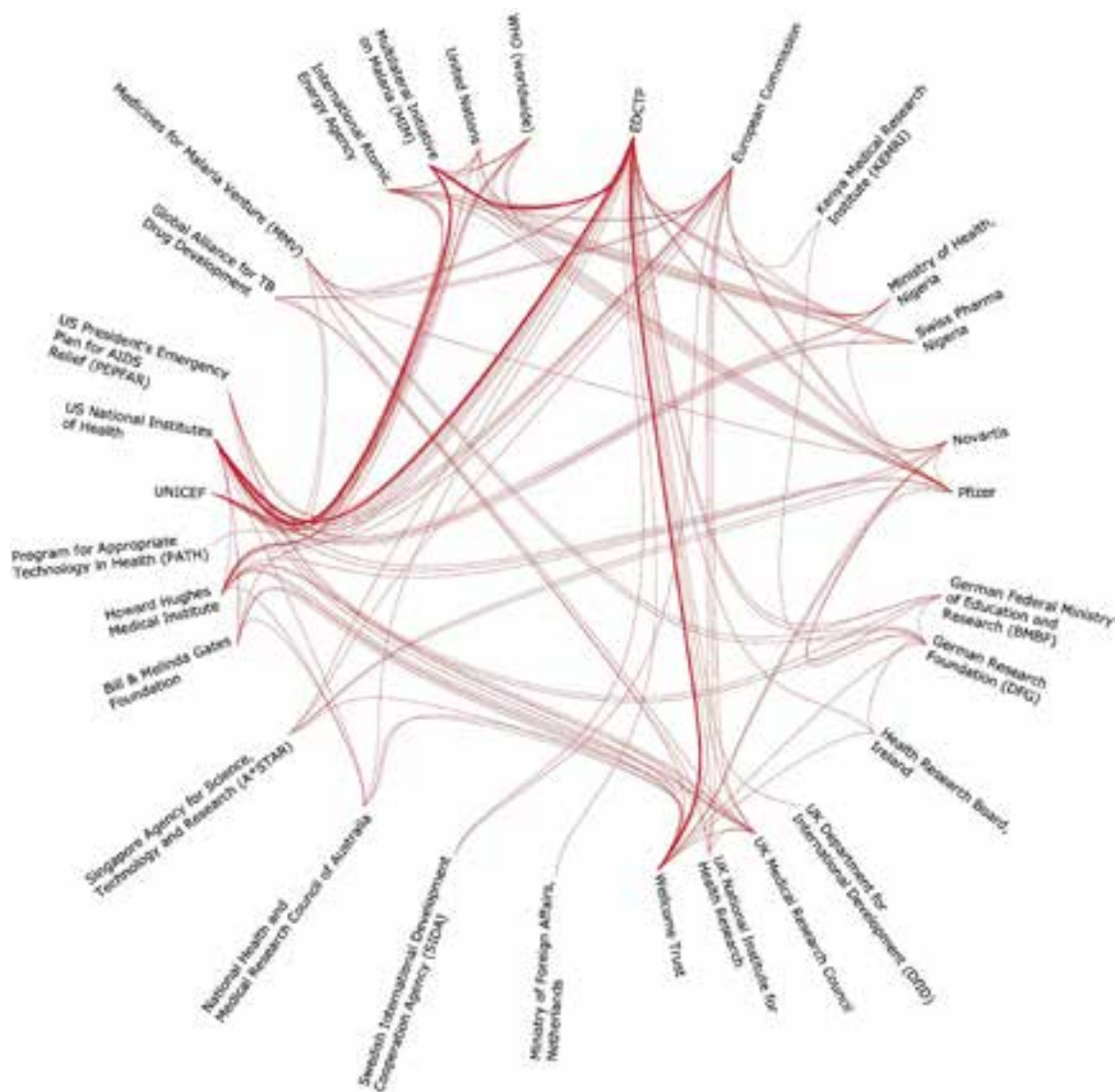


Figure 6.1.6 Collaboration between EDCTP-associated papers and other funding agencies, malaria, sub-Saharan Africa (2008-11)

A line between two funding agencies represents at least one paper, thicker lines represent more co-funded papers.

Agencies acknowledged in EDCTP-associated papers across sub-Saharan Africa in malaria research include the US National Institutes of Health (12

papers), the Multilateral Initiative on malaria (11 papers) and the Wellcome Trust (9 papers).

6.2. European research in malaria

Malaria research is the most highly-cited of the disease areas (average citation impact 1.24) and EDCTP Member Countries produce over two-fifths of malaria research globally. Whilst the citation impact of their research is high (average citation impact 1.49), the citation impact of European collaboration with sub-Saharan Africa is even higher.

The research output of EDCTP Member Countries in malaria research has increased from 6,480 papers (2003-07) to 8,243 papers (2007-11) but this growth rate is less than global growth in malaria research, and share has consequently fallen from 46.7% (2003-07) to 43.4% (2007-11). The research output of EDCTP Prospective Member Countries (1.5% of global malaria research output) is small (section 6.5).

Whilst collaboration between Europe and sub-Saharan Africa has grown, and grown faster than the research output of EDCTP Member Countries, it is only around the global average growth in malaria research and share of global research output has remained relatively flat (13.1%, 2003-11). By contrast, the citation impact of collaborative malaria research with sub-Saharan Africa is rising and was 1.81 in 2007-11.

The key findings by country (section 6.4 and section 6.5) are:

- The UK is Europe's largest producer of malaria research (5,304 papers) and the citation impact of this research is nearly twice the world average (average citation impact 1.89). The leading UK research institutions collaborating with sub-Saharan Africa are the London School of Hygiene & Tropical Medicine and the universities of Oxford and Liverpool.
- France has published less than half the research volume of the UK in malaria (2,636 papers) and citation impact of this research is lower (average citation impact 1.25). The percentage of its research output that is collaborative with sub-Saharan Africa is similar to that for Europe overall. IRD France, Institut Pasteur, French Forces Institute of Tropical Medicine and University of Paris 5 (Descartes) are major collaborating partners of sub-Saharan Africa.
- Switzerland was Europe's fourth largest research producer (1,677 papers) after Germany and the citation impact of its malaria research is the highest (average citation impact 1.97). The citation impact of German research is around the global average. The leading Swiss institution collaborating with sub-Saharan Africa in malaria research is the Swiss Tropical & Public Health Institute.
- There is malaria research of both volume and excellence in the Netherlands and Belgium as well as Sweden and Denmark. This research is highly-collaborative with sub-Saharan Africa and accounted for nearly two-fifths of national malaria research in the Netherlands and almost half (48.6%) in Denmark.
- In Belgium, its highly-cited collaborative research is led by the Institute of Tropical Medicine, Antwerp. In the Netherlands, the University Medical Centres of Amsterdam and Radboud Nijmegen are active collaborating partners of sub-Saharan Africa, along with the Wageningen University and Research Centre. In Denmark, frequent partners are the University of Copenhagen and associated University Hospitals. In Sweden, key partners are the Karolinska Institutet and University Hospital, and Stockholm University.

6.3. European research trends

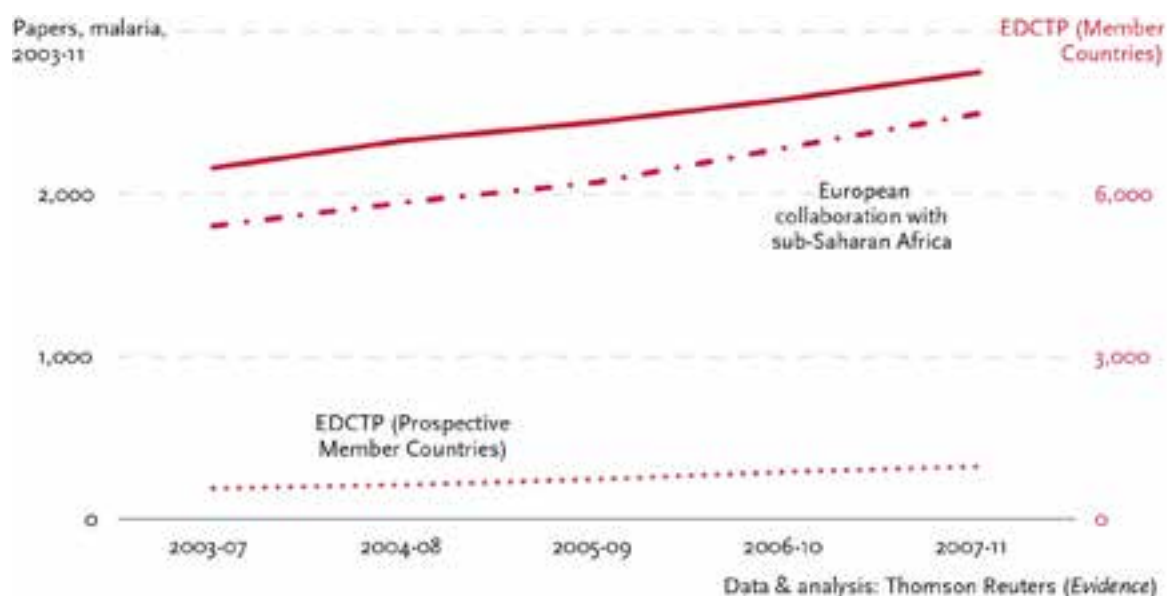


Figure 6.3.1 Trends in malaria research output in Europe

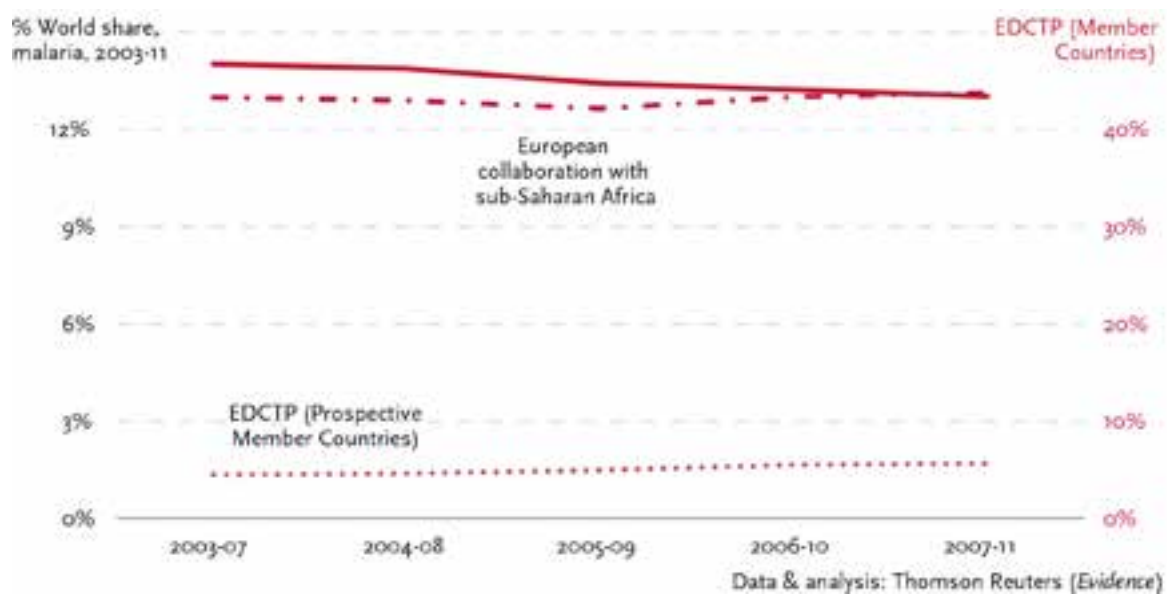


Figure 6.3.2 Trends in world share of malaria research, Europe

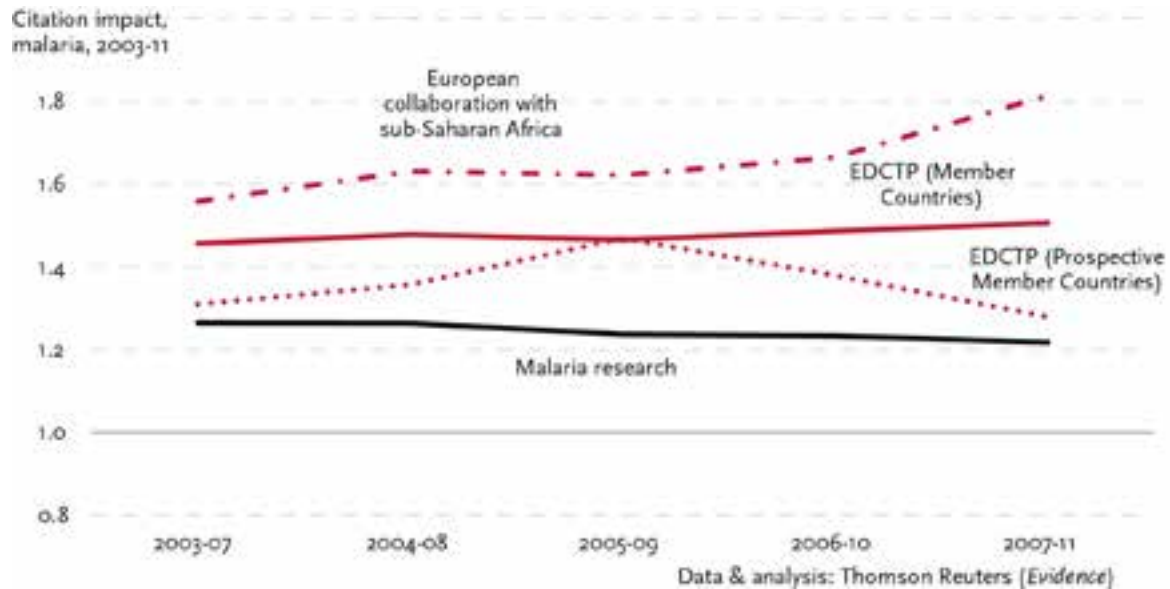


Figure 6.3.3 Trends in citation impact of malaria research, Europe

6.4. EDCTP Member Countries

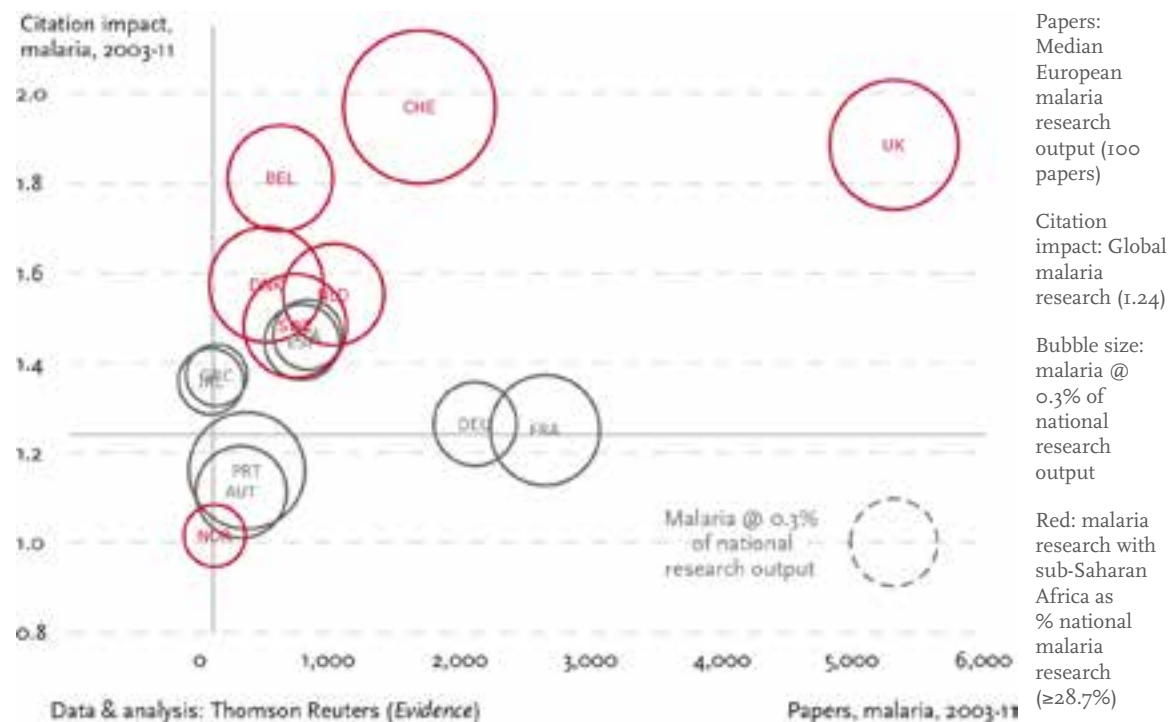


Figure 6.4.1 Country quadrant for malaria research in EDCTP Member Countries

Table 6.4.1 Country data for malaria research in EDCTP Member Countries

National malaria research				Collaborative malaria research		
UN Short Code	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
AUT	315	1.11	0.3%	80	1.13	25.4%
BEL	615	1.81	0.5%	241	2.25	39.2%
CHE	1,677	1.97	1.0%	552	2.29	32.9%
DEU	2,103	1.26	0.3%	494	1.24	23.5%
DNK	506	1.57	0.5%	246	1.54	48.6%
ESP	779	1.45	0.2%	170	2.19	21.8%
FRA	2,636	1.25	0.5%	739	1.37	28.0%
GRC	126	1.37	0.2%	9	1.58	7.1%
IRL	83	1.36	0.2%	16	1.50	19.3%
ITA	823	1.46	0.2%	143	1.34	17.4%
LUX	19	0.92	0.6%	11	1.34	57.9%
NLD	1,020	1.55	0.4%	394	1.53	38.6%
NOR	112	1.02	0.2%	34	0.84	30.4%
PRT	358	1.16	0.6%	70	1.15	19.6%
SWE	728	1.48	0.4%	259	1.40	35.6%
UK	5,304	1.89	0.7%	1,836	2.19	34.6%

Table 6.4.2 Institutions in Europe collaborating on malaria research with sub-Saharan Africa

