

Changing Disease Patterns in Africa

RECOMMENDATIONS TO POLICYMAKERS

by:
NETWORK OF AFRICAN
SCIENCE ACADEMIES
(NASAC)

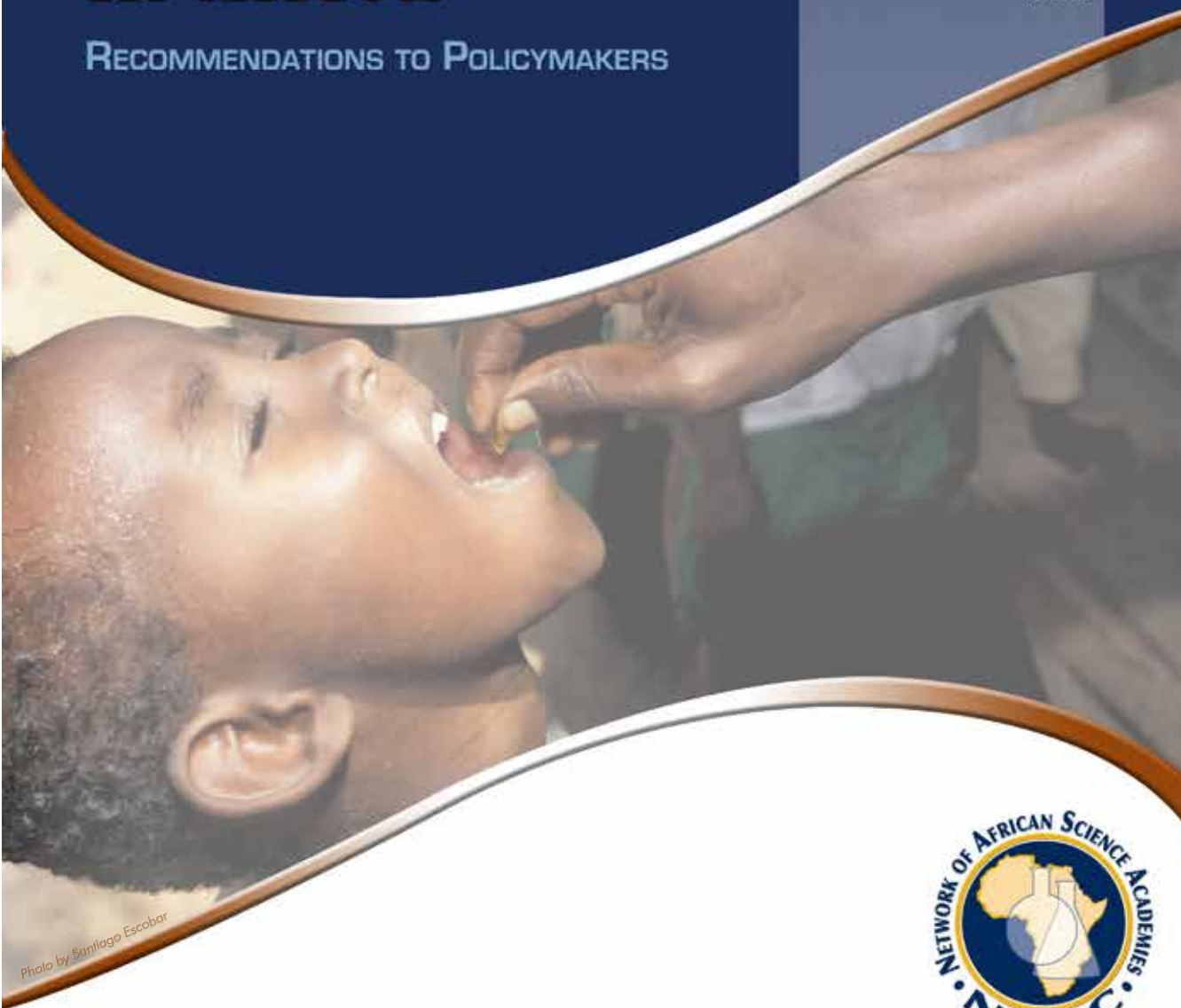


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The Network of African Science Academies (NASAC) was established on 13 December 2001 in Nairobi, Kenya, under the auspices of the African Academy of Sciences (AAS) and the Inter Academy Panel (IAP). NASAC is a consortium of merit-based science academies in Africa and aspires to make the “voice of science” heard by policymakers and decision-makers within Africa and worldwide. NASAC is dedicated to enhancing the capacity of existing national science academies and champions the cause for creation of new academies where none exist.

This document is an output from the cooperation between NASAC and the German National Academy of Sciences Leopoldina. The Leopoldina is the world’s oldest continuously existing academy for medicine and the natural sciences. It was founded in 1652 and has been located in Halle since 1878. It has more than 1,400 elected members, who are outstanding scientists from all over the world. The Leopoldina was appointed Germany’s National Academy of Sciences in July 2008. In this function, one of the Leopoldina’s responsibilities is to provide science-based advice to policymakers and to the public. It represents German scientists in international academy circles and maintains links with scientific institutions in European and non-European countries.

The cooperation project between NASAC and the Leopoldina is funded by the German Federal Ministry of Education and Research (*Bundesministerium für Bildung und Forschung*, BMBF). Education and research are a Federal Government policy priority in Germany, based on the firm belief that they are the foundations on which we will build our future in a changing world, and that we will only be able to master the challenges of the 21st century through international cooperation in education, research and science. BMBF therefore cooperates with individual states and institutions on many interdisciplinary projects.

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Foreword

Changing disease profiles on the African continent have enormous significance for the health and economy of Africa, highlighting the need to avert the looming negative consequences of a shift from a predominantly communicable disease profile to a situation of a dual burden consisting of communicable and non-communicable diseases. In light of this, Africa's leading medical academics have come together through their science academies to undertake an analysis of the situation and to formulate a series of recommendations for African governments and other partners. This policymaker booklet emanates from a writing team constituted from participating science academies and is based on two conferences and a workshop.

The first meeting in Hamburg, held in November 2012, was attended by the Network of African Science Academies, as well as by collaborators from the German National Academy of Sciences Leopoldina. With special input from the Ghana Academy of Arts and Sciences, the meeting enabled leading scientists, including specialists in public health, policymakers, programme managers and the pharmaceutical industry, to share perspectives from the developing and developed economies in addressing the challenges of health problems in Africa. Further, the attendees analysed the causes and the impact of the problems, before considering various ways to overcome them. The Hamburg Symposium was important in identifying and clarifying common issues in terms of the social determinants of both communicable and non-communicable diseases and the need to develop integrated public health strategies. Broadly, efforts to tackle all diseases rely on improved public health infrastructure, services and skills for preparedness and responsiveness, together with education and empowerment of the individual, family and community to raise awareness of diseases, their determinants and management options. Better disease surveillance, primary prevention and early diagnosis are key elements in managing diseases. In terms of the research agenda, there are common strategic issues for new tools to control disease, for research to inform policy and research to support implementation.

The recommendations on non-communicable diseases that emerged from the meeting in Hamburg were presented and endorsed during an Interacademy Medical Panel Conference on changing patterns of non-communicable diseases hosted by the Academy of Science of South Africa in Johannesburg in August 2013. Finally, a writing team workshop was held in Pretoria in September 2014 to formulate this policymakers' booklet that subsequently underwent peer-review. The end-product has been milled by experts in the field to produce the best contemporary options and recommendations to assist policymakers to deal with the emerging problem of the concurrently growing dual burden of communicable and non-communicable diseases in a pro-active manner to avert or minimise their negative impacts.



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List of acronyms

ASSAf	Academy of Science of South Africa
AAS	African Academy of Sciences
AU	African Union
BCG	Bacille Calmette Guerin
BMBF	Bundesministerium für Bildung und Forschung
CD	Communicable Disease
DALY	Disability Adjusted Life Years
EDCTP	European and Developing Countries Clinical Trials Partnership
EU	European Union
FAO	Food and Agriculture Organization
GAVI	Global Alliance for Vaccines and Immunisation
GFATM	Global Fund to Fight AIDS, Tuberculosis and Malaria
IAP	InterAcademy Partnership
IMF	International Monetary Fund
MDG	Millennium Development Goal
MDR	Multidrug-resistant
MTCT	Mother-to-Child-Transmission
NASAC	Network of African Science Academies
NCD	Non-Communicable Disease
NGO	Non-governmental Organisation
OCP	Onchocerciasis Control Programme
PEPFAR	US President's Emergency Plan for AIDS Relief
R&D	Research and Development
TB	Tuberculosis
UNDP	United Nations Development Programme
WHO	World Health Organization
XDR	Extensively Drug-Resistant

Africa as a whole is undergoing demographic and socio-economic changes, albeit the levels of these changes vary by region resulting in variation in health profiles (WHO, 2014a). Concomitant with these changes is a shift in disease pattern from a predominantly communicable disease scenario to a situation of emerging non-communicable diseases and is often a mix of communicable and non-communicable diseases (NCDs) resulting in a double burden of disease. The co-existence of a high burden of infectious diseases with an increasing prevalence of NCDs will pose a formidable challenge to Africa. Addressing these health challenges in a timely and planned manner will avert and mitigate the possible dire health consequences that could emerge.


There are many health consequences of these changing disease trends. These hamper economic development through productive life lost and make the achievement of the Millennium Development Goals (MDGs) more difficult. They put pressure on the already fragile healthcare systems, that are not well equipped, and have inadequately trained personnel.

This emerging trend has to be addressed in a holistic way to anticipate the health consequences and to respond to the resultant pressures. Investing in health contributes both to economic and demographic development; however there is a danger of uneven health development due to externally driven pressure in prioritising and planning for health. While keeping with international standards, health planning for Africa has to be done in a local context, based on evidence that is generated in Africa. This facilitates the formulation of sound health policy.

A plethora of health policy strategies and documents exists both globally and specifically for the African continent including the draft Sustainable Development Goals, the Millennium Development Goals, the WHO Global NCD Action Plan, and the Science, Technology & Innovation Strategy for Africa 2024-STISA-2024 (African Union, 2014). However, progress in attaining the health related MDGs has sometimes been disappointing (Smith and Mackellan, 2007). The main reason for this failure is that the interrelationships of the various components of the health system have been ignored. The objective of an African health policy should be to strengthen the health system and not to undermine the health system development that is already suffering from fragmentation due to competing vertical programmes. In order to circumvent this fragmentation, the health system must be strengthened to address infrastructure and human resources that can comprehensively respond to different scenarios of health development in the various countries of Africa. Action on health system strengthening must also be considered within the broader context of other necessary actions, for example in education and with respect to tackling political and economic instabilities.

The continuing preparation of a set of Sustainable Development Goals (<https://sustainabledevelopment.un.org/topics/sustainabledevelopmentgoals>), to build upon the MDGs and converge with the post-2015 development agenda, provides new opportunities for coordinated action for tackling communicable diseases (CDs) and non-communicable diseases and (NCDs).

The value-addition of this document is that it provides an integrated compendium to complement all the other policy documents in achieving the desired goal. It is a ready source of reference for policymakers seeking an integrated approach in health development and without having to sift through pages dispersed in various sections.



In this document, the working group identified six cross-cutting issues, namely:

- (i) Conducting country level assessment of changing disease patterns;
- (ii) Planning to avert and mitigate the dire consequences of CDs and NCDs in an evidence based manner;
- (iii) Creating and enhancing partnership;
- (iv) Mobilising resources;
- (v) Conducting research and surveillance; and
- (vi) Identifying the role of academies in articulating the voice of science.

These approaches will help in the formulation and implementation of sound public health policy of countries in Africa.

KEY MESSAGE 1: Assessing the changing disease patterns

Each African country should undertake a national assessment of the burden of communicable and non-communicable diseases as well as develop estimates of how the country's demographic and epidemiological transitions are likely to influence their long-term trends.

KEY MESSAGE 2: Planning to avert and mitigate the dual communicable and non-communicable disease burden

Africa can avert and mitigate the impact of its changing disease patterns and choose a path to a healthier future. This will require meticulous, evidence-informed planning, that should include engagement with the key stakeholders to define the priorities, specific objectives and the approaches, milestones and funds needed to reach the desired outcome.

KEY MESSAGE 3: Creating and enhancing partnerships

In order to achieve coordinated action for a healthy future, Africa must mobilise partners across disciplines, sectors and borders. This tenet accords also with the recently developed concept of One Health.

KEY MESSAGE 4: Mobilising resources for a healthy future

Additional resources will be required to meet the estimated cost for the implementation of the plan of action. Resources should be mobilised at national level from public and private sectors as well as from international partners to achieve the shared vision.

KEY MESSAGE 5: Research and surveillance – generating evidence for action

Research should generate evidence to inform policymaking and provide new tools to control disease and to support programme implementation.

Surveillance should be timely, complete and accurate in order to generate information for action in prevention and control of health conditions.

KEY MESSAGE 6: Role of science academies in articulating the voice of science

The academies of science have an increasingly important role to play, individually and collectively, in helping to achieve the goal of a healthy Africa. Major tasks of the academies in providing leadership and support to the scientific community include collecting, validating and synthesising and supplying independent evidence to support policy options. Countries should strengthen their capacity to conduct research and surveillance to meet these goals for achieving a healthy African population.

Short introduction to the shift: Africa is undergoing an epidemiological transition from high to low mortality as a consequence of structural demographic changes in age and sex and causes of death, as seen elsewhere in the world (Omran, 1971). Contingent on this epidemiological transition are the inherent health consequences that have to be anticipated and preparations to be initiated in anticipation of the likely disease burden scenarios.

What is the current epidemiological situation in Africa? The existing pattern of health problems in Africa is a combination of communicable and non-communicable diseases, although the frequency varies among different countries.

Communicable diseases: Infectious diseases constitute a major problem in Africa where they account for about 27% of Disability Adjusted Life Years (DALYs) and cause approximately 70% of the deaths in Africa (WHO, 2014b). Communicable diseases can be broadly considered in terms of:

- (i) diseases targeted by Global Fund (HIV, TB and malaria);
- (ii) Vaccine-preventable diseases (e.g. meningococcal meningitis, yellow fever, and poliomyelitis among others);
- (iii) Neglected tropical diseases (e.g. soil-transmitted helminths, schistosomiasis and leishmaniasis); and
- (iv) emerging/re-emerging diseases (e.g. viral haemorrhagic fevers including Ebola, Marburg, Chikungunya and Dengue).