Institution	Country	Papers (N)	Citation impact
London School of Hygiene & Tropical Medicine	UK	769	2.52
University of Oxford	UK	424	2.88
University of Liverpool	UK	360	1.90
Swiss Tropical & Public Health Institute, Basel	CHE	249	2.29
IRD	FRA	238	1.41
University of Tübingen (Eberhard Karl)	DEU	209	1.13
WHO	CHE	204	2.65
University of Copenhagen	DNK	199	1.60
UMC Amsterdam	NLD	150	1.52
Institut Pasteur	FRA	135	1.44
Imperial College London	UK	116	2.57
University of Barcelona	ESP	112	2.61
Institute of Tropical Medicine Antwerp	BEL	108	1.86
Karolinska Institutet	SWE	107	1.60
University College London	UK	103	1.81
Wageningen University and Research Centre	NLD	86	1.84

Karolinska University Hospital	SWE	85	1.79
University Hospitals, Copenhagen	DNK	81	1.39
University of Heidelberg (Ruprecht Karl)	DEU	78	1.38
UMC Radboud Nijmegen	NLD	76	1.46
University of Edinburgh	UK	74	2.60
Bernhard Nocht Institute for Tropical Medicine	DEU	68	1.25
French Forces Institute of Tropical Medicine	FRA	68	1.31
John Radcliffe Hospital	UK	63	1.95
Stockholm University	SWE	63	0.87
University of Paris 5 (Descartes)	FRA	63	1.09
Durham University	UK	58	2.04
University of Aix-Marseille 2 (Mediterranean)	FRA	57	1.01
CNRS (Centre National de la Recherche Scientifique) France	FRA	55	1.71
University of Rome Sapienza	ITA	51	1.50

6.5. EDCTP Prospective Member Countries

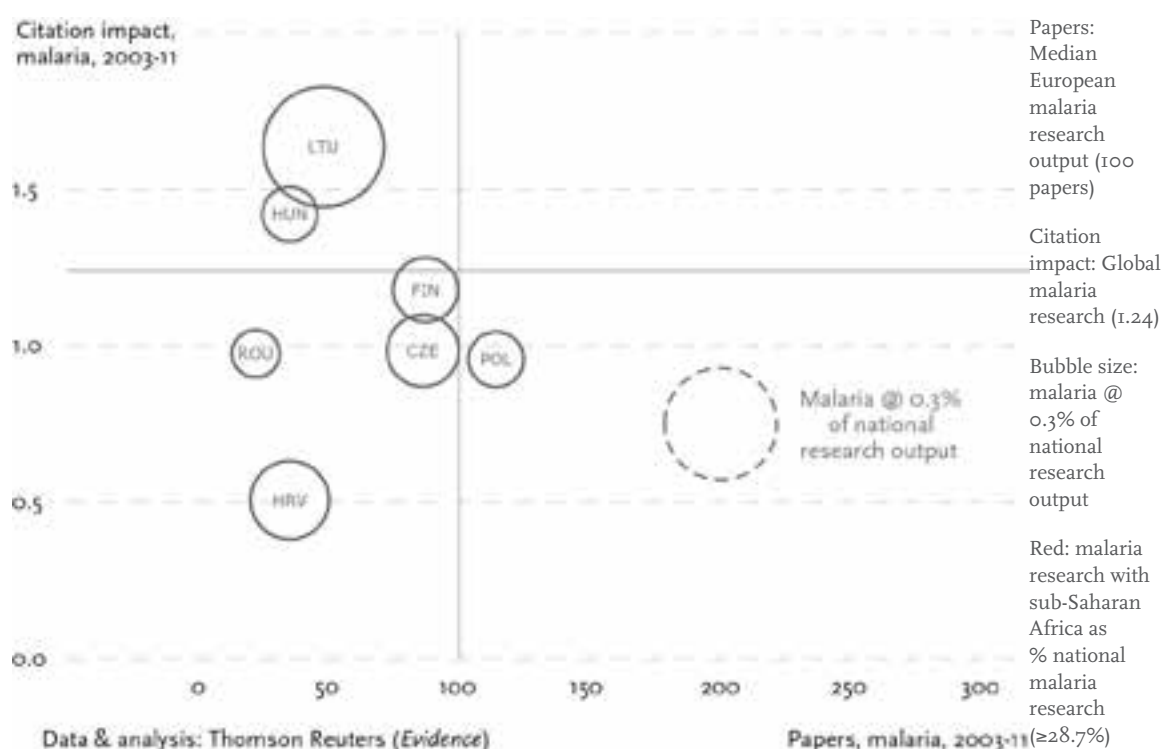


Figure 6.5.1 Country quadrant for malaria research in EDCTP Prospective Member Countries

Table 6.5.1 Country data for malaria research in EDCTP Prospective Member Countries

UN Short Code	National malaria research			Collaborative malaria research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
BGR	16	0.47	0.1%	0	0.00	0.0%
CYP	4	0.07	0.1%	0	0.00	0.0%
CZE	86	0.98	0.1%	1	0.30	1.2%
EST	9	1.61	0.1%	1	0.00	11.1%
FIN	87	1.18	0.1%	14	1.62	16.1%
HRV	35	0.51	0.2%	0	0.00	0.0%
HUN	35	1.42	0.1%	3	1.76	8.6%
LTU	48	1.63	0.4%	1	2.21	2.1%
LVA	4	1.53	0.1%	0	0.00	0.0%
MLT	0	0.00	0.0%	0	0.00	0.0%
POL	114	0.96	0.1%	7	1.18	6.1%
ROU	22	0.97	0.1%	1	3.71	4.5%
SVK	17	4.59	0.1%	3	0.28	17.6%
SVN	14	2.01	0.1%	1	1.97	7.1%

No institution from these countries has 20 or more collaborative papers with sub-Saharan Africa in malaria research. No data are displayed.

6.6. Sub-Saharan African research in malaria

Malaria research output in sub-Saharan Africa accounted for around one-fifth of global research output, which is a higher share than for other disease areas (section 6.7) and has grown slightly. The citation impact of this research is higher than the global average (average citation impact 1.44). Collaboration with Europe accounted for 13.1% of global research output (2003-11).

Within sub-Saharan Africa, the major regions conducting malaria research are East Africa (2,651 papers) and West Africa (2,239 papers). The citation impact of research from East Africa is the highest (average citation impact 1.72) and it has been consistently high. Research volume from Southern Africa is

smaller (1,387 papers) which is in accord with the relative disease burden.

The citation impact of West African research is below the global average despite growing output. Central Africa research output is small (749 papers) despite a relatively high disease burden. Recent increases in citation impact in these regions suggests that they are receiving increased research attention.

Southern Africa

Southern Africa has a comparatively low malaria burden, with exceptions in Zambia, Malawi and Mozambique (section 6.8).

- Zambia has the highest relative malaria disease burden but this is much less than the burden of HIV/AIDS. Malaria research accounted for 9.4% of national research output and HIV/AIDS research accounted for 41.5%.
- In Malawi, malaria research accounted for 15.9% of its national research, but HIV/AIDS accounted for 38.5%. The University of Malawi is the most active collaborating sub-Saharan African partner of Europe,

alongside the Malawi-Liverpool-Wellcome Trust Clinical Research Programme.

- Mozambique's research output is very highly-cited (average citation impact 2.44) and 91.9% of its research output is collaborative with Europe. These links are through the Manhica Health Research Centre and the Ministry of Health administering the WHO National malaria Control Programme.

The South African National Research Foundation is the most prominent funding agency in malaria research in Southern Africa, though this research is not particularly well-cited (average citation impact 0.81). Research funded by WHO and the Bill & Melinda Gates Foundation is very well-cited (average citation impact 5.00 and 4.83 respectively).

East Africa

East Africa is sub-Saharan Africa's leading research producer in malaria (8.9% of global research output), and the region which has the majority of collaborative research links with Europe (section 6.9). The citation impact of this research is well above the global average (1.72).

- In East Africa, there is similar citation impact (around twice the world average) for collaborative research with Europe across Kenya, Tanzania, Ethiopia and Rwanda, which may reflect a network of European/sub-Saharan African research collaboration. This research accounted for over 60% of the research output of Kenya, Tanzania, Uganda and Rwanda and 39.0% of the national research output of Ethiopia. The citation impact of Ethiopian research is higher than in other disease areas.
- Kenya has the largest research output in East Africa in malaria research (1,304 papers). This research output is very highly-cited (total national malaria research, 1.89; European collaborative research, 2.26).

This is due to KEMRI, particularly at its site in Kilifi where the Centre of Geographical Medicine Research-Coast is based.

- Tanzania has published the second largest volume of malaria research in East Africa (731 papers) and the citation impact of this research is very high (1.99). The Ifakara Health Institute, the National Institute for Medical Research and the Kilimanjaro Christian Medical Centre are prominent collaborating partners.
- In Uganda, citation impact of research output is lower (average citation impact 1.59). Makerere University is a key collaborating partner in malaria research.
- Sudan has published 192 papers in malaria research but the citation impact of its research is below average (average citation impact 1.08) at both a national and a collaborative level.

The Wellcome Trust is the most prominent funding agency in malaria research in East Africa (237 papers), followed by the US National Institutes of Health, the Bill & Melinda Gates Foundation and the European Commission. KEMRI is the most prominent of the Africa-based funding organisations.

The citation impact of EDCTP-associated research in malaria is below the global average (average citation impact 0.89) though this is based on a small number of papers (18).

West Africa

West African malaria research has accounted for a growing share of global output (section 6.10). It has risen from 6.8% (2003-07) to 8.1% (2007-11), the highest increase within sub-Saharan Africa.

- Nigeria is the largest producer of malaria research in this region, but the citation impact of this research is below the global average (average citation impact 0.62) and it is less collaborative with Europe

than other areas of West Africa (23.2%). The research output of Niger is small (43 papers) although the disease burden of malaria is high (8,212 DALYs per 100,000).

- Malaria accounted for nearly 30% of the research output of The Gambia and Mali. Mali and The Gambia stand out in terms of citation impact. Research collaboration with Europe is through Mali's University of Bamako and its Malaria Research and Training Centre. The very highly-cited collaborative research output of The Gambia is through MRC Unit, The Gambia.
- Ghana has the second largest research output in this region, and nearly three-quarters of this is collaborative with Europe, through the University of Ghana and Kwame Nkrumah University of Science and Technology.
- Countries in Francophone West Africa (Burkina Faso, Senegal, Benin, Côte d'Ivoire and Guinea-Bissau) produce comparatively highly-cited, highly-collaborative research output (around 80% of their national research output in malaria). Collaboration is through IRD centres such as the Centre national de recherche de Formation sur le Paludisme in Burkina Faso, Centre de Recherche Entomologique de Cotonou in Benin and Institut Pasteur in Senegal.

In West Africa, the US National Institutes of Health and the Bill & Melinda Gates Foundation are the most prominent funding agencies in malaria research. Research funded by the Bill & Melinda Gates Foundation is amongst the most highly-cited after the US Agency for International Development. European organisations such as the European Commission, Wellcome Trust, IRD and the UK MRC are within the top 10.

There are 20 West African malaria research papers that can be associated with EDCTP for 2008-11, but the citation impact of these (average citation impact 0.90) is below the global average.

Central Africa

Research output is very poorly correlated with disease burden in Central Africa. Growth has been below average and share of global output is unchanged (section 6.11).

- For Equatorial Guinea, 10 research papers compare with at 7,011 DALYs per 100,000 population. In Chad, there are 7 research papers, and a malaria disease burden of 6,532 DALYs per 100,000 population.
- In the Democratic Republic of Congo where the disease burden is 6,467 DALYs per 100,000 population equating to 3,680,780 person years overall, there is greater (if still small) research output (75 papers). About two-thirds of this is collaborative with Europe (average citation impact of 2.18).
- In Cameroon, the major collaborating partners with Europe are the IRD Coordination Organization for the Fight Against Endemic Diseases in Central Africa and the University of Yaoundé 1. In Gabon, where 95.0% of the country's malaria research output is collaborative with Europe, the leading institutions are the Albert Schweitzer Hospital, the University of Health Sciences, Gabon and the Franceville International Medical Research Centre.

There are comparatively few funding agencies in malaria research in Central Africa, but the most prominent are the US National Institutes of Health, the European Commission and the Bill & Melinda Gates Foundation.