HIV/AIDS accounts for 26% of global DALYs and 68% of the global total occur in Africa. In some African countries, more than 20% of the population may be affected. Mother to child transmission remains a significant problem with some 1,000 HIV-positive births every day in Africa, compared to only one in USA/Europe. A significant factor in the changing epidemiological profiles on the African continent is the growing co-morbidity associated with HIV/AIDS. People harbouring HIV and with access to antiretroviral therapy are living longer and more prone to develop both communicable diseases (such as TB, malaria, opportunistic infections, viral hepatitis and human papilloma virus) and non-communicable diseases. The latter include renal and genitourinary diseases and diseases affecting the cardiovascular system, liver, cognitive function as well as malignancies and metabolic bone disease. Access to treatment for HIV/AIDS is turning the disease into a chronic disorder, and healthcare providers must be knowledgeable about the management of co-morbidities in the context of HIV; thus lessening the present line of demarcation between CDs and NCDs. It is also important to recognise other links between NCDs and CDs, for example TB as a risk factor for diabetes and *vice versa*.

There are one million deaths from malaria every year in Africa, accounting for 90% of the global total. A high proportion occurs in children younger than five, accounting for 25% of all childhood deaths (WHO, 2014c). The estimated economic cost is up to US\$ 40 billion annually (WHO, 2008).

Nine of the twenty countries with the highest burden of tuberculosis are in Africa. Up to 70% of TB patients in Africa are co-infected with HIV accounting for more than 80% of the global total. Associated with the TB infection is the development of Multidrug-Resistant (MDR) and Extensively Drug-Resistant (XDR) strains, making TB a major threat.

Vaccine-preventable diseases contribute substantially to early childhood mortality with up to one million preventable deaths each year. Yellow fever is endemic in 32 African countries, with more than 500 million at risk. Cholera remains endemic in Africa, contributing 90% of the global total (Minz, 2009; WHO, 2012).

Emerging and re-emerging diseases including viral haemorrhagic fevers have been present on the continent for some time now. Epidemics due to dengue and Chikungunya have been noted in some countries of the African continent, and such epidemics have the potential to explode as seen in the Asian countries. Among the viral haemorrhagic fevers, Ebola, Congo fever viruses and to some extent Marburg viruses continue to pose health threats and disrupt trade and travel. Lessons learned from the Ebola outbreak in West Africa are discussed in further detail in the Appendix. Many of the conclusions in the Appendix may be generalisable to other health threats and exemplify the key messages in this report.

Non-communicable diseases: NCDs include hypertension and cardiovascular diseases, diabetes, chronic kidney disease, cancer, malnutrition-related diseases and chronic respiratory diseases. An estimated annual 36 million deaths are caused by NCDs globally; of these almost 80% of the deaths occur in low and middle income countries like Africa (Lozano *et al.*, 2012). While it is recognised that mental health has considerable morbidity, it is excluded in this document as has been adequately addressed in specialised papers elsewhere (WHO and Gulbenkian, 2014).

It is now timely to focus attention on NCDs. The three-year review of the impact of the UN High-level meeting on NCDs (the review was initiated in 2014, <http://ncdalliance.org/2014review>) provides an opportunity to take stock of progress, identify gaps in the desired actions and build consensus on scaling-up of commitments to tackle the NCDs.

Two-thirds of people with hypertension live in low-middle income countries and the condition is estimated to affect one-quarter of the adult population in Africa. In common with other NCDs, hypertension is significantly under-diagnosed and only about one-third of those with the disorder in Africa are aware of its presence, many of those who are aware are not on medication, and many of those treated are not well controlled (van de Vijver *et al.*, 2013).

Cardiovascular diseases and risk factors such as hypertension, obesity, alcohol intake, smoking and physical inactivity are increasing dramatically in Africa. This was shown in a 5-year longitudinal study in South Africa (Schutte *et al.*, 2012). Chronic kidney disease affects 10% of the general public in Africa, as elsewhere, with high impact because of concomitant mortality from cardiovascular disease and its presence in younger people in Africa.

It has been estimated that infectious agents are responsible for 26% of cancers in developing countries, in particular liver, cervical, bladder and gastric cancers and the most common African male cancers namely Kaposi's sarcoma (Mathers and Loncar, 2006). Seventy percent of all tumours associated with AIDS occur in sub-Saharan Africa and cancer rates are rising in some parts of the region as a direct consequence of the HIV/AIDS epidemic. Cancer is one of the three commonest causes of death after age five. However reporting is incomplete in Africa since only 650,000 persons out of a population of 965 million people are diagnosed annually.

Malnutrition-related diseases are characterised by the double burden of under- and over-nutrition, presenting challenges for both public health and food security, and associated with many NCDs. Food and nutrition security continues to be a fundamental challenge facing Africa. An estimated 200 million people on the continent are undernourished. More than one-third of African children are stunted in their growth and must face a range of physical and cognitive challenges not faced by their better-fed peers. The aggregate costs of food and

nutrition insecurity impose a heavy burden on efforts to foster sustained economic growth and improved general welfare.

At the same time, there is an emerging prevalence of obesity, including childhood obesity in Africa. Changing lifestyles, globalisation trends and advertising for international fast foods on commonly available media are leading to changing patterns of diet in urban areas. The prevalence of obesity, especially in women, can be regarded as a neglected disease and reliable epidemiological studies are needed to set baselines for monitoring.

What are the projections and consequences? As illustrated in Figure 1, the disease pattern is predicted to change dramatically within the next 10–20 years. Many infectious diseases will show a decline or a modest increase in prevalence across African countries, while NCDs will increase significantly. However, infectious diseases will continue to pose serious health threats although health status is improving, attributable in part to intervention programmes such as Roll Back Malaria Initiative, GAVI and the Global Fund, which is now supporting 2.8 million people in Africa with HIV who are on anti-retroviral therapies.

The WHO projects that 28 million people in Africa will die from one or other chronic disease

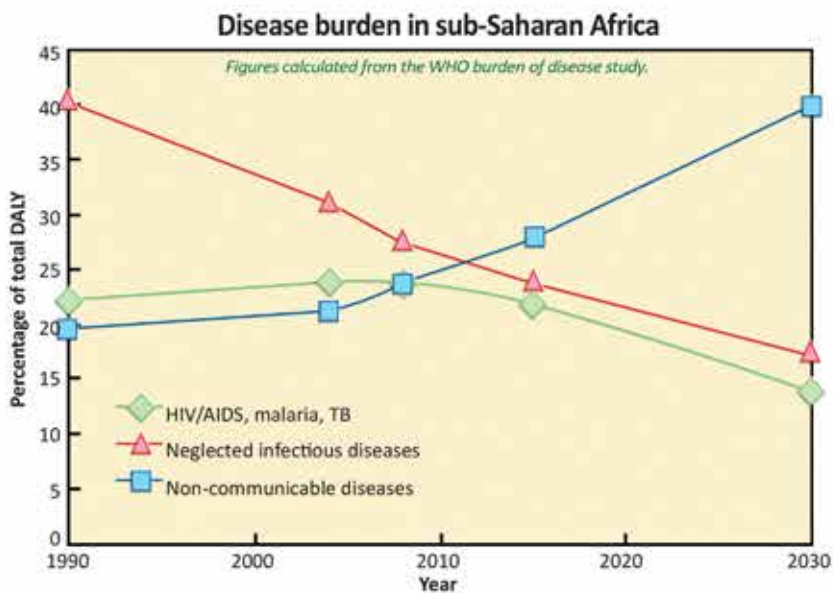


Figure 1. Disease burden in disability adjusted life years (DALYs), distribution from the first burden of disease study in 1990 to 2030 for three disease groups: HIV/AIDS, malaria, TB; Neglected Infectious Diseases (NID); Non-communicable diseases (NCD), maternal, perinatal and nutritional conditions, and injuries (WHO 2008).

during the next 10 years, and that the rate of increase of deaths from chronic diseases will outstrip that from infectious diseases by more than four-fold in the next 10 years. The prevalence of cancer, for example, is predicted to increase by more than 50%, diabetes deaths by more than 40% during the next 10 years (WHO) while the DALY of cardiovascular diseases are expected to double (WHO, 2008 and 2008a; Mathers *et al.*, 1999). At the same time, the morbidity of many other chronic diseases such as neurological disorders is likely to increase, though they are substantially under-diagnosed.

The epidemiological shift from a low to a high burden of NCDs will occur over a relatively short

BOX 1

CLIMATE CHANGE AND HEALTH

Africa's climate is already changing, with significant impact. Further climate change is inevitable, which will present challenges to growth and development in Africa and may undermine progress that African countries have made in tackling disease and malnutrition (Climate and Development Knowledge Network, 2014 **The IPCC's Fifth Assessment Report: What's in it for Africa?** http://cdkn.org/wp-content/uploads/2014/04/J1731_CDKN_FifthAssessmentReport_WEB.pdf).

It is important to ensure an appropriate focus on issues for health at this time when global policymakers deliberate some important strategic instruments including the UN Framework Convention on Climate Change, the Framework for disaster risk reduction and the definition of the Sustainable Development Goals.

The WHO Conference on Health and Climate Change in 2014 (<http://www.who.int/globalchange/mediacentre/events/climate-health-conference/en>) emphasised twin objectives: (i) to reduce health impacts from climate change already occurring and (ii) to realise potential health benefits from measures to mitigate climate change, for example through reductions in death and disease achieved by installing new energy provision to tackle sources of air pollution or by improving urban transport systems. The health co-benefits of policies to tackle climate change have been discussed in further detail in previous work by IAMP (<http://www.iamp-online.org/statements>, 2010).

WHO draws attention to some key points from the Fifth IPCC assessment relating to climate change impact, including effects on both communicable and non-communicable disease:

1. Increased risk of injury, disease and death from intense heat waves.
2. Increased risk of food- and water-borne diseases.
3. Increased risk of vector-borne diseases (exemplified by recent TDR research in East Africa, http://www.who.int/tdr/news/2014_impact-climate-change/en).

4. Increased risk of under-nutrition resulting from diminished food production.
5. Consequences for health from lost work capacity and reduced labour productivity in vulnerable populations.
6. Additional health risks cannot be discounted, for example from increasing severity and frequency of extreme weather events.

All of the health risks are strongly affected by other determinants of health, for example socio-economic status, gender and age. Overall, climate change is likely to widen existing health inequalities. Adaptation to climate change in Africa, to reduce impacts on human health and food security can build on previous experience with interventions in public health and agriculture. Thus, the health community has a critical role to play in raising awareness and through broadly-based action in public health: the recommendations made throughout the present report are relevant to the necessary response to climate change. However, the IPCC assessment also highlights the potential limitations to adaptation in Africa (CDKN, 2014). That is, climate change combined with other stresses may tend to overwhelm abilities to cope and adapt. Therefore, governments in Africa also need to promote ambitious global action on climate change mitigation, for example low carbon development options. Such options may also represent new economic opportunities for Africa.

It is also important to increase efforts to collect evidence in pan-African programmes on impact, vulnerabilities and adaptation to climate change and on the complex interactions with multiple other determinants of stress and disease. This requires interdisciplinary research collaboration and it is encouraging, for example, that the recently initiated collaboration between Africa and the EU will focus on trans-national challenges such as climate change, as well as research and innovation (**The Africa-EU Partnership**, <http://www.africa-eu-partnership.org>).

period of time, and it will, therefore, be significantly different from the epidemiological shift that has occurred in the highly industrialised countries during the last century.

Consequences of the shift: Many African countries will be faced with a double burden of disease, where infectious diseases will co-exist with an increasing number of NCDs. The net effects of this epidemiological shift will be to create pressure at various levels, namely: to hamper attainment of the MDGs, negatively impact socio-demographic trends by a reduction of life expectancy due to

HIV/AIDS, undermine economic development and put pressure on the already fragile health system.

What are the driving forces for the shift?: The driving forces for causing this epidemiological shift in disease patterns are multi-factorial including poverty, underdevelopment, food and nutrition insecurity, lack of sanitation and safe water, lack of education, access to basic health care, pressures from the tropical environment and ecological burden, climate change (see Box 1), urbanisation population migration, human behaviour changes, and economic instability. The pattern of diseases in Africa is moving increasingly to NCDs in consequence of demographic transition (the ageing population) and nutritional transition.

Demographic transition and nutritional transition, resulting from changes in societal lifestyle such as reduced physical activity and adoption of unhealthy diets, and increase in tobacco use and excessive alcohol consumption are the main risk factors driving the projected high NCD burden.

Many of the social determinants of health influence both CDs and NCDs. Poverty and underdevelopment have a major impact, with poor nutrition and lack of effective sanitation and safe water; lack of education and access to basic health care compound these problems. In addition to these, there are pressures from the tropical environment and the ecological burden compounded by climate change (Box 1), population migration and other demographic and human behavioural changes, and economic instability. The social determinants of CDs and NCDs are complex and interrelated, covering a broad range of determinants, thus requiring trans-disciplinary and multi-sectoral approaches to address health problems in Africa.

Actions to be taken: It is imperative to develop comprehensive and implementable coping strategies to mitigate the negative health consequences of the epidemiological shift. Such strategy should start with country level assessment of the situation; planning to avert and mitigate the dual burden of communicable and non-communicable diseases; creating and enhancing partnership to achieve the planned goals; conducting research and surveillance to guide the programme implementation and exploiting the role of academies in articulating the voice of science in the entire process. These issues are addressed in details in the ensuing chapters.

Key Message

Each African country should undertake a national assessment of the burden of communicable and non-communicable diseases as well as develop estimates of how the country's demographic and epidemiological transition is likely to influence their long-term trends.

Following an assessment of the changing disease patterns, it is important to recognise that Africa has an opportunity to avert and/or mitigate, at least partially, the dire future scenarios and to choose a path to a healthier future. This will require careful and methodical planning, informed by the evidence of what works and how best to implement change.

Planning is a comprehensive process, as illustrated in Figure 2. The key steps in this process include: engagement with the key stakeholders, defining the priority challenges, articulating the overall goal and specific objectives as well as the approach, formulating milestones for monitoring and identifying funds required to attain the desired outcome.

Each African country should develop a plan(s) to combat communicable and non-communicable diseases. The plan should stipulate the key elements of the country's evidence-informed strategy to prevent and control high priority CDs and NCDs – as a guide to concerted national action to reduce the burden of these diseases. Other key elements of country plans are: the capability to mount an emergency response to epidemics as diverse as influenza, cholera and Ebola (see Appendix specifically for Ebola); engagement with communities for public education to improve health and establishment of lines of communication between neighbouring states and international agencies such as WHO for the purposes of effective communication in the event of a health crisis that may have cross-border impacts. This also highlights the importance of monitoring and evaluation of the implementation of the plan to be accompanied by appropriate surveillance.

Evidence-based planning using proven, effective interventions: Planning should be evidence-based on local context and not donor-driven. Such evidence includes what is known to have worked previously and what has failed in the past.

The knowledge needed for the control of a large number of infectious diseases in Africa is readily available. However, in many cases, the existing tools are not sufficient to achieve the total elimination of communicable diseases. This is the case for antiretroviral therapy for AIDS; the BCG vaccine against TB, and most of the anti-helminthic drugs, such as praziquantel that do not kill all stages of the worm. It is important to leverage current programmes tackling HIV, TB and malaria to strengthen chronic disease services.