6.7. Sub-Saharan African research trends

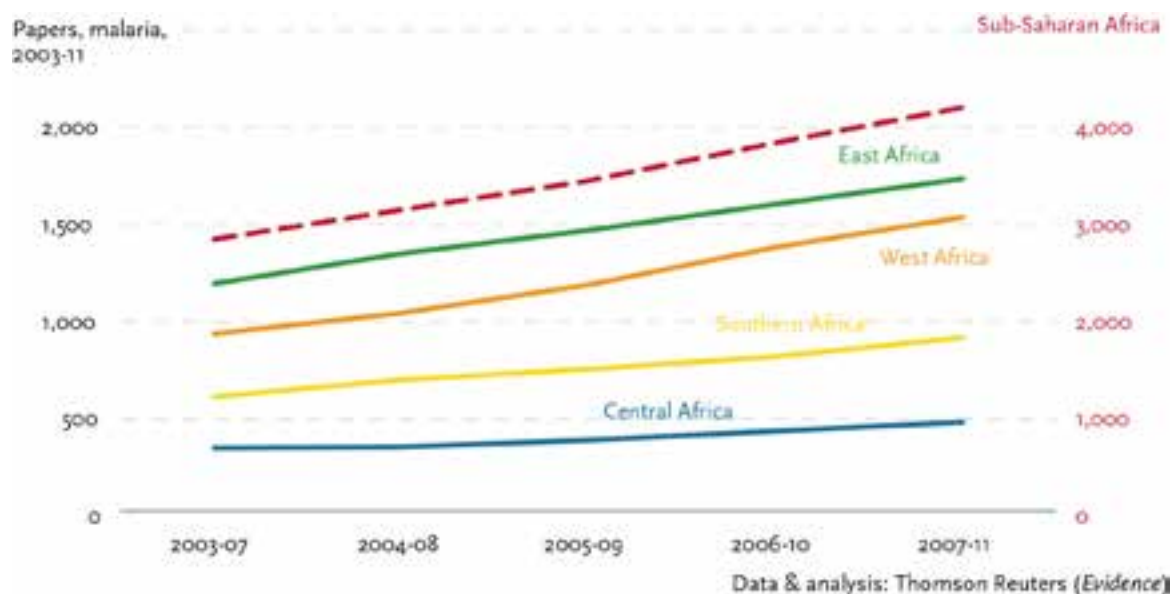


Figure 6.7.1 Trends in malaria research output in sub-Saharan Africa

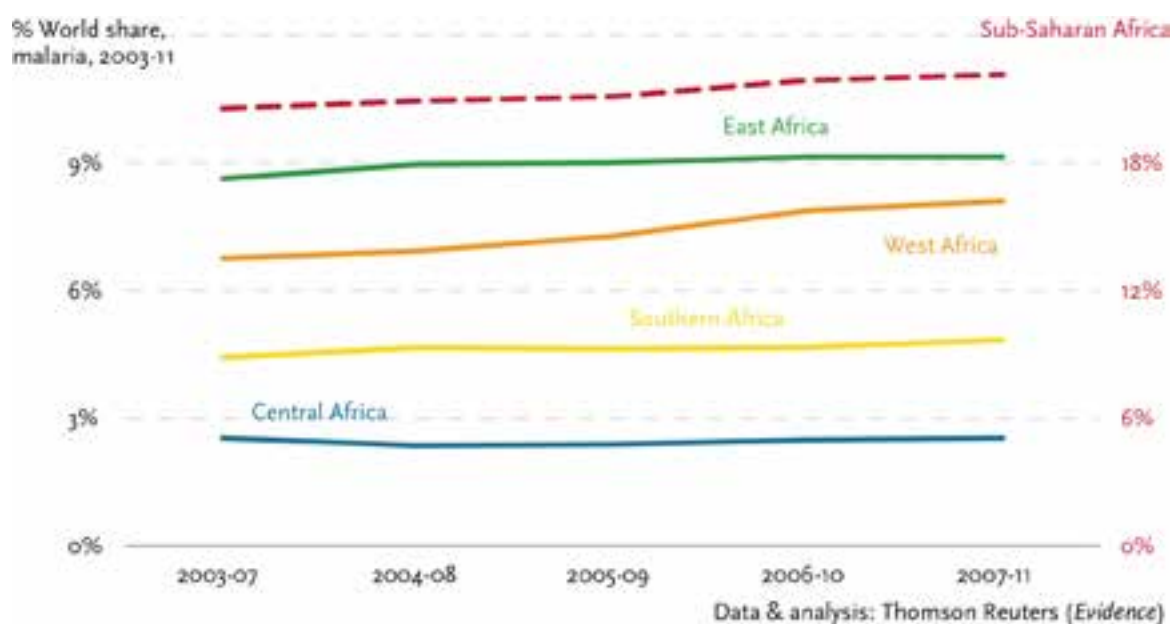


Figure 6.7.2 Trends in world share of malaria research, sub-Saharan Africa

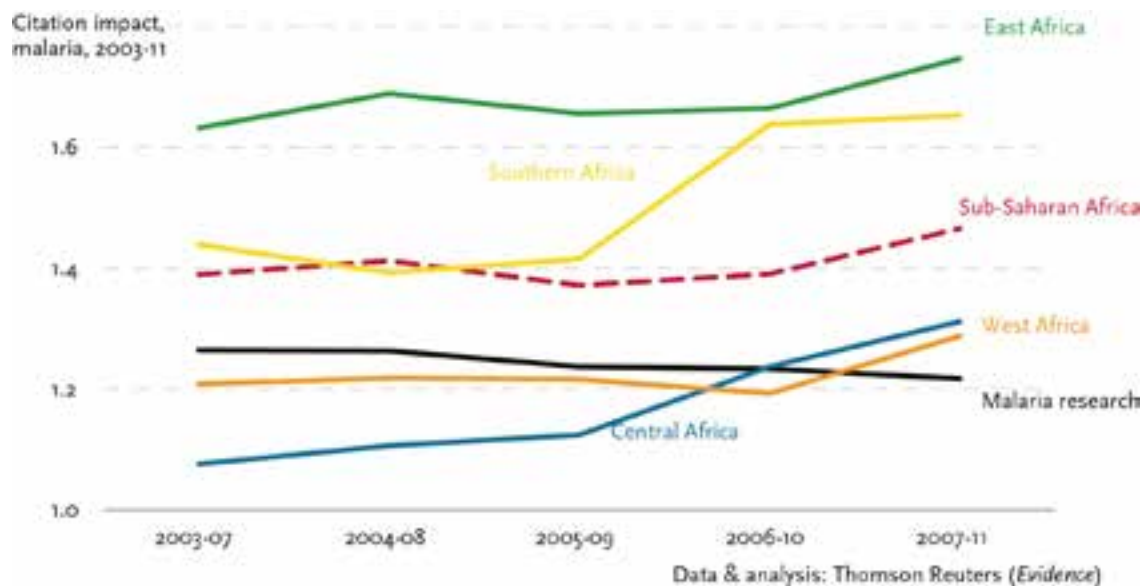


Figure 6.7.3 Trends in citation impact of malaria research, sub-Saharan Africa

6.8. Southern Africa

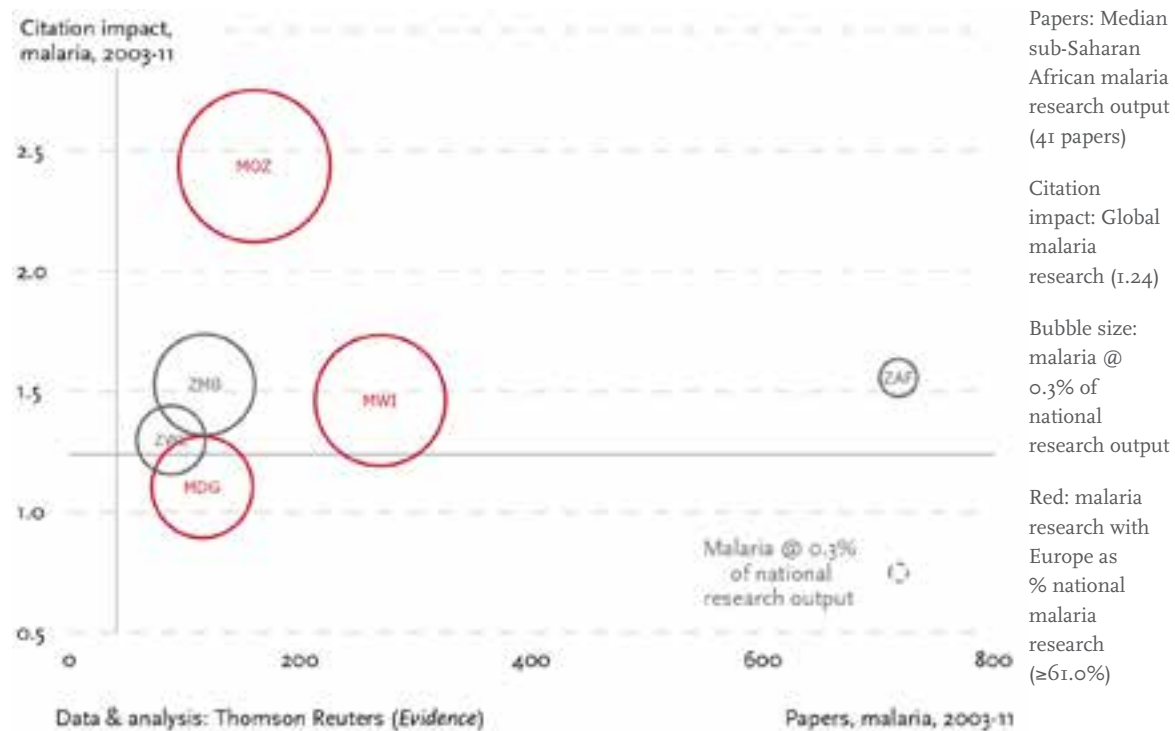


Figure 6.8.1 Country quadrant for malaria research in Southern Africa

Table 6.8.1 Country data for malaria research in Southern Africa

UN Short Code	National malaria research			Collaborative malaria research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
BWA	15	1.47	1.0%	4	2.51	26.7%
COM	9	1.02	31.0%	7	0.85	77.8%
LSO	1	1.76	0.8%	0	0.00	0.0%
MDG	115	1.10	9.5%	80	1.12	69.6%
MOZ	160	2.44	21.4%	147	2.53	91.9%
MUS	3	2.74	0.6%	1	1.19	33.3%
MWI	269	1.46	15.9%	182	1.63	67.7%
NAM	5	3.40	0.8%	2	5.08	40.0%
SWZ	5	2.85	2.2%	1	2.47	20.0%
SYC	1	0.00	0.6%	1	0.00	100.0%
ZAF	717	1.56	1.3%	316	2.13	44.1%
ZMB	117	1.53	9.4%	54	1.78	46.2%
ZWE	88	1.30	4.4%	49	1.69	55.7%

Table 6.8.2 Institutions in Southern Africa collaborating on malaria research with Europe

Institution	Country	Papers (N)	Citation impact
University of Malawi	MWI	118	1.61
University of Cape Town	ZAF	95	1.68
Manhica Health Research Centre	MOZ	87	2.66
Ministry of Health	MOZ	84	2.27
University of Witwatersrand	ZAF	83	2.21
Malawi-Liverpool-Wellcome Trust Clinical Research Programme	MWI	72	1.96
MRC of South Africa	ZAF	61	3.38
Institut Pasteur	MDG	58	1.23
Eduardo Mondlane University	MOZ	36	2.97
University of KwaZulu-Natal	ZAF	35	1.19
University of Pretoria	ZAF	25	0.88
National Institute for Communicable Diseases	ZAF	23	2.69
National Health Laboratory Service South Africa	ZAF	22	1.59
University of Zimbabwe	ZWE	21	1.73

Table 6.8.3 Agencies funding Southern African malaria research, 2008-11

Institution	Region	Papers (N)	Citation impact
South African National Research Foundation	AFR	99	0.81
US National Institutes of Health	ROW	74	2.06
Wellcome Trust	EUR	63	2.61
Bill & Melinda Gates Foundation	ROW	59	4.83
MRC of South Africa	AFR	40	1.15
European Commission	EUR	39	1.14
Department of Science and Technology, South Africa	AFR	31	1.03
Spanish Ministry of Foreign Affairs	EUR	29	1.79
University of Cape Town	AFR	28	1.07
WHO	IGO	27	5.00
US Centers for Disease Control and Prevention	ROW	15	0.73
UK MRC	EUR	14	2.04
US Agency for International Development	ROW	14	3.01
Banco Bilbao Vizcaya Argentaria	EUR	13	1.62
Institut Pasteur	EUR	13	1.97
Instituto de Salud Carlos III (Spanish National Public Health Institute)	EUR	13	1.67
Institut Pasteur, Madagascar	AFR	12	1.14
National Health and MRC of Australia	ROW	12	0.57
National Health Laboratory Service South Africa	AFR	12	1.03
Novartis	COR	12	2.38
South African Malaria Initiative	AFR	12	0.51
German Research Foundation	EUR	11	1.33
Program for Appropriate Technology in Health	ROW	11	2.54
UK DfID	EUR	11	1.94
University of Witwatersrand	AFR	11	0.80
Johns Hopkins University	ROW	10	2.00
Medicines for Malaria Venture	NGO	10	1.54

6.9. East Africa

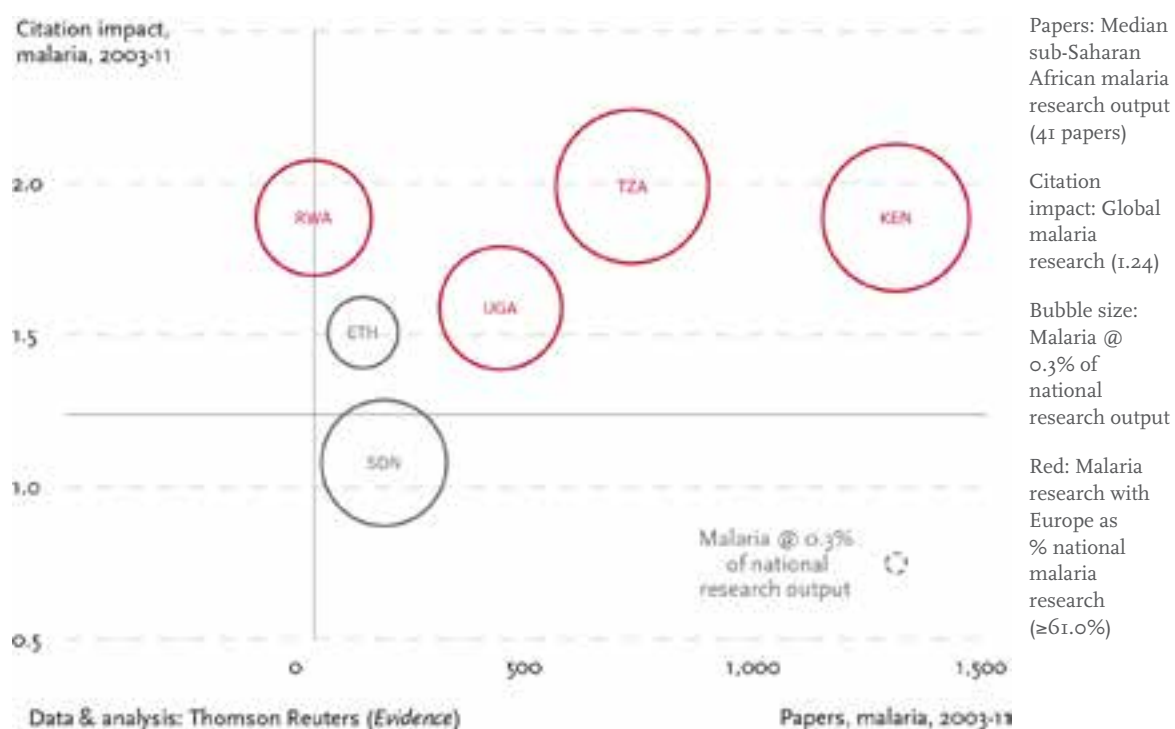


Figure 6.9.1 Country quadrant for malaria research in East Africa

Table 6.9.1 Country data for malaria research in East Africa

UN Short Code	National malaria research			Collaborative malaria research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
BDI	11	1.54	10.3%	11	1.54	100.0%
ERI	17	1.93	8.6%	6	1.24	35.3%
ETH	146	1.51	3.9%	57	2.26	39.0%
KEN	1,304	1.89	17.1%	815	2.26	62.5%
RWA	39	1.89	10.5%	31	2.24	79.5%
SDN	192	1.08	12.5%	106	1.18	55.2%
SOM	2	1.36	14.3%	2	1.36	100.0%
SSD	7	1.00	6.8%	3	1.18	42.9%
TZA	731	1.99	18.5%	571	2.24	78.1%
UGA	445	1.59	11.9%	277	1.77	62.2%

Table 6.9.2 Institutions in East Africa collaborating on malaria research with Europe

Institution	Country	Papers (N)	Citation impact
KEMRI, Kilifi	KEN	312	2.10
KEMRI, Nairobi	KEN	264	3.18
Ifakara Health Institute	TZA	212	2.27
National Institute for Medical Research	TZA	156	2.08
Makerere University	UGA	138	1.90
KEMRI, Kisumu	KEN	120	1.68
Kilimanjaro Christian Medical Centre	TZA	109	3.14
Ministry of Health	KEN	94	2.19
Ministry of Health	UGA	89	1.65
University of Khartoum	SDN	81	1.06
Muhimbili University of Health and Allied Sciences	TZA	74	1.93
University of Nairobi	KEN	67	1.61
Ministry of Health	TZA	57	3.08
International Centre of Insect Physiology and Ecology	KEN	54	1.76
University of Dar es Salaam	TZA	27	1.78
Kilifi District Hospital	KEN	25	3.04
International Livestock Research Institute	KEN	24	1.09
Tumaini University	TZA	24	2.27
Mbarara University of Science and Technology	UGA	22	2.39
Sokoine University of Agriculture	TZA	21	1.96
Ministry of Health	ETH	20	3.52

Table 6.9.3 Agencies funding East African malaria research, 2008-11

Institution	Region	Papers (N)	Citation impact
Wellcome Trust	EUR	237	2.77
US National Institutes of Health	ROW	181	1.75
Bill & Melinda Gates Foundation	ROW	127	3.12
European Commission	EUR	82	1.81
KEMRI	AFR	60	3.00
US Agency for International Development	ROW	60	2.58
US Centers for Disease Control and Prevention	ROW	48	1.70
WHO	IGO	48	1.92
UK DfID	EUR	43	1.94
UNICEF	ROW	36	1.88
Swedish International Development Cooperation Agency	EUR	35	0.84
Novartis	COR	25	3.34
Netherlands Organisation for Scientific Research	EUR	23	1.13
UK MRC	EUR	23	3.69
University of Oxford	EUR	21	2.58
German Research Foundation	EUR	19	2.71
European & Developing Countries Clinical Trials Partnership	EUR	18	0.89
Danish International Development Agency	EUR	17	1.47
Pfizer	COR	17	3.41
Doris Duke Charitable Foundation	ROW	14	1.28
German Academic Exchange Service	EUR	14	1.04
Multilateral Initiative on Malaria	IGO	14	1.20
Ministry of Health & Social Welfare, Tanzania	AFR	13	0.98
Program for Appropriate Technology in Health	ROW	13	5.56
Medicines for Malaria Venture	NGO	12	2.03
Swedish Research Council	EUR	12	1.16
Swiss National Science Foundation	EUR	11	2.44
UK Biotechnology and Biological Sciences Research Council	EUR	11	0.84
International Atomic Energy Agency	IGO	10	0.75
London School of Hygiene & Tropical Medicine	EUR	10	1.13
National Health and MRC of Australia	ROW	10	1.01
University of Copenhagen	EUR	10	1.44

6.10. West Africa

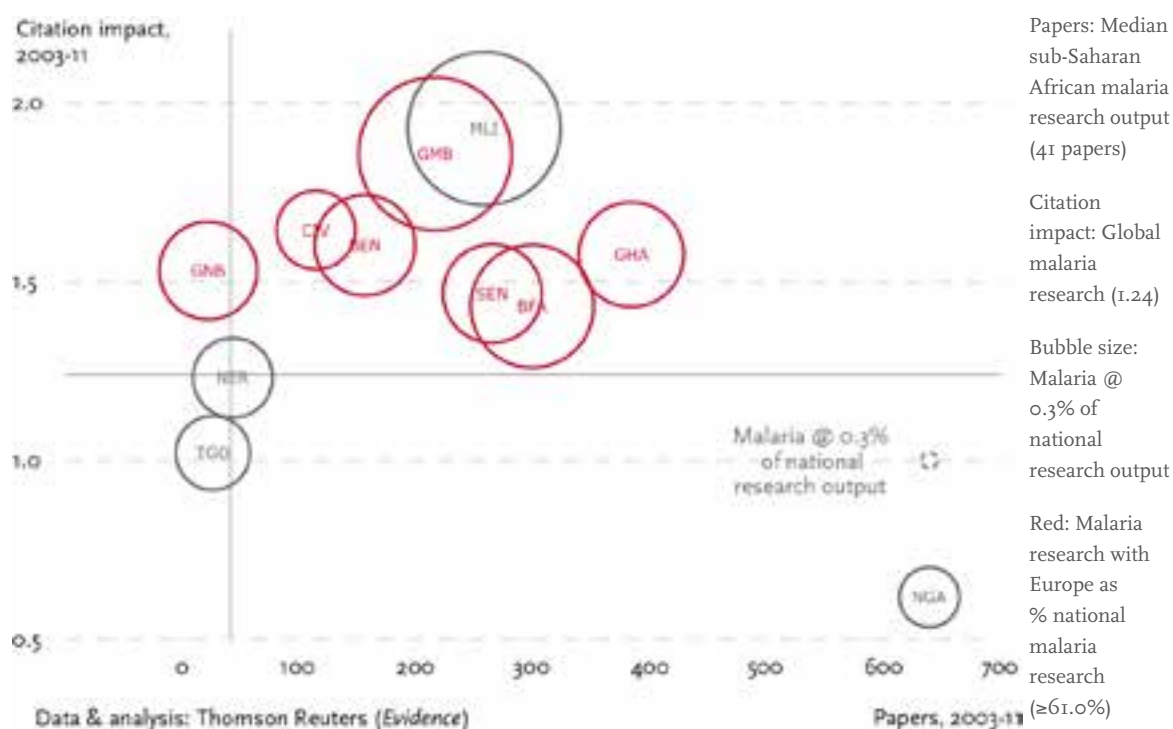


Figure 6.10.1 Country quadrant for malaria research in West Africa

Table 6.10.1 Country data for malaria research in West Africa

UN Short Code	National malaria research			Collaborative malaria research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
BEN	156	1.60	12.6%	134	1.70	85.9%
BFA	299	1.43	18.7%	243	1.50	81.3%
CIV	114	1.64	7.7%	92	1.96	80.7%
CPV	2	0.11	4.8%	2	0.11	100.0%
GHA	384	1.58	13.6%	281	1.77	73.2%
GIN	16	2.22	8.6%	13	2.65	81.3%
GMB	216	1.86	29.1%	196	1.94	90.7%
GNB	22	1.53	11.8%	22	1.53	100.0%
LBR	7	0.87	17.5%	5	1.21	71.4%
MLI	258	1.93	29.0%	137	2.20	53.1%
MRT	4	0.14	2.4%	3	0.14	75.0%

NER	43	1.23	7.9%	25	1.57	58.1%
NGA	639	0.62	4.5%	148	1.08	23.2%
SEN	265	1.47	12.1%	205	1.53	77.4%
SLE	11	0.89	9.8%	8	0.86	72.7%
TGO	26	1.02	6.8%	16	1.13	61.5%

Table 6.10.2 Institutions in West Africa collaborating on malaria research with Europe

Institution	Country	Papers (N)	Citation impact
MRC Unit, The Gambia	GMB	192	1.94
University of Bamako	MLI	105	2.27
University of Ghana	GHA	85	2.13
Centre national de recherche de Formation sur le Paludisme	BFA	73	1.91
Centre de Recherche Entomologique de Cotonou	BEN	72	2.22
Institut Pasteur	SEN	71	1.48
Kwame Nkrumah University of Science and Technology	GHA	67	1.55
Cheikh Anta Diop University	SEN	64	1.91
University of Ibadan	NGA	58	1.17
Ministry of Health	GHA	56	2.22
Burkina Faso Health Sciences Research Institute	BFA	55	1.63
Université d'Abomey-Calavi	BEN	45	1.23
Centre MURAZ	BFA	41	1.49
University of Cocody-Abidjan	CIV	41	2.15
Nouna Health Research Centre	BFA	39	0.68
Ministry of Health	BFA	33	1.67
IRD	SEN	32	2.32
Swiss Academy of Science	CIV	31	2.66
University of Ouagadougou	BFA	30	1.58
Organization for the Fight Against Endemic Diseases in Central Africa	SEN	27	1.69
Komfo Anokye Teaching Hospital	GHA	26	2.02
Institut Pierre Richet	CIV	23	1.78
Kumasi Centre for Collaborative Research in Tropical Medicine	GHA	23	1.25
University for Development Studies	GHA	22	1.31
University of Nigeria	NGA	20	0.79

Table 6.10.3 Agencies funding West African malaria research, 2008-11

Institution	Region	Papers (N)	Citation impact
US National Institutes of Health	ROW	128	1.54
Bill & Melinda Gates Foundation	ROW	91	3.26
European Commission	EUR	73	1.62
Wellcome Trust	EUR	66	1.68
IRD	EUR	50	1.18
UK MRC	EUR	50	1.83
French National Research Agency	EUR	34	1.25
WHO	IGO	33	1.13
UNICEF	ROW	32	1.65
French Ministry of Foreign Affairs	EUR	29	1.22
Multilateral Initiative on Malaria	IGO	28	0.84
International Atomic Energy Agency	IGO	23	0.70
US Agency for International Development	ROW	22	3.49
German Research Foundation	EUR	21	0.82
Swiss National Science Foundation	EUR	21	2.42
European & Developing Countries Clinical Trials Partnership	EUR	20	0.90
Ministry of Higher Education and Research	EUR	19	1.02
Howard Hughes Medical Institute	ROW	17	0.82
Ministry of Defence, France	EUR	17	1.74
Swedish International Development Cooperation Agency	EUR	17	0.76
United Nations	IGO	14	1.20
Institut Pasteur	EUR	13	1.00
German Federal Ministry of Education and Research	EUR	12	0.53
London School of Hygiene & Tropical Medicine	EUR	12	1.54
German Academic Exchange Service	EUR	11	0.35
UK DfID	EUR	11	1.66
Institut de Médecine et d'Epidémiologie Appliquée	EUR	10	0.24
Pfizer	COR	10	1.92

6.II. Central Africa

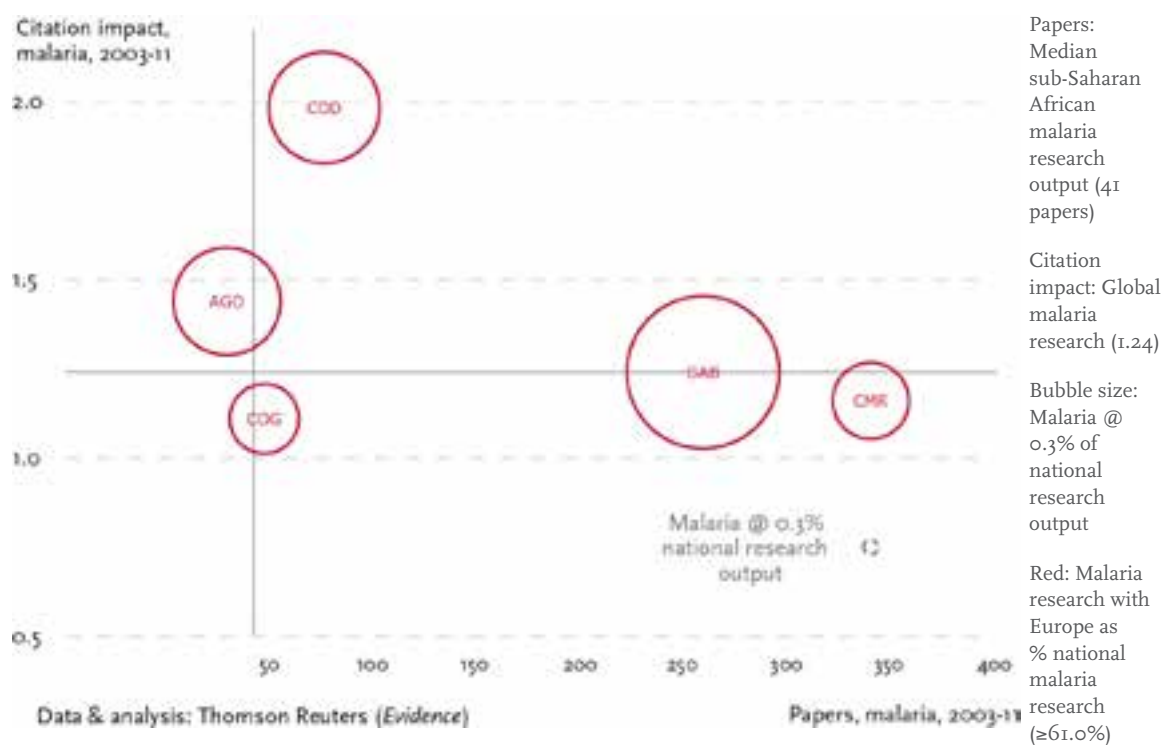


Figure 6.II.1 Country quadrant for malaria research in Central Africa

Table 6.II.1 Country data for malaria research in Central Africa

UN Short Code	National malaria research			Collaborative malaria research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
AGO	28	1.44	17.3%	24	1.49	85.7%
CAF	11	0.78	6.3%	4	0.97	36.4%
CMR	339	1.16	8.7%	217	1.30	64.0%
COD	75	1.98	18.5%	48	2.18	64.0%
COG	46	1.11	7.2%	33	1.28	71.7%
GAB	258	1.24	35.1%	245	1.24	95.0%
GNQ	10	1.03	34.5%	9	1.15	90.0%
STP	12	0.84	66.7%	12	0.84	100.0%
TCD	7	2.44	5.0%	5	3.06	71.4%

Table 6.11.2 Institutions in Central Africa collaborating on malaria research with Europe

Institution	Country	Papers (N)	Citation impact
Albert Schweitzer Hospital	GAB	191	1.16
Organization for the Fight Against Endemic Diseases in Central Africa	CMR	114	1.44
University of Yaoundé 1	CMR	79	1.07
University of Health Sciences	GAB	42	1.08
Franceville International Medical Research Centre	GAB	32	1.62
University of Kinshasa	COD	21	2.26

Figure 6.11.3 Agencies funding Central African malaria research, 2008-11

Institution	Region	Papers (N)	Citation impact
US National Institutes of Health	ROW	49	1.89
European Commission	EUR	30	0.97
Bill & Melinda Gates Foundation	ROW	21	2.38
IRD	EUR	19	2.16
Wellcome Trust	EUR	15	2.68
French Ministry of Foreign Affairs	EUR	11	2.17
French National Research Agency	EUR	11	1.63
WHO	IGO	10	1.32

7. Neglected infectious diseases (NIDs) research

This section of the report provides a comprehensive bibliometric analysis of European and sub-Saharan African research in NIDs focussing on research output and citation impact (as an indicator of research quality in the context of disease burden).³⁶ Country and institutional analyses show where leading collaborative research between Europe and sub-Saharan Africa is being undertaken. From these publication data, the principal agencies funding sub-Saharan African research in NIDs have been identified – this is based on research volume not investment. This section also provides analyses showing how much global NIDs research is associated with clinical trials and the main research organisations participating in this in sub-Saharan Africa.

7.1. Summary

Globally, around 45,000 papers have been published in NIDs research between 2003 and 2011.

More than one third of NIDs research has been published by European-based researchers in the last decade. In absolute terms, the number of European papers published in NIDs research has increased since 2003, but the share of global research has dropped due to rapid growth in the research output of developing economies. Global NIDs research is cited less well than the other disease areas, and is below world average of 1.0, but European research cited more (average citation impact 1.23). Some disease areas such as cysticercosis, lymphatic filariasis, onchocerciasis and trachoma are not well researched relative to their disease burden.

Sub-Saharan African research in NIDs has increased as a share of world research output.

Sub-Saharan African research accounted for 7.4% of global research output and has an average citation impact just slightly above the global average. This is in contrast to the other disease areas analysed in this report. However, the citation impact of research from Central Africa in particular, but also West and East Africa, is increasing suggesting greater research attention to these regions. The burden of Tropical Cluster Diseases (the WHO proxy for the 'NIDs' covered in this report) is high in Central and West Africa. Research capacity is concentrated in East Africa – particularly in Kenya (through KEMRI) but also in Ethiopia, Tanzania and Uganda. In Ethiopia and Nigeria there is research capacity; however, the citation impact of this research is low.

Collaboration between Europe and sub-Saharan Africa in NIDs research is flat. It has not grown as a share of world output although in absolute terms more papers have been published.

61.4% of sub-Saharan African research has at least one European address. Citation impact is higher than the European or sub-Saharan African averages. The UK has published the largest volume of NIDs research, and the London School of Hygiene & Tropical Medicine and the University of Liverpool are key collaborating partners with sub-Saharan Africa. France is a key link to the regions of Africa where the disease burden is greatest. Collaboration with France is led by the IRD which has a number of satellite offices across sub-Saharan Africa working in NIDs research. Almost half the research output of Denmark in NIDs was collaborative with sub-Saharan Africa. This is due to the University of Copenhagen's DBL-Centre for Health Research and Development. The Institute of Tropical Medicine (Antwerp), and the Swiss Tropical & Public Health Institute are active in sub-Saharan Africa.

³⁶ Burden of disease data are for the WHO defined 'Tropical-Cluster Diseases' including Trypanosomiasis, Chagas Disease, Schistosomiasis, Leishmaniasis, Lymphatic Filariasis, and Onchocerciasis.

There is a greater research focus in epidemiology papers in NIDs research but less in terms of clinical trials compared to other disease areas. This may reflect the fact that there are safe and effective treatments and control methods to fight some of these diseases, and the difficulty is in getting the interventions to where they are most needed: in poor and hard-to-reach communities. The London School of Hygiene & Tropical Medicine and the University of Copenhagen are active in clinical trials research which is typically conducted in East Africa and West Africa.

There are fewer funders of NIDs research across sub-Saharan Africa compared to other disease areas. The Wellcome Trust and the European Commission are most active, followed by the US National Institutes of Health, the WHO and the Bill & Melinda Gates Foundation. The IRD is active in West Africa and Central Africa, as is the European Commission. EDCTP is not currently active in the area of NIDs research.

National disease burden for Tropical Cluster Diseases

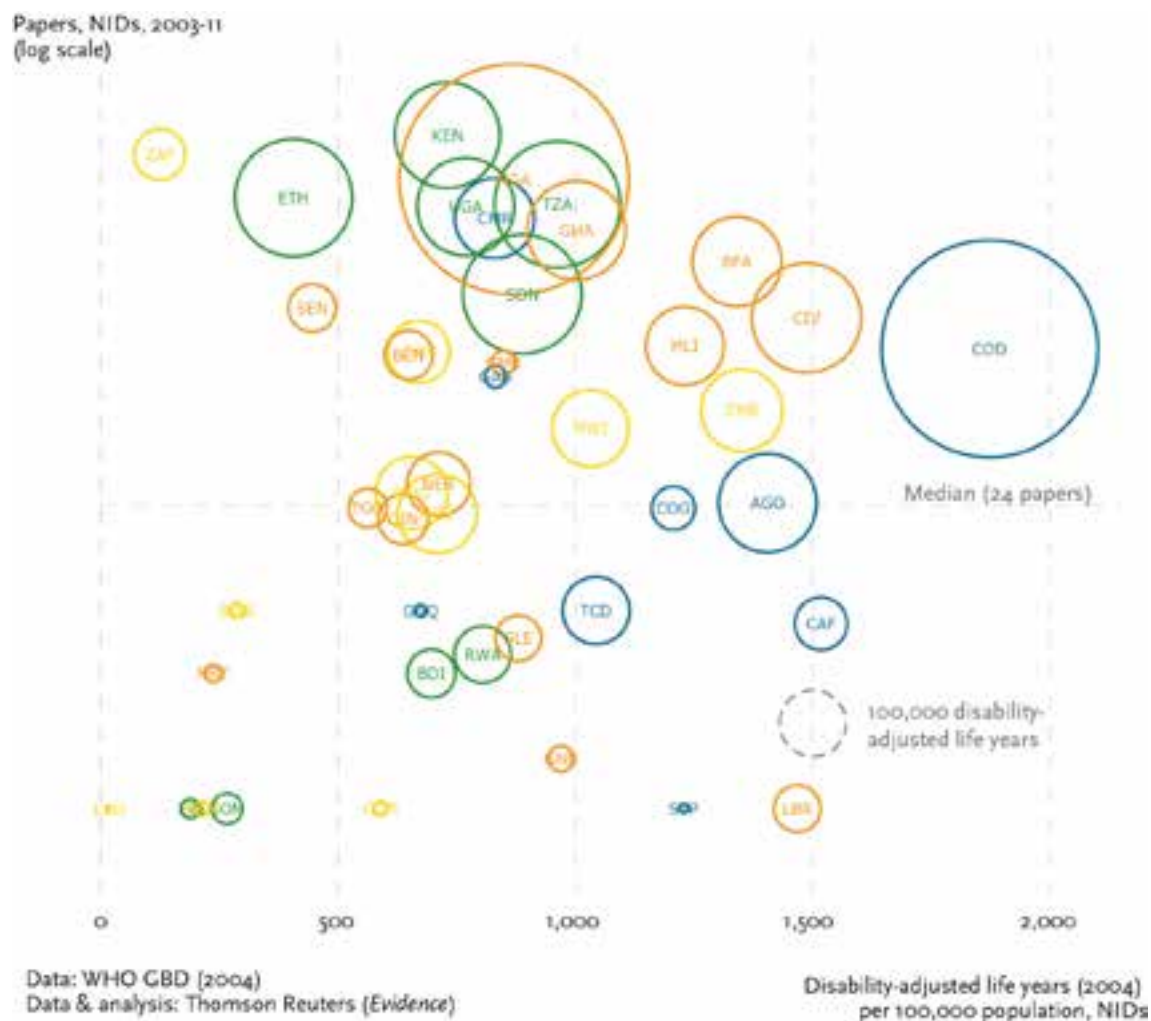


Figure 7.1.1 National disease burden and research output, Tropical Cluster Diseases

EXAMPLE (data for Democratic Republic of Congo, COD): Bubble size – 1,065,860 DALYs lost to Tropical Cluster Diseases; x-axis – 1,873 DALYs per 100,000 (population = 56,917,960); y-axis - 84 papers published in neglected infectious diseases research.

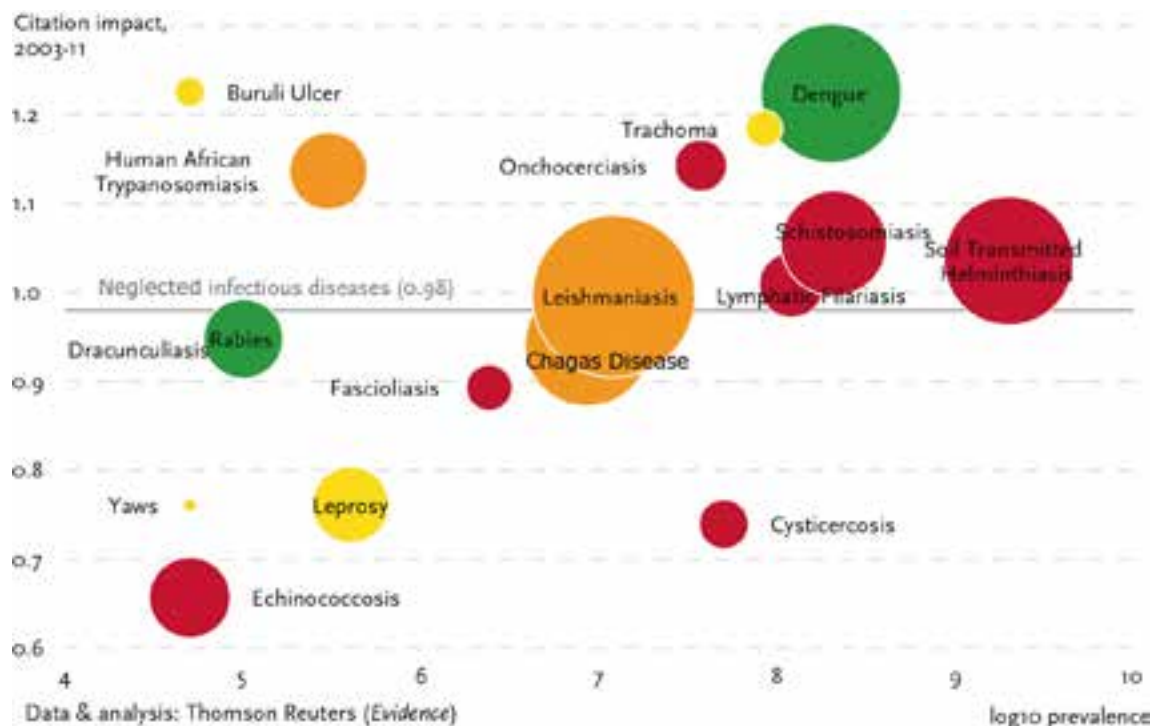


Figure 7.1.2 Prevalence of NIDs, publication volume, citation impact, 2003-11

Helminth diseases are shown in red; protozoan diseases are shown in orange; bacterial diseases are shown in yellow; viral diseases are shown in green.