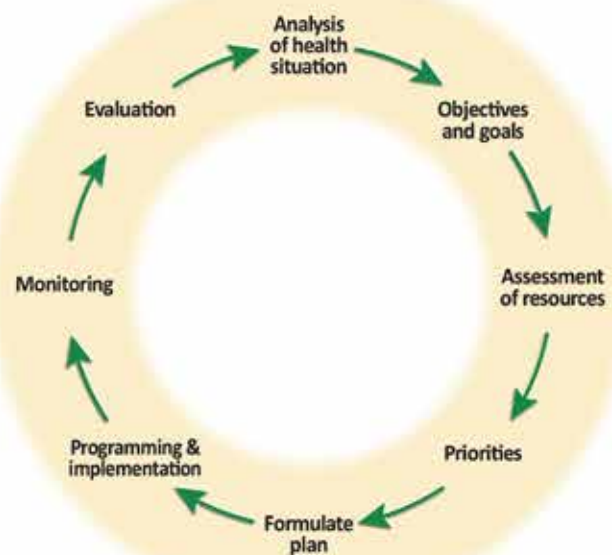


Figure 2: The planning cycle is a comprehensive process. The key steps in this process include: engagement with the key stakeholders, defining the priority challenges, articulating the overall goal and specific objectives as well as the approach, formulating milestones for monitoring and identifying funds needed to attain the desired outcome

While many infectious diseases can be contained and controlled, they will likely still exist as latent or transient infections in large proportions of the population. Planning must take this into account so as not to create a disastrous situation, where the burden of NCDs will increase, while infectious diseases may still be highly prevalent.

Human resources: The co-existence of a high burden of infectious diseases with an increasing prevalence of NCDs will pose a formidable challenge to Africa as they are generally under-diagnosed, poorly or not treated and insufficiently controlled. The health care systems in many countries are inadequate and the health care personnel are not appropriately trained to confront this growing burden. Planning should ensure that the health care system is strengthened in terms of adequate and trained manpower and infrastructure.

Financial resources: An integral part of planning is ensuring that the required financial resources are made available for the programme. Many projects are donor driven and may carry the risk of inadequate ownership, poor sustainability of benefits or even disproportionate resource allocation, creating further gaps in the weak health care system. For example, there is considerable financial support in ambitious initiatives such as the Global Fund to Fight AIDS, Tuberculosis, and Malaria (GFATM), the U.S. President's Emergency Plan for AIDS Relief (PEPFAR), and the European and Developing Countries Clinical Trials Partnership (EDCTP). While these innovative funding streams have mobilised resources for HIV/AIDS, malaria and TB programmes, they have not contributed adequately to tackling other diseases in Africa. Hence there is a gap in the public health preparedness in Africa, creating a situation of increased 'neglected' or 'orphaned' diseases. This aspect is further discussed in the chapter on resource mobilisation.

Key message

Africa can avert and mitigate the impact of its changing disease patterns and choose a path to a healthier future. This will require meticulous, evidence-informed planning, that should include engagement with the key stakeholders to define the priorities, specific objectives and the approaches, milestones and funds needed to reach the desired outcome.

Meeting the health challenges that arise as consequences of shifting epidemiological trends is an undertaking that cannot be done in isolation. Although the primary responsibility of health rests with the Ministries of Health, implementation of many health projects is also within the scope of other ministries, development partners and interested parties. Hence the Ministries of Health have to work in partnership with international funding agencies, government and non-governmental organisations, and representatives of other sectors both within and outside the country. Partnership is an integral part of coping with the shifting epidemiological disease patterns and is a key recommendation of this document. Some opportunities for partnership are between:

- (a) health and other sectors (including coordinated strategies for human health, animal health and environmental health),
- (b) national government, regional network and international agencies, and
- (c) research scientists.

Partnerships between health and other sectors at the national level: As illustrated in Figure 3, health cannot be perceived as the sole domain of the Ministry of Health, many non-health partners are involved in the implementation of health and forging partnership and coordination with the other sectors will avoid redundancy and ensure more effective programme implementation. Effective ongoing communication strategies between all partners are strongly encouraged to ensure a forum for efficient coordination. Shared visions in different sectors can help craft sound public policy for example, with:

- (i) those responsible for food and nutrition security, to tackle the double burden of under- and over-nutrition and their impacts on communicable and non-communicable diseases;
- (ii) introduction of sin-tax on sales of harmful substances such as alcohol and tobacco,
- (iii) agricultural and environmental policy in delivering better health impact assessment of development projects in the agricultural or other infrastructural initiatives.

Regional and international levels: These shared visions in partnership have to be fostered at the regional and international

A Model of Partnership

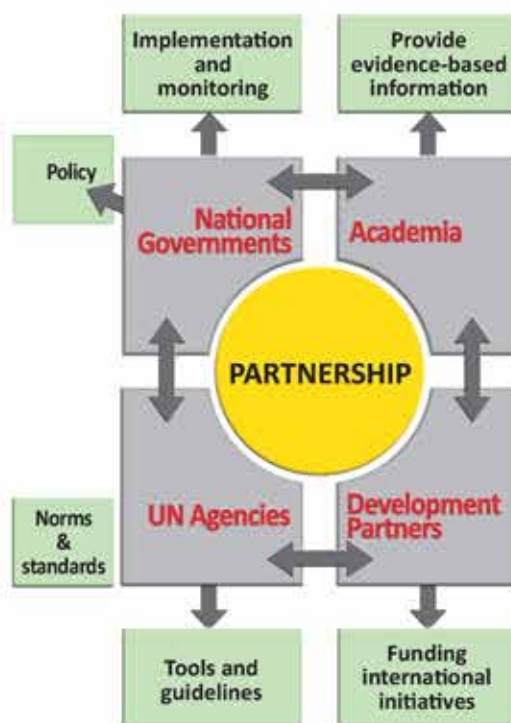


Figure 3: A model for the possible ways in which partners can interact to achieve the common goal of coping with the emerging health trends in Africa. SOURCE: Deoraj Caussy, Joint Academies' Symposium, Hamburg

levels in creating policies and implementing programmes with international agencies in order to build critical mass and sustainability, to catalyse new initiatives and to share good practice. For example, the Global Fund might be seen as a model for expanding partnership into additional disease areas. There will be increasing need for multilateral collaboration between national governments, international agencies and other development partners and centres of excellence, including the Academies, in coping with existing threat and emerging threats such as climate change, viral haemorrhagic fevers and the burden of non-communicable diseases. However, for this form of partnership to be sustainable, it has to be assured of funding, as exemplified by the UK-Africa partnership on chronic diseases that met with limited long term success (de Graft, 2012).

Collaboration between African and other scientists. African scientists should explore novel ways for formal and informal collaboration with scientists from Europe, America, Australia and elsewhere. This partnership can result in:

- (i) research training and technology transfer;
- (ii) sharing insight from international experience (e.g. pneumonia, obesity, diabetes as elaborated in a Joint Academies Symposium held in Hamburg (Joint Academies Symposium 2012);
- (iii) implementing experience on “what works” but based on local culture and opportunities; and
- (iv) involving the academies to inspire scientists, share experience and resources in providing relevant, timely and credible advice to policymakers. In addition there is a Diaspora of African scientists who work in major health research centres in North America and Europe (for example, the US National Institutes of Health, the US Centers for Disease Control and Prevention and similar centres in Europe) those scientists have acquired significant human capital, that can be shared with their colleagues in Africa in order to partially reverse the scientific brain drain.