Bubble size is scaled on the number of papers (2003-11); x-axis: prevalence² is on a log-scale so 6 is one million and 9 is 1 billion; y-axis: citation impact (2003-11)

- Helminth diseases such as Soil Transmitted Helminthiasis and Schistosomiasis are highly prevalent (1,987 million and 207 million) and the extensive research is well-cited. Cysticercosis (50 million), Lymphatic Filariasis (120 million) and Onchocerciasis (37 million) are less researched. Dracunculiasis (100,000) is diminishing in significance as a public health concern.
- Protozoan diseases such as Leishmaniasis (12 million) and Chagas Disease (8.5 million) are highly prevalent and researched, but less well-cited. Research into Human African Trypanosomiasis is very well-cited, though less prevalent (300,000).
- Bacterial diseases, particularly Trachoma (84 million) is less researched relative to its prevalence, but comparatively highly-cited; the converse is true of Leprosy (400,000). Research into Buruli Ulcers is comparatively highly-cited (50,000). Given the prevalence of Trachoma, this disease may require more research attention than it currently receives. Similarly to Dracunculiasis, Yaws is diminishing in significance as a public health concern (50,000).
- Dengue is highly prevalent (200 million), and research is well-cited, whereas Rabies research is less well-cited, but the prevalence is lower (100,000). This may be because dengue fever has a risk in terms of

² Hotez PJ (2008) *Forgotten People, Forgotten Diseases: The Neglected Tropical Diseases and Their Impact on Global Health and Development*. American Society for Microbiology Press, Washington, DC, USA: ISBN 978-1555814403

potential severity and likelihood of increase with climate change.

Clinical trials and epidemiology research

Epidemiology-associated research in NIDs diseases accounted for under half the research output in this disease area in sub-Saharan Africa (46.2%), compared to 19.2% globally. Much of this is conducted in East Africa and West Africa and relatively little is conducted in Central Africa.

Clinical trials research output in NIDs accounted for just 2.5% of global research output, and is the lowest in sub-Saharan

Africa compared to other disease areas (7.5%). Around half this research is conducted in East Africa and one-third in West Africa. Relatively little is conducted in Central Africa. Only two institutions published more than 20 clinical trials research papers in NIDs: the London School of Hygiene & Tropical Medicine and the University of Copenhagen. Their highly-cited research is linked to malaria clinical trials research papers mentioned in section 6.1.2, due to analysing trial participants who had taken the rabies vaccine in addition to the RTS,S/AS01E vaccine.

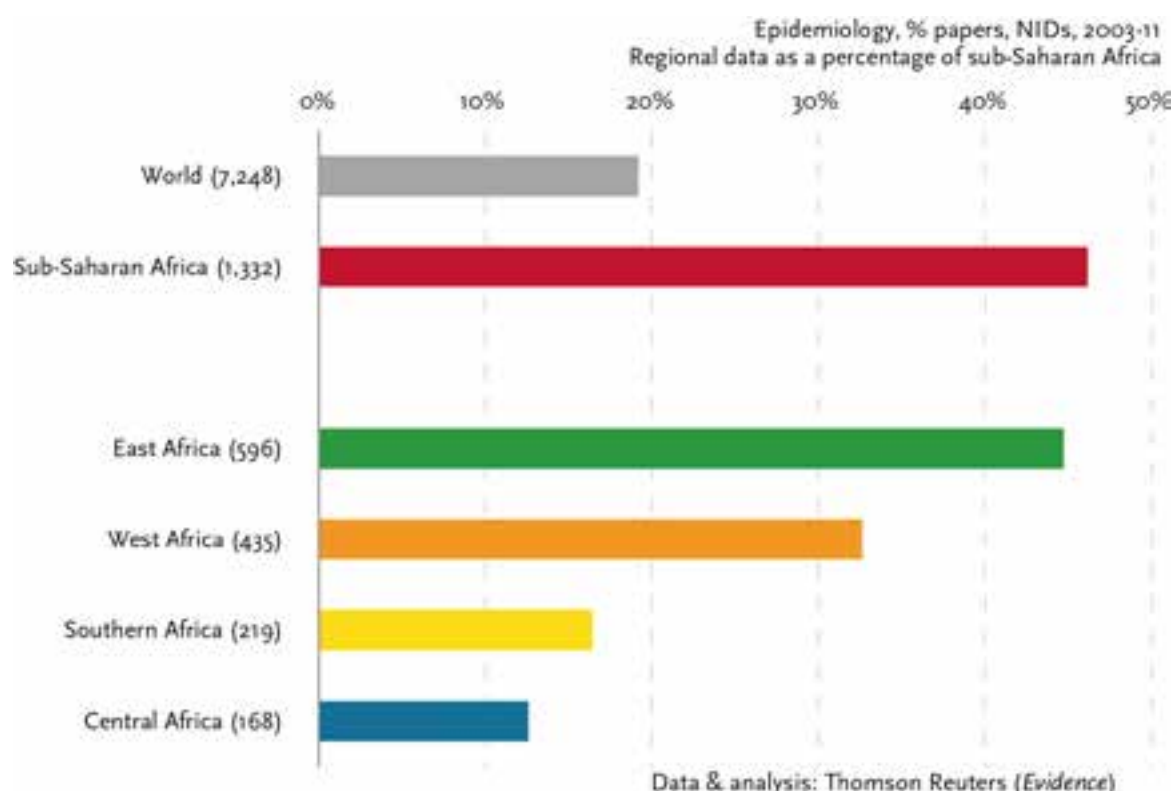


Figure 7.1.3 Epidemiology research, NIDs, sub-Saharan Africa and world

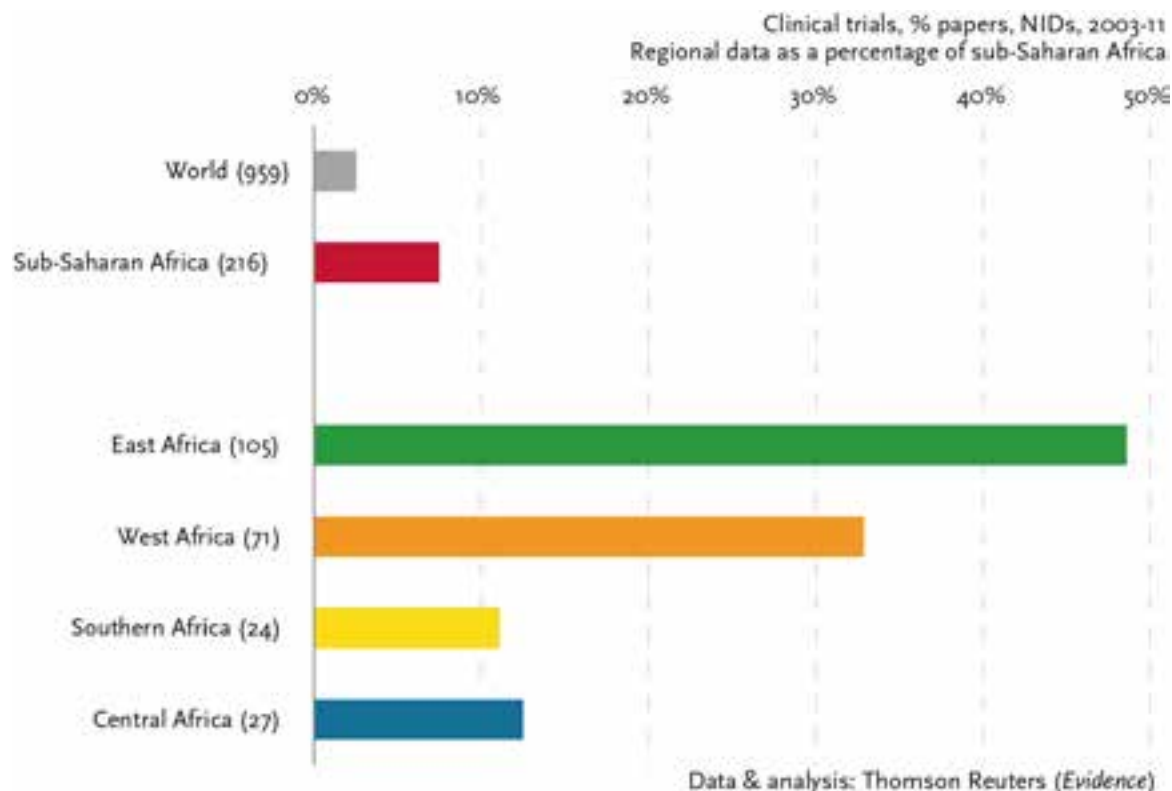


Figure 7.1.4 Clinical trials research, NIDs, sub-Saharan Africa and world

Table 7.1.1 Institutions involved in sub-Saharan African clinical trials research, NIDs

Institution	Country	Papers (N)	Citation impact
London School of Hygiene & Tropical Medicine	UK	44	2.93
University of Copenhagen	DNK	25	2.79

EDCTP-associated funding collaboration

As EDCTP is currently not involved in NIDs research, a collaboration cartwheel is not shown for this disease area.

for Malaria Venture and the German Federal Ministry of Education and Research.

EDCTP is associated with just two papers in sub-Saharan African between 2008 and 2011. Both of these papers are related to malaria research and have acknowledged the European Commission, Wellcome Trust, Medicines

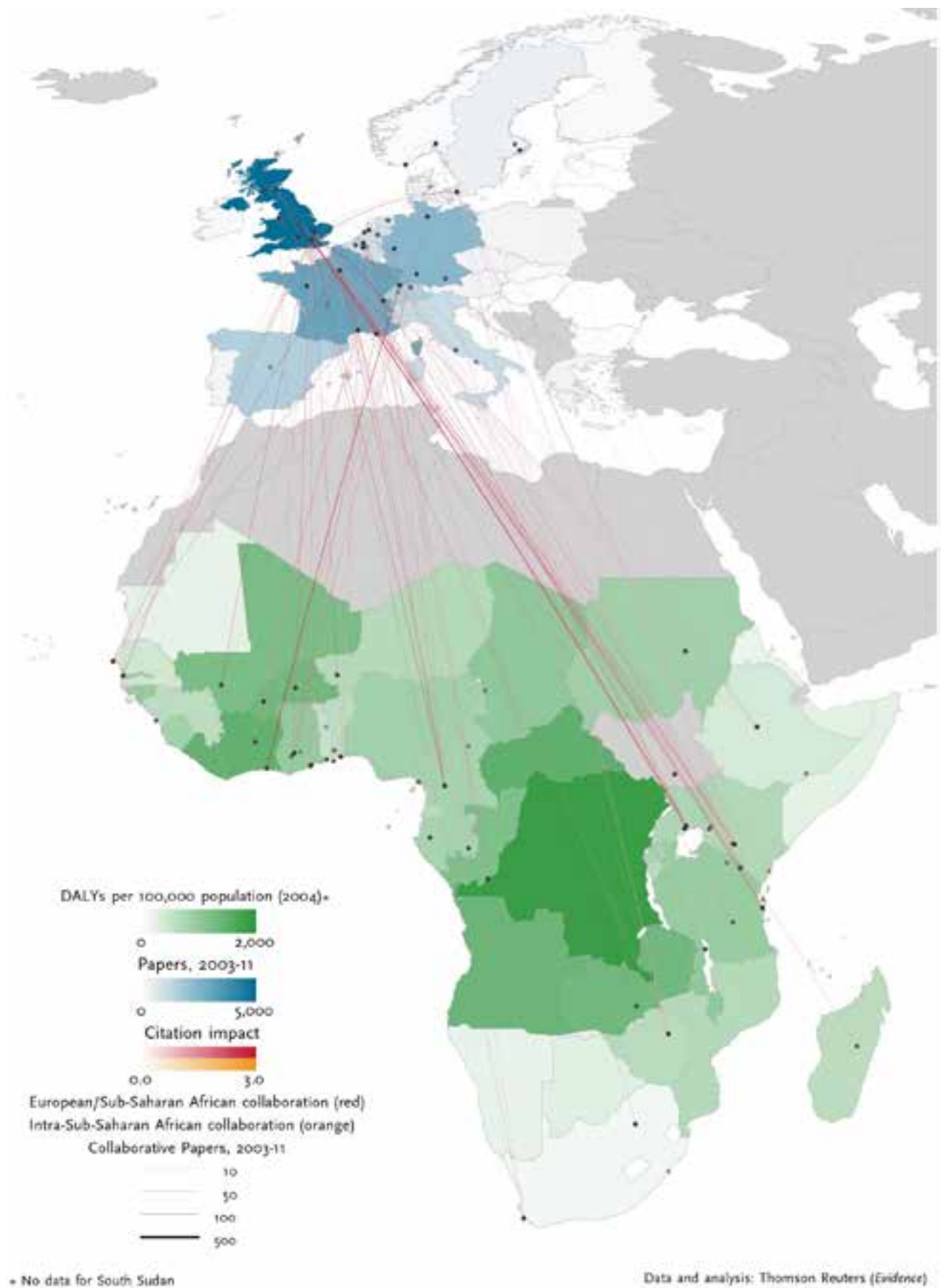


Figure 7.1.5 Disease burden in Sub Saharan Africa, research output in Europe and their collaborative links in neglected infectious diseases

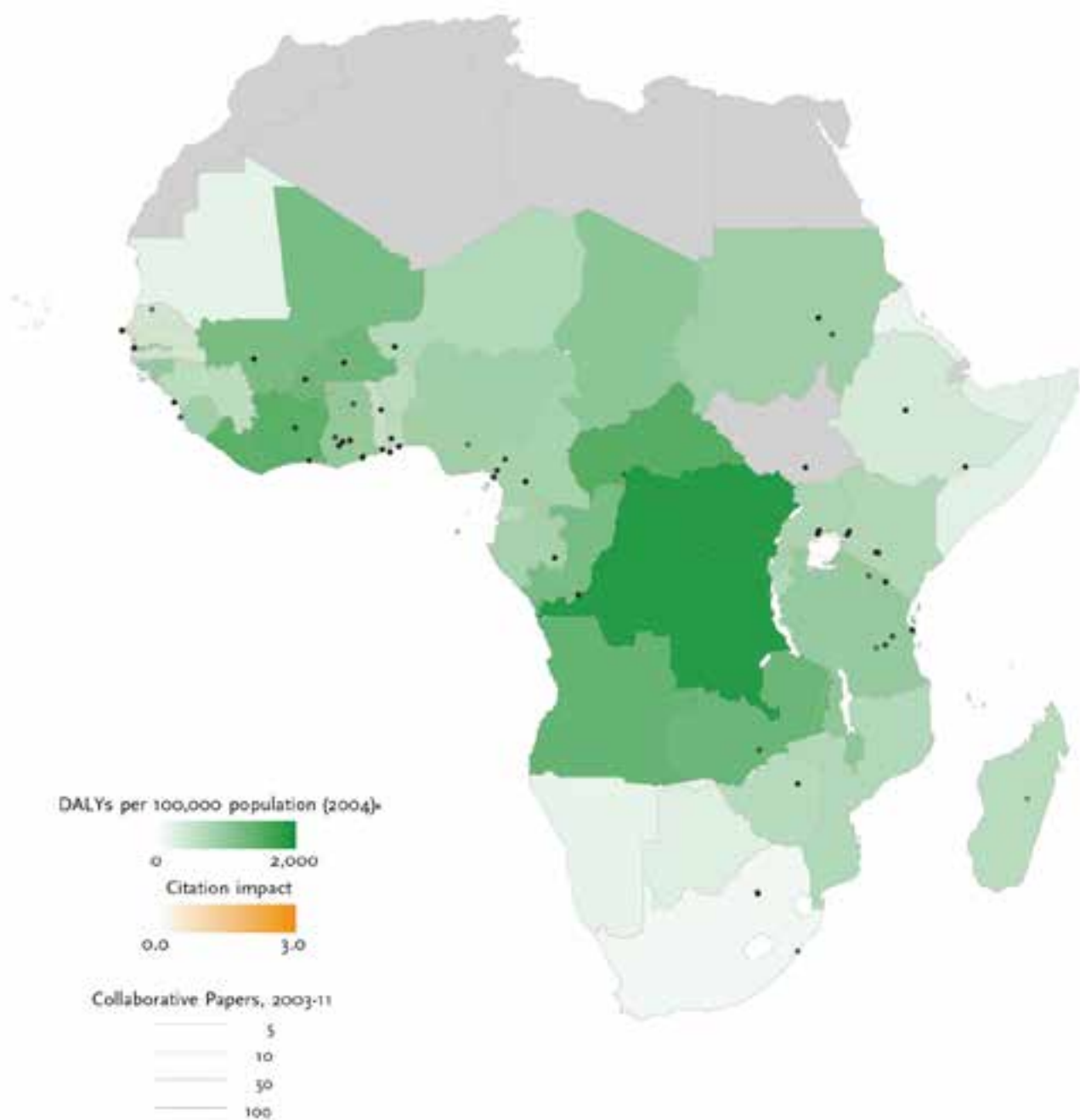


Figure 7.1.6 Disease burden and collaborative research links within Sub-Saharan Africa in neglected infectious diseases

7.2. European research in NIDs

Globally NIDs research is less well cited than other disease areas. France is particularly active in collaborating with sub-Saharan Africa through its links with the Francophone areas of West and Central Africa where the disease burden is high.

EDCTP Member Countries published 15,284 papers in NIDs research (2003-11). Though annual research output is rising, share of global research output has fallen (section 7.3). Collaboration between Europe and sub-Saharan Africa has risen from 933 papers (2003-07) to 1,279 papers (2007-11) but share of global research output has remained flat at 4.5%.

The citation impact of NIDs research globally has remained around world average of 1.0. The citation impact of research conducted by EDCTP Member Countries is higher (average citation impact 1.23) and the citation impact of collaborative research with sub-Saharan Africa is 1.28 and rising.

The key findings by country (section 7.4 and section 7.5) are:

- The UK published the largest volume of research in NIDs (5,212 papers, 2003-11). This research is very highly-cited (average citation impact 1.49). The UK is the leading collaborative partner of sub-Saharan Africa in Europe particularly via the London School of Hygiene & Tropical Medicine, the University of Liverpool and Imperial College London.
- France published the second largest volume of research in NIDs and 13.4% of its national research output is collaborative with sub-Saharan Africa; higher than the European average in contrast to other disease areas. This is led by the IRD, which has a number of satellite offices in sub-Saharan Africa working in NIDs research,

such as the Coordination Organization for the Fight Against Endemic Diseases in Central Africa.

- Swiss highly-cited research output (average citation impact 1.93) is partly due to WHO³ and partly to the Swiss Tropical & Public Health Institute, Basel.
- Belgium and the Netherlands stand out in NIDs on research volume, citation impact and relative collaborative volume with sub-Saharan Africa. In the Netherlands, this is because of its network of UMC Leiden and Wageningen University and Research Centre. In Belgium, this is because of the Institute of Tropical Medicine in Antwerp, which is the third most frequent collaborating institution with sub-Saharan Africa.
- Denmark is notable not just for the high citation impact of its research (average citation impact 1.49) but also that almost half of its national research output in NIDs is collaborative with sub-Saharan Africa. This is led by the DBL-Centre for Health Research and Development (formerly the Danish Bilharziasis Laboratory) and now part of the University of Copenhagen, the second most frequent collaborating partner of sub-Saharan Africa in NIDs research.

³ WHO accounts for 18.9% of the NIDs research of Switzerland; it accounts for 30.4% of the research which is collaborative with sub-Saharan Africa.

7.3. European research trends

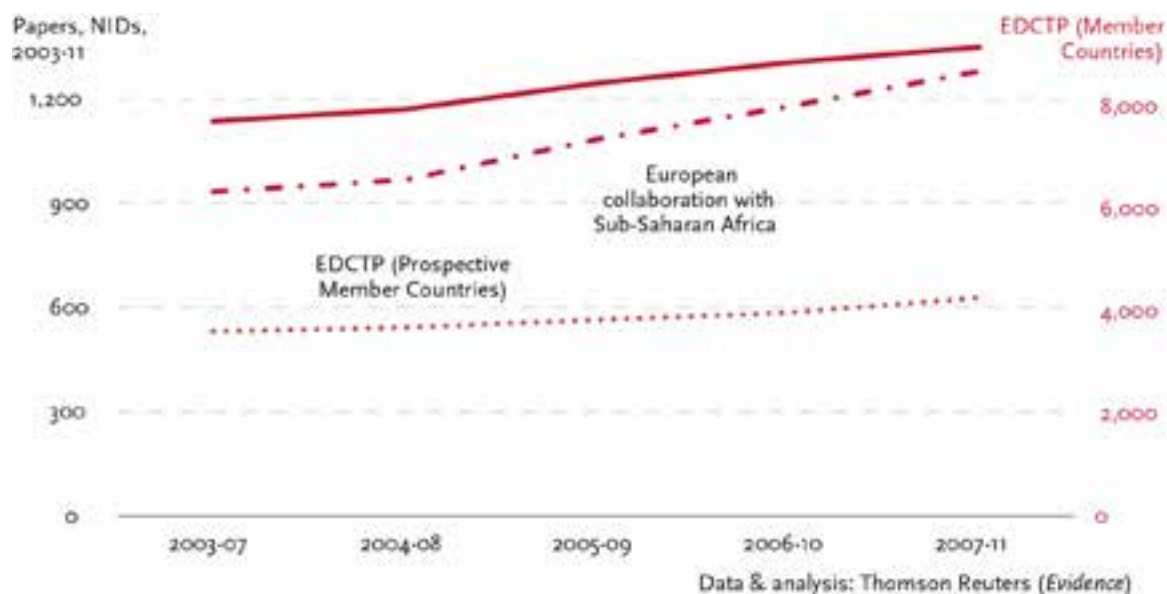


Figure 7.3.1 Trends in NIDs research output in Europe

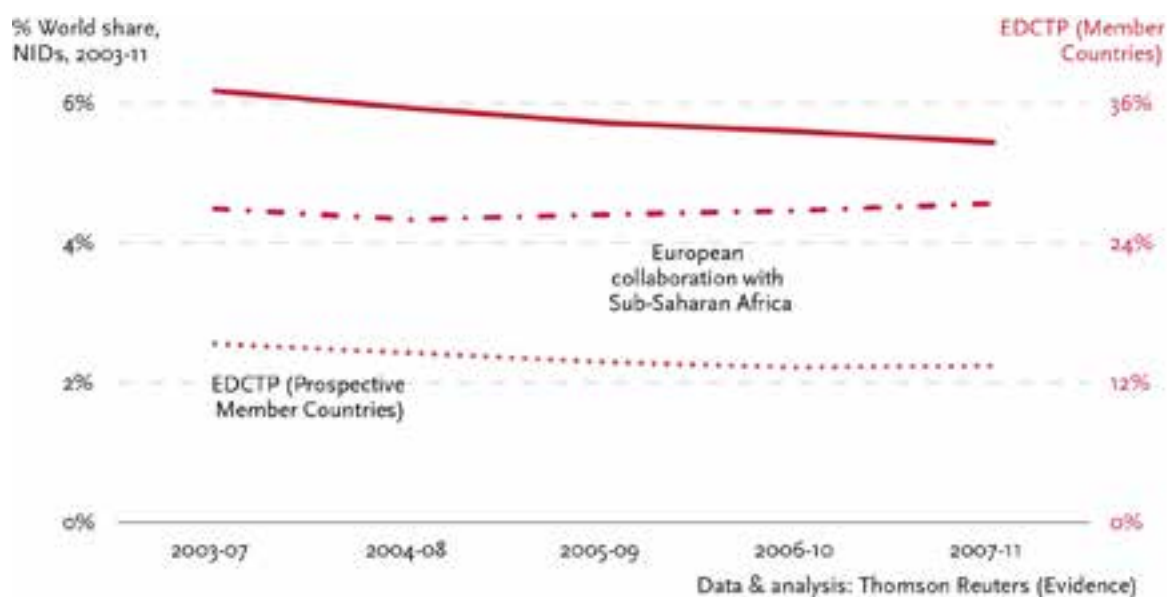


Figure 7.3.2 Trends in world share of NIDs research, Europe

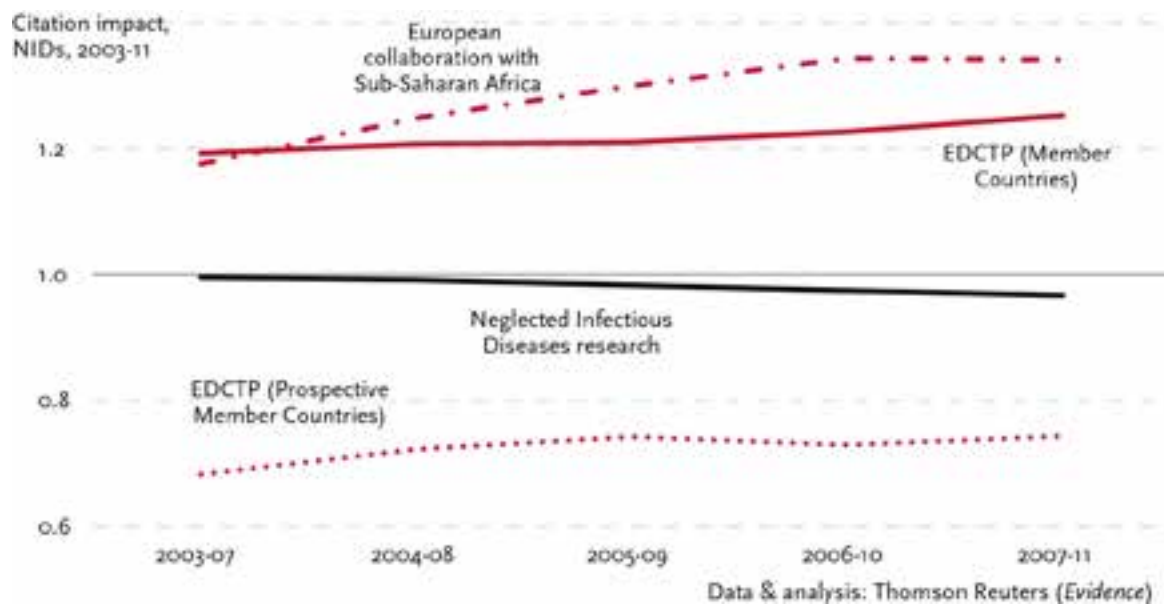


Figure 7.3.3 Trends in citation impact of NIDs research, Europe

7.4. EDCTP Member Countries

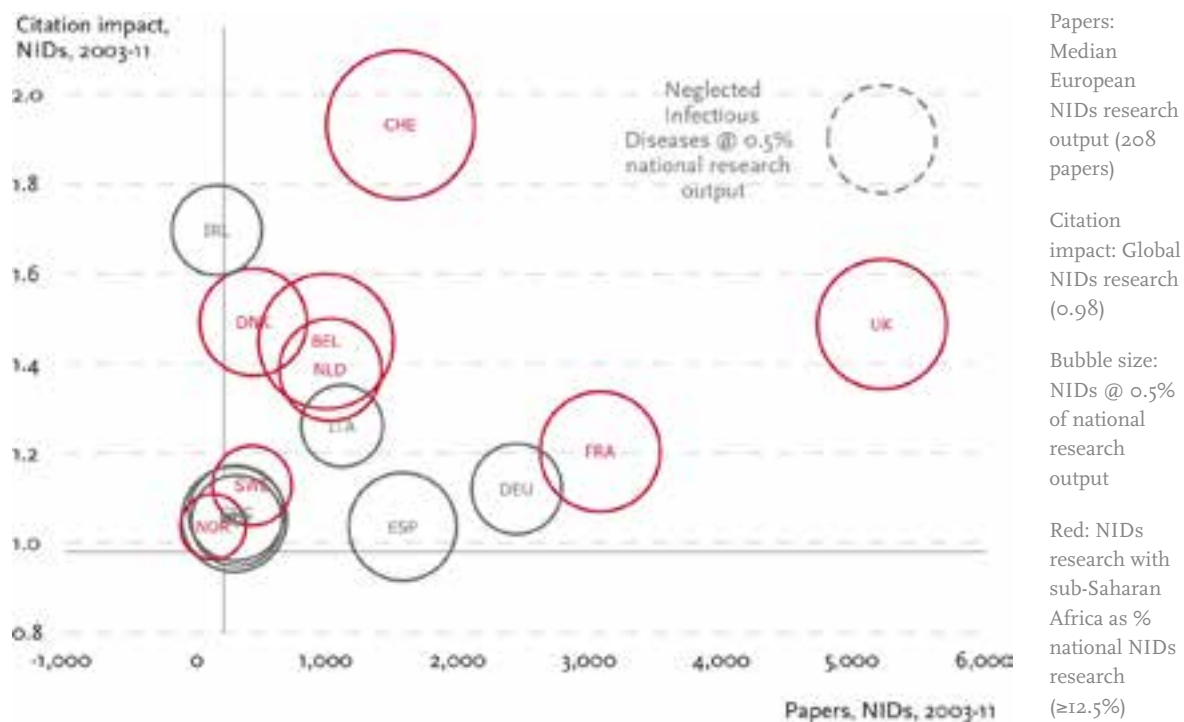


Figure 7.4.1 Country quadrant for NIDs research in EDCTP Member Countries

Table 7.4.1 Country data for NIDs research in EDCTP Member Countries

UN Short Code	National neglected infectious diseases research			Collaborative neglected infectious diseases research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
AUT	303	1.05	0.3%	29	1.08	9.6%
BEL	983	1.45	0.7%	238	1.61	24.2%
CHE	1,549	1.93	0.9%	273	1.98	17.6%
DEU	2,433	1.12	0.3%	245	1.07	10.1%
DNK	430	1.49	0.5%	194	1.24	45.1%
ESP	1,565	1.04	0.5%	35	1.21	2.2%
FRA	3,069	1.20	0.6%	411	1.20	13.4%
GRC	299	1.07	0.4%	4	2.09	1.3%
IRL	151	1.70	0.3%	14	2.21	9.3%
ITA	1,104	1.26	0.3%	74	1.99	6.7%
LUX	8	3.84	0.3%	0	0.00	0.0%
NLD	1,015	1.39	0.4%	198	1.21	19.5%
NOR	122	1.04	0.2%	40	0.62	32.8%
PRT	284	1.05	0.4%	12	1.69	4.2%
SWE	420	1.13	0.3%	62	1.04	14.8%
UK	5,212	1.49	0.7%	882	1.53	16.9%

Table 7.4.2 Institutions in Europe collaborating on NIDs research with sub-Saharan Africa

Institution	Country	Papers (N)	Citation impact
London School of Hygiene & Tropical Medicine	UK	311	1.93
University of Copenhagen	DNK	177	1.18
Institute of Tropical Medicine Antwerp	BEL	176	1.37
IRD	FRA	136	1.20
Swiss Tropical & Public Health Institute, Basel	CHE	133	1.89
University of Liverpool	UK	113	1.81
Imperial College London	UK	105	2.09
Natural History Museum	UK	87	1.70
University of Edinburgh	UK	87	1.39
WHO	CHE	83	2.55
University of Cambridge	UK	82	1.12
CIRAD (Agricultural Research for Development)	FRA	65	1.27
University of Oxford	UK	59	2.74
University of Glasgow	UK	55	1.13
UMC Leiden	NLD	54	1.20

Institut Pasteur	FRA	52	1.69
Bernhard Nocht Institute for Tropical Medicine	DEU	50	1.29
University of Tübingen (Eberhard Karl)	DEU	37	0.87
Wageningen University and Research Centre	NLD	33	1.94
University of Aix-Marseille 2 (Mediterranean)	FRA	32	1.67
University College London	UK	30	1.36
University of Basel	CHE	30	1.99
University of Limoges	FRA	29	1.13
CNRS (Centre National de la Recherche Scientifique) France	FRA	27	0.87
Royal Tropical Institute Amsterdam	NLD	26	0.88
University of Ghent	BEL	26	1.28
UMC Amsterdam	NLD	25	1.71
University of Nottingham	UK	25	1.46
St Georges University of London	UK	23	1.32
UMC Groningen	NLD	21	1.20
University of Munich (Ludwig Maximilian)	DEU	20	1.49

7.5. EDCTP Prospective Member Countries

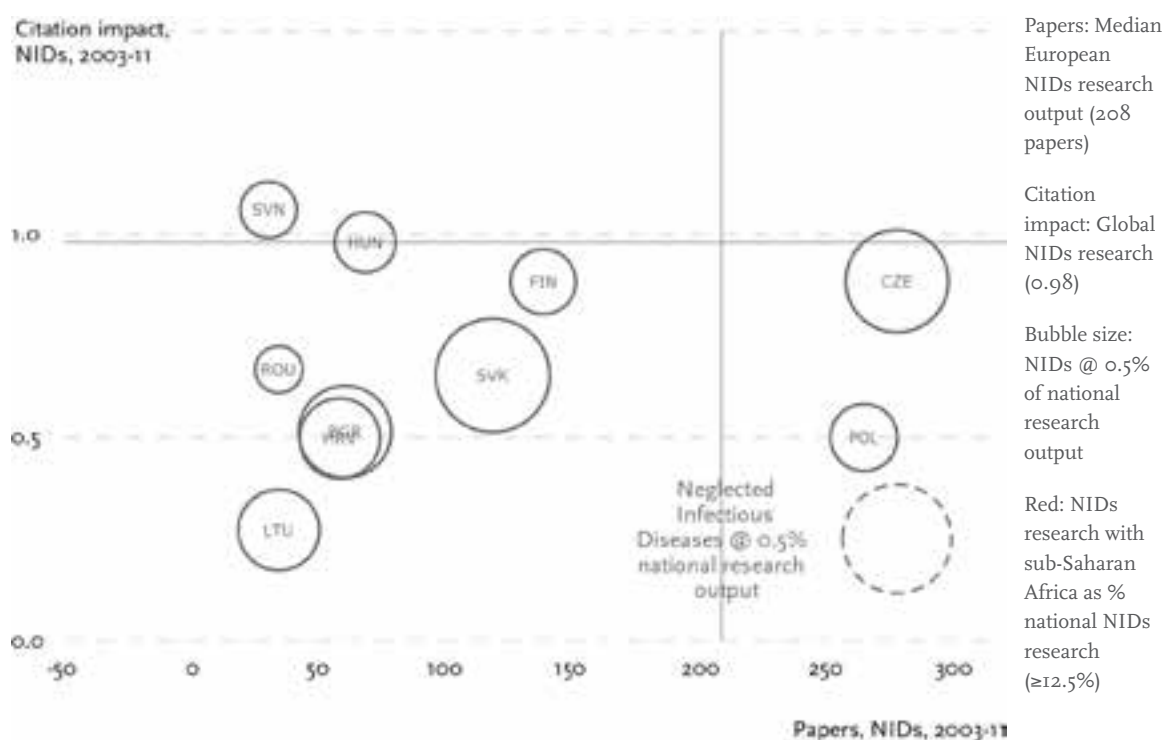


Figure 7.5.1 Country quadrant for NIDs research in EDCTP Prospective Member Countries

Table 7.5.1 Country data for NIDs research in EDCTP Prospective Member Countries

UN Short Code	National neglected infectious diseases research			Collaborative neglected infectious diseases research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
BGR	60	0.51	0.3%	0	0.00	0.0%
CYP	7	1.24	0.2%	0	0.00	0.0%
CZE	277	0.88	0.4%	5	0.42	1.8%
EST	13	1.20	0.1%	0	0.00	0.0%
FIN	138	0.88	0.2%	3	0.49	2.2%
HRV	58	0.50	0.3%	0	0.00	0.0%
HUN	68	0.98	0.1%	0	0.00	0.0%
LTU	34	0.27	0.3%	0	0.00	0.0%
LVA	4	1.01	0.1%	0	0.00	0.0%
MLT	3	0.61	0.4%	1	0.00	33.3%
POL	264	0.50	0.2%	1	0.00	0.4%
ROU	34	0.67	0.1%	0	0.00	0.0%
SVK	118	0.65	0.5%	2	0.52	1.7%
SVN	30	1.06	0.1%	1	0.50	3.3%

No institution from these countries has 20 or more collaborative papers with sub-Saharan Africa in NIDs research. No data are displayed.

the global average but in Southern Africa the pattern has been more variable.

Southern Africa

NIDs are not an area of major research focus for countries in Southern Africa. This reflects relative disease burden (section 7.8).

7.6. Sub-Saharan African research in NIDs

NIDs research in sub-Saharan African has grown from 1,470 papers (2003-07) to 2,137 papers (2007-11). This means a rising share of global research output (7.6%, 2007-11). East Africa and West Africa published more than 1,000 papers in this period. Southern Africa published 617 papers but Central Africa has only 433 papers. These research output figures do not reflect the relative burden of disease.