Partnership between the public and private sectors: New forms of partnership have to be explored and forged, for example between academia and the pharmaceutical industry to increase access to medicines, vaccines and therapeutic development for existing and emerging threats such as malaria and Ebola, address risk factors, support and implement innovation, develop new models for collaboration in R&D and exploitation of intellectual property, jointly support human resources capacity development. Such partnership must ensure academic independence and the definition of needs by the country, and have no conflict of interest.

Multi-disciplinary partnership: Developing and standardising new tools for disease prevention and treatment requires research in support of innovation which is often multidisciplinary with implications for improving the interface between different scientific disciplines, for new models of public-private partnership and for ensuring healthcare delivery in multidisciplinary workforce teams. The complexities of research are likely to be tackled more successfully if the academies and academia play a bigger advisory role in national and international public health strategy. One of particular interest to the academies might be the collaboration between medical sciences and health economists to provide better estimates of the cost of disease and benefits of intervention. These estimates are important to inform policymakers in Finance ministries of the economic value of health and, thereby, support the case for increased investment in health and research.

Key message

To achieve coordinated action for a healthy future, Africa must mobilise partners across disciplines, sectors and borders. This accords also with the recently developed concept of One Health.

Africa's disease burden and the related health challenges are diverse. Compared to other parts of the world, Africa bears the largest brunt of the global disease burden. It is also estimated that at least 30% of the burden is associated with climate-sensitive vector borne diseases such as malaria. Due to the significant impact these diseases have on the health status of the populations and to an extent the economy, African governments are continuously urged to dedicate at least 2% of their GDP of their national budgets to health research. These are discussed in the following paragraphs.

In an effort to raise awareness and increase government internal funding for health research, ministerial task forces have been established through which various declarations have recommended that governments increase their health systems research budgets to between 2–5% of the total public health sector expenditure. However, many of these countries do not have sufficient income to share among priority sectors including health. This therefore calls for alternative means of funding mainly from external donor sources, as well as in-country collaborative partnerships such as the public-private partnerships.

The role of the private sector: In some of the countries, the private sector plays a significant and growing role in health research and health promotion. The need for governments to embrace collaborative partnerships to raise funds cannot therefore be over-emphasised. Collaboration ranges from consultative processes over programmes logistics to drug and equipment donations. Examples of such collaborations include efforts made to combat river blindness in West Africa, immunisations against poliomyelitis and vitamin A supplementation.

Coordinating health programmes: A number of African countries have many health-related and donor-sponsored programmes operating within their boundaries. Most of the programmes have access to large financial resources, that the host country may not have. Although this is considered good for the country, it may carry its own unpredictable risks and transaction costs if not well coordinated by the host governments. Lack of coordination of programmes, be they in health or other sectors, has been identified as a weakness that requires government intervention in some countries. Most governments lack appropriate human resources to monitor programme activities effectively, making it possible for funds earmarked for the needy populations to be misused. It is on this understanding that this policymakers' booklet recommends to African governments to increase their involvement in the coordination and monitoring of health programmes for their citizens' benefit.

Finally, despite a significant increase in expenditure on health from external sources, a great deal of the funds is not channelled towards government priorities. They are instead earmarked for specific purposes making it difficult for the same governments to support their health service delivery systems. It is therefore recommended that governments work collaboratively with funded groups to prioritise their activities.

Key Message

Increased resources are required to meet the estimated costs for the implementation of the health sector reform programmes. These resources should be mobilised and coordinated at national level from the private and public sectors as well as from international partners to help achieve stakeholder action plan.

What should the governments in Africa do?

1. Governments in Africa made commitments to comply with the declarations in Mexico 2004 (Mexico Statement 2004), Bamako 2008 (Bamako 2008) and Algiers 2008 (Algiers Declaration 2008) to increase their budgets to finance health systems for better health. Only a few have been able to meet their commitments.

✓ **Countries that have not fulfilled their commitments are urged to honour them.**

2. There is a need to collaborate and raise funds through increased public – private partnership initiatives. Collaboration starts with consultative processes in research and development and may end up with drug and equipment donations. Good examples on this have been the control of river blindness in West Africa, polio immunisation as well as vitamin A supplementation programmes.

✓ **Governments in Africa are encouraged to take up collaborative initiatives to help ease their burden of financing the health sector.**

3. In some countries, health programmes are coordinated mostly by NGOs and the civil society. These organisations play prominent roles in designing, planning and executing the projects. Furthermore, it is indicated from published reports that 40% of healthcare in poor countries is provided by private and faith-based organisations.

✓ **Governments should work with other stakeholders in the coordination of health programmes in their countries in order to reap maximum benefits for the people.**

CASE STUDY:

PARTNERSHIP AND RESOURCE MOBILISATION

Onchocerciasis Control Programme (OCP)

Following the dramatic consequences of onchocerciasis (river blindness) in West Africa, the World Health Organization (WHO) launched the OCP in collaboration with three other United Nations agencies including the World Bank, the United Nations Development Programme (UNDP) and Food and Agriculture Organization (FAO) in 1974. These agencies constituted the sponsoring agencies of OCP. The programme stretched over 1,200,000 km² to protect 30 million people in 11 countries from the debilitating effects of river blindness (WHO, 1995).

For years, OCP operations were exclusively based on the spray of insecticides by helicopters and aircrafts over the breeding sites of the black flies (vectors transmitting the disease) in order to kill their larvae (aerial larviciding). With the donation of ivermectin (Mectizan®) by Merck & Co., Inc. in 1987, control operations changed from exclusive vector control to larviciding combined with ivermectin treatment and in some areas, to treatment with ivermectin

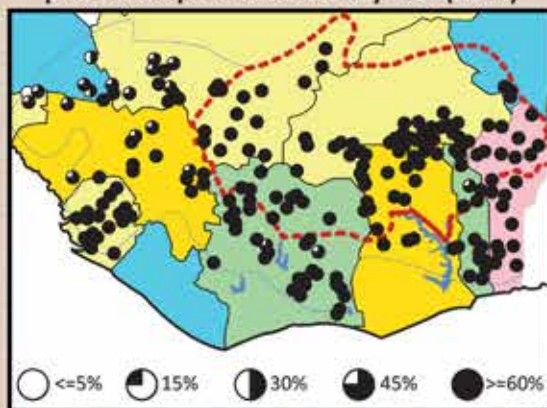
alone. OCP was officially closed in December 2002 after virtually stopping the transmission of the disease in all the participating countries except Sierra Leone where operations were interrupted by a decade-long civil war (See Figure 4 for illustration). The wide-ranging benefits of this achievement include the prevention of 600,000 cases of blindness, 18 million children born in now-

controlled areas spared from the risk of river blindness and 25 million hectares of land safe for cultivation and resettlement.

OCP clearly demonstrated the important role of partnership in health and socioeconomic development in remote and neglected areas.