Citation impact of NIDs research has risen from 1.02 (2003-07) to 1.28 (2007-11) in East Africa. The citation impact of research from Central Africa increased from 0.86 to 1.17, suggesting that this region is receiving increasing research attention. The citation impact of research in West Africa is consistently above

- South Africa is the largest research producer in this region (408 papers). NIDs accounted for 0.7% of its national research output compared to 7.7% in HIV/AIDS and 2.9% in tuberculosis. The citation impact of its research is around the global average.
- NIDs is a higher percentage of the research output of Zambia and Zimbabwe. The citation impact of Zambia's research is boosted by collaboration between the University of Zambia and European partners.
- The high citation impact of research in Malawi is because the majority of this research is collaborative with Europe. This is due to the Karonga Prevention Study run with the London School of Hygiene & Tropical Medicine.

There are few funding agencies in Southern Africa, reflecting the lower burden of disease. The most prominent is the South African National Research Foundation (54 papers) though the citation impact of this research is well below average (average citation impact 0.73).

East Africa

Research in NIDs has increased from 596 papers (2003-07) to 859 papers (2007-11, 3.1% share of global output). The citation impact of this research is above the global average and rose to 1.28 in the most recent five-year period, 2007-11 (section 7.9).

- Kenya is the largest producer in this region (477 papers) and 57.4% of this research output is collaborative with Europe. The citation impact of this collaborative research is high (average citation impact 1.69) through KEMRI in Nairobi, Kenya.
- Ethiopia is the second largest producer of NIDs research in East Africa, but the citation impact of its research is below the global average (0.88) and the citation impact of its collaborative research is around the global average (average citation impact 1.01) despite accounting for nearly half of its research output. Addis Ababa University is the most frequent collaborating partner of Europe.
- Tanzania and Uganda are notable for the high citation impact of their research and collaborative research accounted for nearly 80% of their national research output. In Uganda, the major collaborators with Europe are the Ministry of Health (Vector Control Division) and Makerere University. In Tanzania, the most frequent collaborators are the National Institute for Medical Research, the Ministry of Health (Helminth Control Programme) and the Ifakara Health Institute.
- Research in Sudan and South Sudan is cited around the global average collaboratively.

The University of Khartoum and its Institute of Endemic Diseases has collaborated with European partners.

The most prominent funding agency in NIDs research in East Africa is the Wellcome Trust (102 papers), followed by the US National Institutes of Health and the European Commission. Research by the Bill & Melinda Gates Foundation is the most highly-cited (average citation impact 2.39).

West Africa

Research in NIDs has grown from 494 papers (2003-07) to 726 papers (2007-11) to some 2.6% of global research output. Citation impact whilst low in the earlier period, has risen to an average of 1.10 in the most recent five-year period, 2007-11 (section 7.10).

- The citation impact of Nigerian research in NIDs is 0.38, far below the global average.
- Research in NIDs represented over 10% of the research output of Burkina Faso and The Gambia, but also Guinea whose 21 papers in this disease area accounted for 11.4% of its total national research output.
- In Anglophone West Africa, Ghana has published 220 papers in NIDs research with a citation impact of 1.32, of which about three-quarters is collaborative with Europe. The leading collaborative institutions are Kwame Nkrumah University of Science and Technology and the Ministry of Health, responsible for the National Buruli Ulcer Control Programme. Almost all of The Gambia's research is collaborative with Europe, mostly through the MRC Unit, The Gambia.
- In Francophone West Africa, malaria and NIDs research is an area of national research focus for Burkina Faso which has a high disease burden. A major collaborating partner is the Centre International de Recherche-Developpement Sur l'Elevage en Zone Subhumide conducting research in

the transmission of Trypanosomiasis. Côte d'Ivoire has high citation impact through collaboration between the University of Cocody-Abidjan and the Swiss Academy of Science (Centre Suisse de Recherches Scientifiques).

There are few funding agencies active in NIDs research in Central Africa and those few are based in Europe. These include the European Commission, IRD and also the WHO.

In West Africa, prominent European funding agencies are the European Commission, Wellcome Trust and the IRD France, followed by US funding agencies such as the Bill & Melinda Gates Foundation and the US National Institutes of Health. The WHO has funded 25 papers.

Central Africa

NIDs have a high burden in Central Africa. The Central African Republic, Chad and São Tomé and Príncipe have little or no research in these disease areas (section 7.11) despite this burden.

- Cameroon has the largest research output in NIDs (243 papers), but this accounted for just 6.3% of its national research output of which 75.3% was collaborative with Europe. At the institutional level, collaboration was led by the University of Yaoundé I, Institut Pasteur, Organization of Coordination for the Fight Against Endemic Diseases in Central Africa and the Cameroon Ministry of Health.
- For the Democratic Republic of Congo, collaboration with Europe accounted for the majority of its total research output in NIDs with a citation impact of 1.38. Collaborating partners include the Ministry of Health, National Institute for Biomedical Research and the University of Kinshasa.
- 88.1% of the research output of Gabon is collaborative with Europe, and one of the main partners is the Franceville International Medical Research Centre.
- For Angola, its 24 papers in NIDs represented 14.8% of its total national research output: all this research is collaborative with Europe.

7.7. Sub-Saharan African research trends

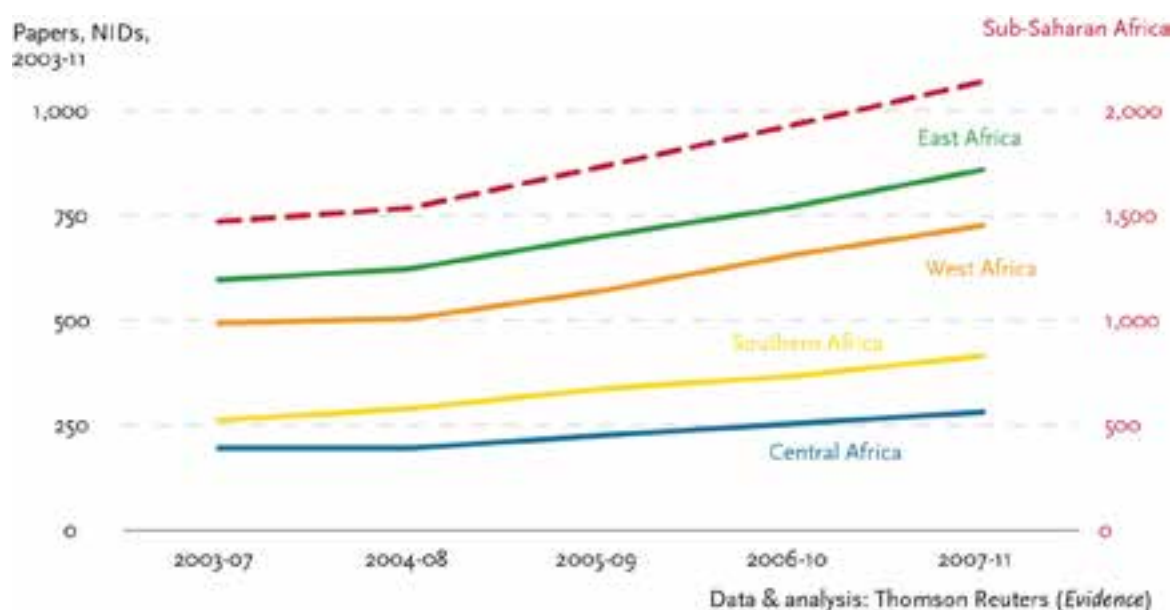


Figure 7.7.1 Trends in NIDs research output in sub-Saharan Africa

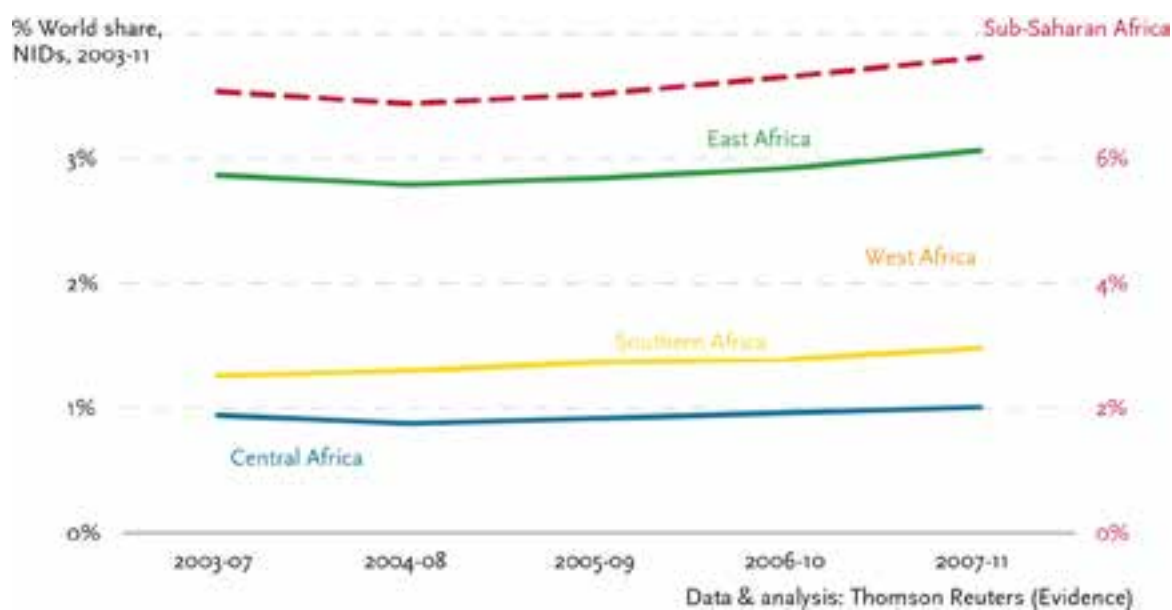


Figure 7.7.2 Trends in world share of NIDs research, sub-Saharan Africa

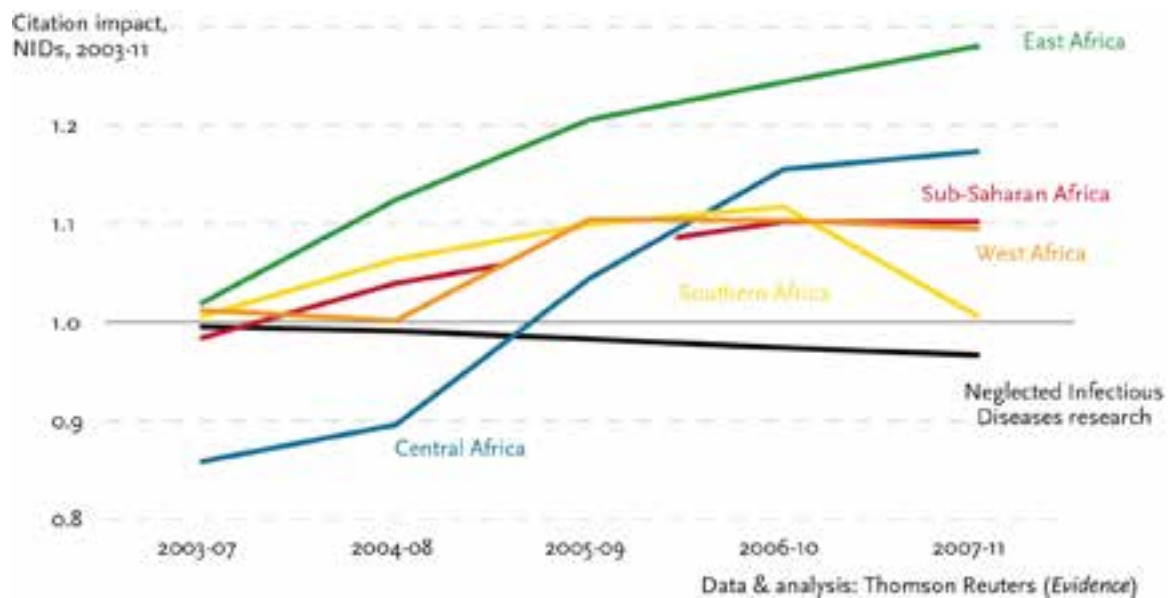


Figure 7.7.3 Trends in citation impact of NIDs research, sub-Saharan Africa

7.8. Southern Africa

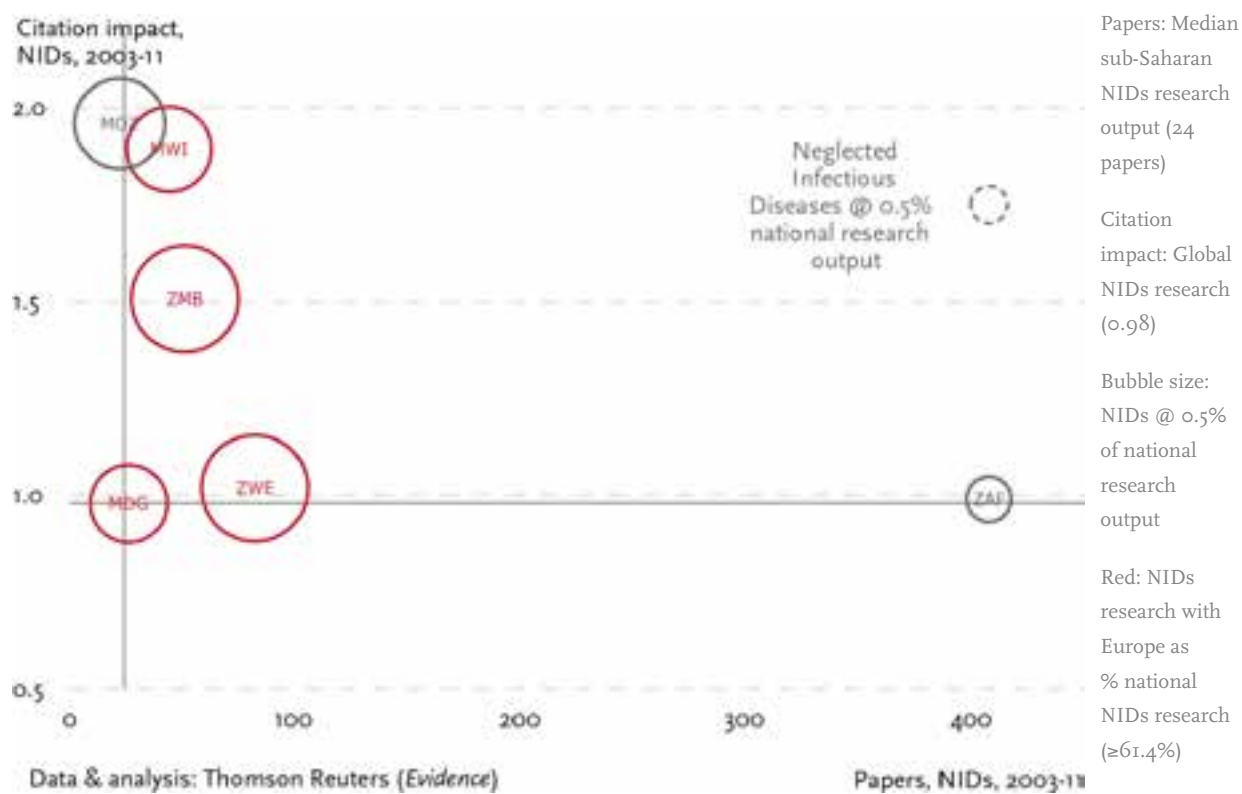


Figure 7.8.1 Country quadrant for NIDs research in Southern Africa

Table 7.8.1 Country data for NIDs research in Southern Africa

UN Short Code	National neglected infectious diseases research			Collaborative neglected infectious diseases research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
BWA	10	0.23	0.7%	2	0.51	20.0%
COM	2	1.49	6.9%	0	0.00	0.0%
LSO	1	0.00	0.8%	1	0.00	100.0%
MDG	26	0.98	2.1%	20	0.97	76.9%
MOZ	22	1.96	2.9%	17	2.23	77.3%
MUS	2	0.27	0.4%	0	0.00	0.0%
MWI	44	1.89	2.6%	38	2.12	86.4%
NAM	1	0.21	0.2%	0	0.00	0.0%
SWZ	1	0.00	0.4%	0	0.00	0.0%
SYC	0	0.00	0.0%	0	0.00	0.0%
ZAF	408	0.99	0.7%	177	1.23	43.4%
ZMB	51	1.51	4.1%	33	1.94	64.7%
ZWE	82	1.02	4.1%	59	1.09	72.0%

Table 7.8.2 Institutions in Southern Africa collaborating on NIDs research with Europe

Institution	Country	Papers (N)	Citation impact
University of Cape Town	ZAF	56	1.26
University of Zimbabwe	ZWE	41	1.09
University of Pretoria	ZAF	40	1.73
National Institute of Health Research	ZWE	27	1.26
University of Zambia	ZMB	25	1.93
University of KwaZulu-Natal	ZAF	23	0.64

Table 7.8.3 Agencies funding Southern African NIDs research, 2008-11

Institution	Region	Papers (N)	Citation impact
South African National Research Foundation	AFR	54	0.73
Wellcome Trust	EUR	29	1.10
European Commission	EUR	20	1.17
Department of Science and Technology, South Africa	AFR	13	0.33
WHO	IGO	12	2.19
US National Institutes of Health	ROW	11	0.93