Elimination of River Blindness

Map of West Africa showing onchocerciasis prevalence prior to control by OCP (1974)



Map of West Africa showing onchocerciasis prevalence at the end of OCP activities (2002)

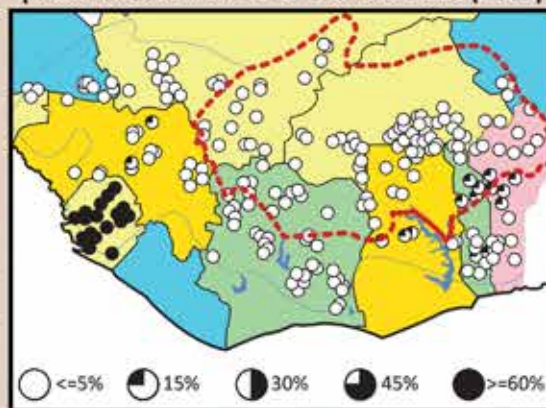


Figure 4. The wide-ranging benefits of the joint international intervention for elimination of river blindness in West Africa between 1974 and 2002 include the prevention of 600,000 cases of blindness, 18 million children born in now-controlled areas spared from the risk of river blindness and 25 million hectares of land safe for cultivation and resettlement

4. In the recent past, the capacity of academia to access international funding and implement health projects has resulted in a significant elevation of their roles to advise their governments and their responsibilities to contribute to the well-being of their populations. An increasing number of researchers from the academic community are now leading key in-country projects on behalf of international donors such as the President's Emergency Plan for AIDS Relief (PEPFAR) and the Global Fund for AIDS, TB and Malaria (GFATM).

✓ African governments should therefore promote an enabling environment for continued attraction of funds from the donor community through academia.

A primary task of the Ministry of Health is to generate interdisciplinary evidence coping with the health consequences of the epidemiological shift in Africa. Research and surveillance are two fundamental tools that cut across all the six themes addressed in this policy document. Research generates evidence for policy formulation, programme implementation and for measuring impacts of intervention programmes. Surveillance is gathering information for action and hence is a useful adjunct to research in guiding, assessing and fine-tuning policy formulation and programme implementation.

A great deal of policy decision and programme implementation in Africa is based on evidence derived from settings outside Africa that may not necessarily be similar to the African population in genetic composition, nutrition, disease state and life-style. This dearth in African data can be reduced through conducting research in the following areas: basic fundamental research, applied research or operational research and identifying the social determinants of health.

Generating Evidence through Fundamental Research: Fundamental research is critically needed in many areas: for understanding basic African pathophysiology, e.g. to clarify impacts of maternal programming of the foetus, mediated by epigenetic modifications, and whether there are specific pathogenesis of diseases in Africa. Basic research is also needed, for example, in the study of the metabolic syndrome, underlying obesity, hypertension and diabetes. There is evidence to identify ethnicity as influencing the different responses in the metabolic syndrome and there is need for genetic studies to predict and understand the future impact of these diseases. Other areas include elucidating whether chronic kidney disease frequency in West Africa is associated with variation in Apo lipoprotein L1, which may have selective advantage because of a protective role against sleeping sickness. Also important is better understanding of the clinical correlates of vaccine protection including malarial and viral haemorrhagic fever vaccines, of the mechanisms for pathogen drug resistance such as the emerging threats of antimicrobial resistance, and vector insecticide resistance. Furthermore, options for prevention and control will also be aided by the advancing science that explains the significant co-morbidities between infectious and non-infectious diseases, for example TB-diabetes and pneumonia-cardiovascular disease.

Many of these issues could be addressed through the science of comparative epidemiology including using longitudinal cohort studies in Africa to document and understand variation in disease incidence and transmission, the role of environmental and genetic risk factors and the response to intervention. Population-level interventions may need to be accompanied by specific interventions at the clinical level, perhaps targeting high-risk groups.

Using applied or operational research to guide implementation projects: lessons from past attempts at disease elimination or eradication have to be operationalised when devising new strategies for diseases such as malaria. Countries should share lessons and experiences to demonstrate that ambitious goals are achievable, e.g. successful malaria control efforts in Ghana, or prevention of mother-to-child-transmission (PMTCT) of HIV in Botswana (Joint Academies Symposium 2012). The example of the PMTCT programme can be used to integrate other NCDs in the primary health care system and provide enhanced delivery. There is a

BOX 2:

SUCCESS STORY OF RESEARCH AND SURVEILLANCE FOR ACTION

Changes in population cholesterol concentrations and other cardiovascular diseases risk factors after five years of the non-communicable disease intervention in Mauritius (Dowse, GK et al., 1995)

- Surveillance and monitoring in 1987 showed that Mauritius had alarmingly high and increasing rates of non-communicable diseases. This led to
- the use of classic operational research combined with implementation of a national healthy lifestyle intervention programme, including use of mass media, fiscal measures and legislation regulating content of saturated fat content of cooking oil.
- Monitoring after five years showed reductions in population blood pressure and serum lipid concentration, increase in leisure exercise, and decreased smoking and alcohol consumption
- Operational research combined with monitoring can be used to generate evidence and guide actions for programme implementation and fine tuning.

need to develop clinical trial research skills – to grow the critical mass of African studies, for example comparing interventions. An operational model for the role of industry to help in this capacity building in academia needs to be defined.

Complex choices may need to be made in setting priorities and this may involve multiple policy-making departments, e.g. in prioritising investments in sanitation or vaccines. Evidence from operational research in these domains will lead to formulation of sound public health policy and evidence-based decision.


Identifying social determinants of health: Poverty and income inequality increase the risk of both communicable and non-communicable diseases. These diseases in turn accentuate poverty and inequity and compromise the development agenda. Broadly, efforts to tackle all diseases rely on improved public health infrastructure, services and skills for preparedness and responsiveness, together with education and empowerment of the individual, family and community to raise awareness of diseases, their determinants and management options. The imperative is to address social determinants at the population level – in particular tackling poverty and underdevelopment, improving food security and nutrition.

Social sciences research is needed to understand the social determinants of disease, together with humanities research to understand cultural differences. Research on the economic costs and benefits of disease prevention and improvement in health status will inform rational health sector policy formulation.

Surveillance: Accurate disease surveillance is indispensable for monitoring the implementation of control programmes and providing the feedbacks loop for modifying and fine-tuning the targeted programmes.

In order to assess whether initiatives are successful, there must also be commitment to devising better mechanisms for monitoring impact. This necessitates both collection of good baseline data and establishment of processes for long-term follow-up. It is important to recognise that disease registries are important as a shared resource for research, e.g. in cancer or in diabetes, and sharing of good practices is required in creating, updating, validating and using registries. Developing and implementing health information systems for sharing health care data and facilitating the secure exchange of health information will improve the efficiency and effectiveness of care, and create large databases/registries for researchers.

There is a critical need for countries to develop their research infrastructure, determine their specific research needs and strengthen their capacity to synthesise, communicate and translate



research results into policies for prevention and treatment of all diseases. One such successful research influencing policy is the work of Dowse G.K. (Dowse *et al.*,1995) documenting the use of operational research in cardiovascular disease in Mauritius. See Box 2 for illustration.

Key Message

Research should generate evidence to inform policymaking and provide new tools to control disease and to support programme implementation. Surveillance, being an integral adjunct of research, should be timely, complete and accurate in order to generate information for action in prevention and control of health conditions.

Many academies of science worldwide have built effective relationships with national policy-makers and with other bodies who inform priority setting and the development of policy options. Academies possess important attributes in exercising their advisory functions – they are independent of commercial or other vested interests, their procedures are transparent, they are able to draw on the best science and scholarship from a wide range of academic disciplines and their outputs are expert, authoritative, credible and widely respected.

In Africa, the national academies work together in NASAC to provide timely and relevant messages on a disparate range of topics of interest to both the policy-making and scientific communities. For example, with support from the German National Academy of Sciences Leopoldina, NASAC is currently producing recommendations on climate change impact, water security, agricultural biotechnology and, in the present booklet, on the changing burden of disease and its implications for achieving a healthy Africa (ASSAf, 2012). Many NASAC members already have experience of engaging productively on health policy matters. For example, the work of ASSAf in South Africa (Figure 5) has delivered evidence-based policy recommendations on communicable diseases that have been influential at the national level.