7.9. East Africa

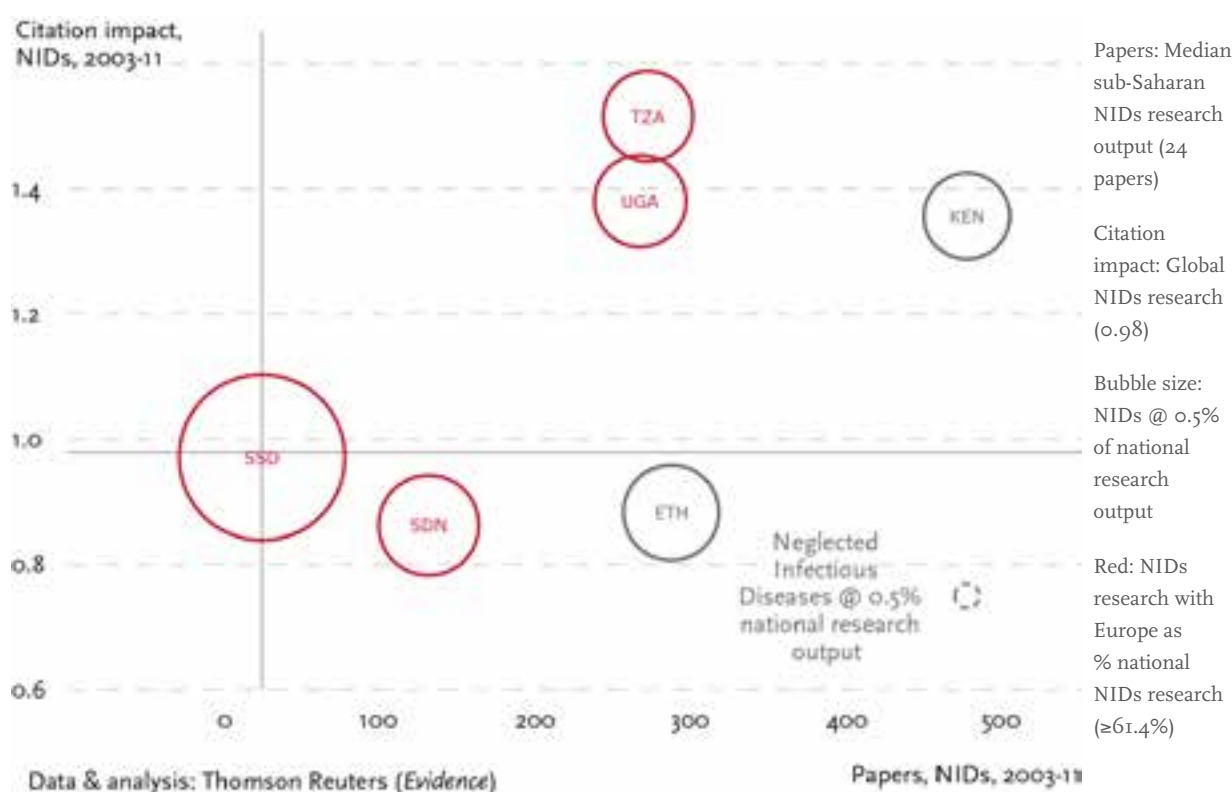


Figure 7.9.1 Country quadrant for NIDs research in East Africa

Table 7.9.1 Country data for NIDs research in East Africa

UN Short Code	National neglected infectious diseases research			Collaborative neglected infectious diseases research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
BDI	6	2.33	5.6%	6	2.33	100.0%
ERI	2	0.60	1.0%	2	0.60	100.0%
ETH	287	0.88	7.7%	138	1.01	48.1%
KEN	477	1.36	6.3%	274	1.69	57.4%
RWA	7	1.65	1.9%	5	2.09	71.4%
SDN	131	0.86	8.5%	86	1.00	65.6%
SOM	2	1.72	14.3%	1	2.36	50.0%
SSD	24	0.97	23.3%	23	1.01	95.8%
TZA	272	1.52	6.9%	214	1.75	78.7%
UGA	267	1.38	7.1%	205	1.61	76.8%

Table 7.9.2 Institutions in East Africa collaborating on NIDs research with Europe

Institution	Country	Papers (N)	Citation impact
Ministry of Health	UGA	100	1.84
KEMRI, Nairobi	KEN	96	1.78
Addis Ababa University	ETH	60	0.88
University of Khartoum	SDN	60	1.08
National Institute for Medical Research	TZA	54	1.68
Makerere University	UGA	52	1.61
Ministry of Health	KEN	50	1.15
International Livestock Research Institute	KEN	44	1.24
Ministry of Health	TZA	34	2.60
MRC Uganda Virus Research Institute	UGA	26	1.43
University of Nairobi	KEN	26	1.50
Ifakara Health Institute	TZA	24	1.68
Armauer Hansen Research Institute	ETH	22	1.39

Figure 7.9.3 Agencies funding East African NIDs research, 2008-11

Institution	Region	Papers (N)	Citation impact
Wellcome Trust	EUR	102	1.70
US National Institutes of Health	ROW	79	1.68
European Commission	EUR	53	1.88
Bill & Melinda Gates Foundation	ROW	43	2.39
WHO	IGO	28	2.10
Addis Ababa University	AFR	20	0.94
University of Copenhagen	EUR	19	0.71
UK DfID	EUR	17	1.14
Swiss National Science Foundation	EUR	14	3.02
UNICEF	ROW	13	0.91
German Academic Exchange Service	EUR	12	1.23
KEMRI	AFR	12	1.49
Research to Prevent Blindness	ROW	11	1.23
US Agency for International Development	ROW	11	1.99
US Centers for Disease Control and Prevention	ROW	10	0.79

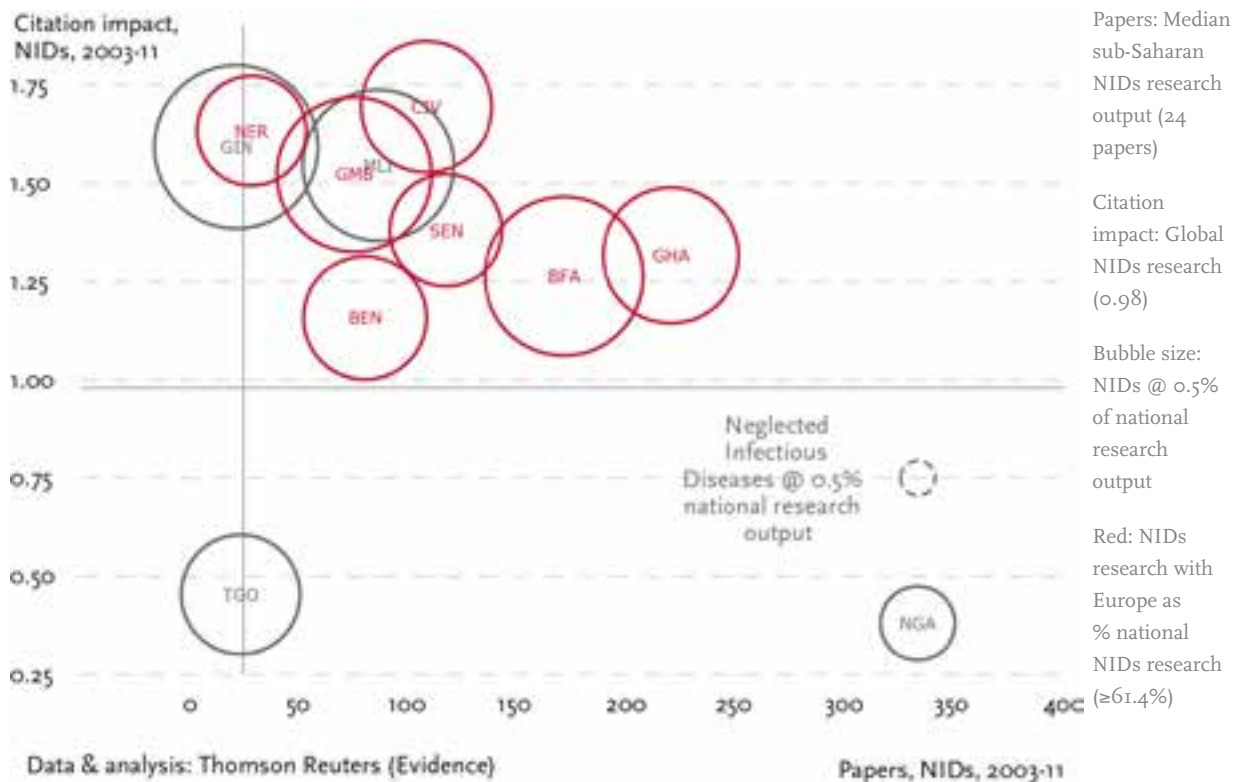


Figure 7.10.1 Country quadrant for NIDs research in West Africa

Table 7.10.1 Country data for NIDs research in West Africa

UN Short Code	National neglected infectious diseases research			Collaborative neglected infectious diseases research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
BEN	80	1.16	6.4%	74	1.10	92.5%
BFA	171	1.26	10.7%	134	1.39	78.4%
CIV	108	1.69	7.3%	91	1.94	84.3%
CPV	2	0.17	4.8%	1	0.00	50.0%
GHA	220	1.32	7.8%	167	1.27	75.9%
GIN	21	1.59	11.4%	18	1.69	85.7%
GMB	75	1.52	10.1%	73	1.55	97.3%
GNB	3	2.47	1.6%	3	2.47	100.0%
LBR	0	0.00	0.0%	0	0.00	0.0%
MLI	86	1.55	9.7%	51	1.90	59.3%
MRT	6	1.14	3.6%	5	1.37	83.3%
NER	28	1.63	5.1%	22	1.97	78.6%
NGA	333	0.38	2.3%	52	0.53	15.6%
SEN	117	1.38	5.3%	81	1.59	69.2%
SLE	8	0.94	7.1%	5	1.34	62.5%
TGO	23	0.45	6.0%	17	0.55	73.9%

Table 7.10.2 Institutions in West Africa collaborating on NIDs research with Europe

Institution	Country	Papers (N)	Citation impact
CIRDES	BFA	68	1.48
MRC Unit, The Gambia	GMB	63	1.66
Kwame Nkrumah University of Science and Technology	GHA	54	1.51
Ministry of Health	GHA	48	1.57
University of Cocody-Abidjan	CIV	43	2.56
University of Ghana	GHA	38	1.13
Swiss Academy of Science	CIV	37	2.85
Ministry of Health	BEN	32	1.16
Ministry of Health	BFA	32	1.83
Kumasi Centre for Collaborative Research in Tropical Medicine	GHA	28	1.78

Figure 7.10.3 Agencies funding West African NIDs research, 2008-11

Institution	Region	Papers (N)	Citation impact
European Commission	EUR	54	2.01
Wellcome Trust	EUR	37	1.78
IRD	EUR	35	1.30
Bill & Melinda Gates Foundation	ROW	32	1.87
US National Institutes of Health	ROW	30	2.15
WHO	IGO	25	1.36
Swiss National Science Foundation	EUR	19	3.44
French Ministry of Foreign Affairs	EUR	18	1.82
US Agency for International Development	ROW	16	2.08
UBS Optimus Foundation	EUR	15	1.50
UK MRC	EUR	14	0.91
French National Research Agency	EUR	13	1.05
Centre National de la Recherche Scientifique	EUR	11	0.91
Belgian Development Organisation	EUR	10	2.33
Raoul Follereau Institute	NGO	10	1.06

7.11. Central Africa

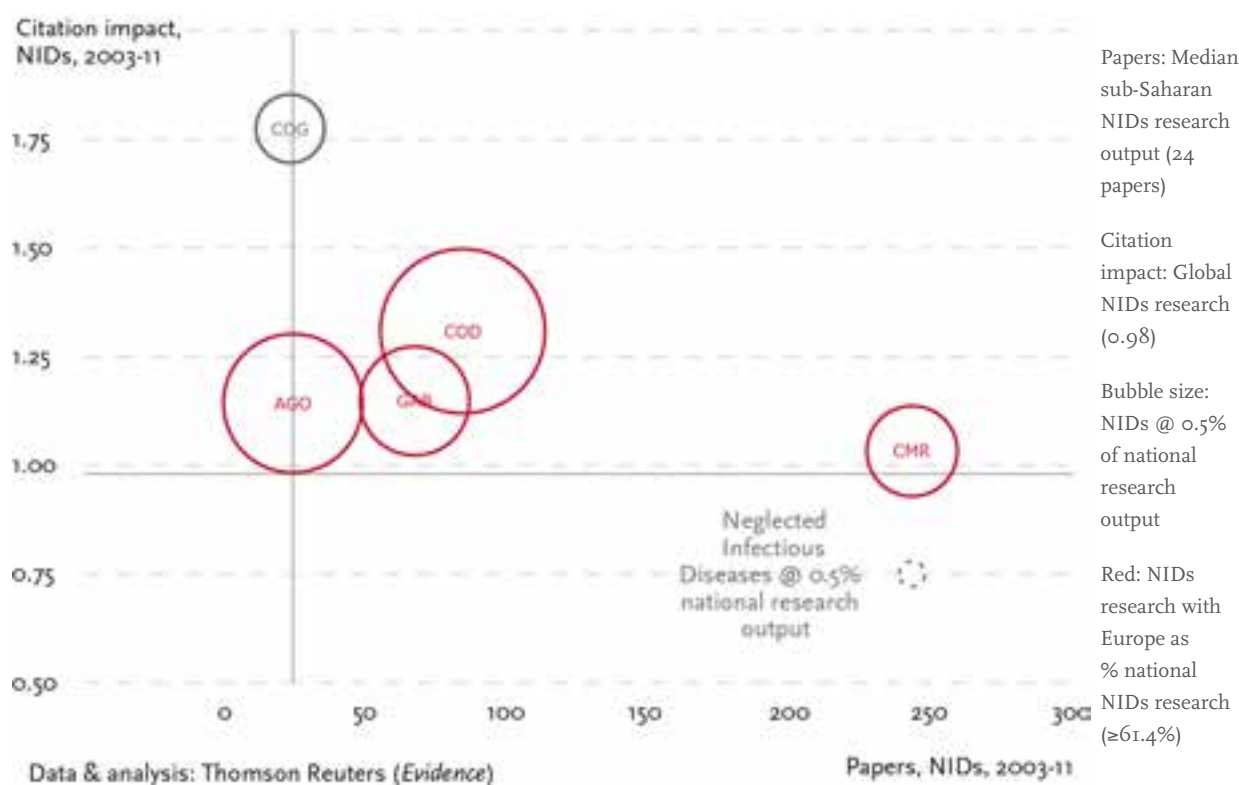


Figure 7.11.1 Country quadrant for NIDs research in Central Africa

Table 7.11.1 Country data for NIDs research in Central Africa

UN Short Code	National neglected infectious diseases research			Collaborative neglected infectious diseases research		
	Papers (N)	Citation impact	% National research	Papers (N)	Citation impact	% National research
AGO	24	1.14	14.8%	24	1.14	100.0%
CAF	9	1.09	5.1%	6	1.35	66.7%
CMR	243	1.03	6.3%	183	1.18	75.3%
COD	84	1.31	20.7%	76	1.38	90.5%
COG	23	1.77	3.6%	17	2.16	73.9%
GAB	67	1.15	9.1%	59	1.29	88.1%
GNQ	10	0.82	34.5%	10	0.82	100.0%
STP	0	0.00	0.0%	0	0.00	0.0%
TCD	10	0.81	7.2%	9	0.69	90.0%

Table 7.11.2 Institutions in Central Africa collaborating on NIDs research with Europe

Institution	Country	Papers (N)	Citation impact
University of Yaoundé 1	CMR	69	0.94
Ministry of Health	COD	36	1.81
National Institute for Biomedical Research	COD	34	1.38
Franceville International Medical Research Centre	GAB	29	1.58
Institut Pasteur	CMR	28	1.38
Organization for the Fight Against Endemic Diseases in Central Africa	CMR	24	1.73
Ministry of Health	CMR	23	2.22
University of Kinshasa	COD	23	0.61

Figure 7.11.3 Agencies funding Central African NIDs research, 2008-11

Institution	Region	Papers (N)	Citation impact
European Commission	EUR	40	1.17
IRD	EUR	30	1.20
WHO	IGO	22	2.10
Belgian Development Organisation	EUR	17	1.85
French Ministry of Foreign Affairs	EUR	11	1.26
French National Research Agency	EUR	11	2.51

8. Conclusion

The objective of this bibliometric analysis was to quantify research output by European and African researchers on poverty-related and neglected infectious diseases (PRDs) and measure its relative impact. The analysis comprises publications in peer-reviewed journals between 2003 and 2011 and describes patterns of research collaboration as well.

Overall, the report shows that the volume and citation impact of papers from sub-Saharan Africa has increased since 2003, as has collaborative research between Europe and sub-Saharan Africa. Papers arising from collaborative research had a higher citation impact than non-collaborative research and over 90% of publications from EDCTP-funded research projects were published in high-impact journals.

The report shows that the European share of world research in HIV/AIDS, TB and neglected infectious diseases is around one-third. Whilst European research output has grown, it has not kept pace with global research growth as the European share of the world output has fallen. Sub-Saharan Africa's share is around one-tenth. The relative contribution of both regions to the global output of malaria research is larger. More than one-fifth of published malaria research involves at least one author from sub-Saharan Africa.

Across sub-Saharan Africa there has been a dramatic growth in research output in PRDs, particularly in HIV/AIDS and TB, over the last decade. With the exception of HIV/AIDS, research output is not always correlated with burden of disease. Typically, the number of publications produced by sub-Saharan African countries is small; and, from some areas with a high disease burden, there is little or no published research at all.

Research output differs by disease area across the four regions of sub-Saharan Africa. In all disease areas research output from Central

Africa is small, whereas research output as well as the connection with European research tend to be more substantial in Southern and East Africa. There is little research collaboration between the sub-Saharan African countries, and even less when there is no European collaboration.

This analysis shows that European/sub-Saharan Africa research collaboration in all these PRDs is exceptionally highly-cited. Such collaboration brings together institutions and funding agencies from across Europe, sub-Saharan Africa and the rest of the world. Moreover, open access journals are increasingly used to publish research in these disease areas which may contribute to greater accessibility to researchers in sub-Saharan Africa and thus facilitate collaboration.

EDCTP-associated papers related to HIV/AIDS, TB and their co-infection and involving authors from Southern Africa and East Africa, are exceptionally highly-cited: around five times the world average. EDCTP works with leading European and sub-Saharan African institutions collaborating in these disease areas.

These results suggest that research on PRDs in sub-Saharan Africa is growing and that the EDCTP partnership contributes to high-impact collaborative research published in high-impact journals. By providing research funds and supporting activities to strengthen the research environment, the partnership also contributes to sub-Saharan African researchers taking a more prominent place in PRD research.

Colophon

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European & Developing Countries
Clinical Trials Partnership

Editors: EDCTP Secretariat
Design: Sam Gobin

Europe Office

Postal address
P.O. Box 93015
2509 AA The Hague
The Netherlands

Visiting address
Anna van Saksenlaan 51
The Hague, The Netherlands

Phone +31 70 344 0880/0897
Fax +31 70 344 0899
E-mail info@edctp.org
Internet www.edctp.org

Africa Office

Postal address
P.O. Box 19070
Tygerberg 7505, Cape Town
South Africa

Visiting address
Francie van Zijl Drive, Parowvallei
Cape Town, South Africa
Phone +27 21 938 0690
Fax +27 21 938 0569