The purpose of the present NASAC work was not to provide a systematic, detailed account of the evidence available relating to the changing burden of disease, although major sources of that evidence are cross-referenced, but rather to examine the implications and to clarify priorities for action, to contribute to providing the impetus for change. The main messages from this work are detailed in the preceding chapters. The process of formulating these key messages has also helped to clarify how NASAC and its academies can continue to play a variety of useful roles, building capacity to generate and deliver collective resource to attain the shared vision of a healthy Africa.

These continuing roles include:

- Identifying what evidence exists to support policy choices, how this evidence should be validated and used.
- Showing where there are gaps in the present evidence base that can and should be filled by additional research and surveillance activities.
- Exploring how the wider scientific community can be involved more actively in providing independent advice in public health project design and implementation, and in assessing the impact of interventions.
- Raising the visibility of the academies throughout the continent – academies are often in a good position to act as partners with decision-makers in governments and parliaments, to understand their issues and needs for evidence, serving as a basis to build longer-term collaboration between the scientific and policy communities.
- Providing accurate and accessible health messages to the general public.

At the country policy-making level, for impact to be sustainable, the NASAC recommendations require commitment to follow up in mobilising resources by each academy. NASAC also has a responsibility to convey its key messages directly to policy-making bodies at the continent-wide and regional levels, to international organisations and to other academy partners outside Africa. NASAC is very well placed as a regional academy network within the Inter-Academy

BOX 3

ASSAF WORK ON HIV/AIDS, TB AND NUTRITION

In the first of these outputs (ASSAf 2007), ASSAf considered the influence of nutrition on immunity with particular regard to two major disease epidemics, tuberculosis and HIV. The report covers physiology, pathophysiology and clinical evidence. Recommendation, based on consensus, focused on the best way to proceed in terms of policy, intervention and development: addressing issues for practice, further research and the adequacy of existing guidelines.

In the second output (ASSAf, 2012) from a workshop, ASSAf explored the regional dimensions of work done previously by the US Institute of Medicine. This discussion of Southern African regional studies emphasises the need



for a multi-stakeholder approach to long-term planning for HIV/AIDS, the challenges for human resources in Africa, the challenges for funding, and the opportunities for collaborative partnership, including the academies.

Panel (IAP, now Interacademy Partnership) to help share analysis of issues, contribute local experience and determine lessons of good practice. For example, IAP has recently published statements on the post-2015 sustainable development goals (IAP, 2013) and, with IAMP, on antimicrobial resistance (IAMP, 2013 and 2013a). Antimicrobial resistance is a rapidly escalating threat worldwide that may significantly influence the impact of the changing burden of disease. The rise of antimicrobial resistance may lead to loss of ability to treat infections that can currently be effectively controlled and it also imperils much of modern medicine that depends on antibiotic cover, for example cancer treatment. The collective IAP resource helps to augment the country- and continent-focused objectives of NASAC to deliver strong messages to policymakers.

Key message

The academies of science have an increasingly important part to play, individually and collectively, in helping to achieve the goals for a healthier Africa. Major tasks of the academies, in proving leadership and support to the scientific community, include collecting, validating, synthesising and supplying evidence to inform policy options.

The time to intervene for Africa is now. The situation analysis underscores the changing trends of health patterns in Africa from a high communicable disease scenario to one of combined communicable and non-communicable diseases. Hence, formulation of health policy will have to be comprehensive in nature in order to face the emerging challenges concomitant with socio-demographic and economic development. In this booklet, the working group describes the best options and states realistic recommendations to deal with these issues in African countries. Each of these recommendations has been carefully pondered and contextualised for real situations in Africa. Full implementation of these recommendations will ensure Africa is on the right path to healthy nations and economically viable countries.

The consensus is that:

1. Before embarking on any intervention, one needs to objectively assess the existing situation in order to undertake future projections. There is a dearth of country-level information in many areas.
2. Careful planning based on priority and evidence can then take place and the planning can then realistically anticipate, avert and mitigate the potentially dire consequences of the changing trend.
3. Reaching the planned goals will not be achieved in isolation by the Ministries of Health. Both traditional and novel partnerships have to be created, enhanced and sustained among different professional disciplines, between government sectors and between government and UN agencies, NGOs and civil society. This will increase national and international funding and support for effective interventions, integrated strategies and collaborative actions for both CDs and NCDs prevention and treatment.
4. Both human and economic capital investment are required in order to reach those goals and governments are urged to allocate proportionate funds, seek external funding at the national level from public-private partnership and international partners.
5. Research infrastructure and capacities are an integral part of the health system that need strengthening so as to ensure translating research results into policies for prevention and treatment of all diseases and to educate, empower and engage the general public in healthy behaviours. Information and surveillance systems need to be established and reinforced in order to fill the data gap to better inform on the CD and NCD burden, its social and economic costs and the benefits of prevention.
6. Science academies have to play a pivotal role in the improvement of health in Africa by using their expertise and independent advisory role to supply evidence to support appropriate policies and public health interventions, to assess impact of strategies and interventions and, to provide responsible health messages to the general public.

In August 2014, WHO declared the Ebola virus disease outbreak in West Africa to be an international public health priority (Abramowitz *et al.*, 2015). While, at the time of writing this report in early 2015, the outbreak is not over, some lessons can be learned: from the countries most affected (Liberia, Guinea and Sierra Leone), from neighbouring countries much less affected and with regard to the nature of the international response.

In its analysis of the outbreak, the African Academy of Sciences (2014) emphasised the vital importance of timely resource mobilisation, effective leadership, active involvement of the affected communities and, above all, rigorous application of the best scientific knowledge. Participants at the World Health Summit in Berlin 2014 observed that the present crisis was exacerbated by the legacy of neglecting to build effective health systems, by neglecting R&D for drugs and vaccines for tropical diseases and by gaps and slow responsiveness both at the national level and in international health governance.

In a recent statement by the German academies (German National Academy of Sciences 2014), it was noted that, in the West Africa outbreak, the Ebola virus spread rapidly and to an unexpected extent (including in urban areas) compared to patterns of disease seen in previous outbreaks (WHO, 2015). The spread of the virus was accelerated by multiple factors, including poor hygiene conditions, collapse of medical infrastructure and lack of public awareness.

Taking account of the work by the academies and other recent literature, the lessons learned from this Ebola outbreak exemplify many of the issues discussed in the preceding text of the present report. There is now need to attend to a range of consequences (O'Donovan, 2015; Vora *et al.*, 2015) as follows:

1. Strengthen national capacities of health care systems in developing countries, adjusted to their respective cultural contexts. This strengthening requires investment in people, infrastructure and practices, including robust chains of supply and fast-acting medical teams to manage outbreaks, and must also include raising public awareness of the threats to health and how to respond. It is critically important to enhance community participation to support active case finding and ensure that community-based interventions work, by building resilient health systems grounded in primary care (Kutalek, 2015). It is also necessary to understand that the Ebola outbreak exacerbates long-standing problems in vulnerable populations, perhaps particularly for women and children's health, such that there is need for concomitant, sustained investment in maternal and reproductive health care (Menendez *et al.*, 2015).
2. Improve surveillance by sharing current good practice and by considering new options for data collection. The experience of Nigeria and Senegal demonstrated the effectiveness of surveillance coupled with conventional epidemiological methods, such as case isolation and contact tracing, in containing Ebola (Vora, 2015). This underscores the priority to develop local capacity. Among new routes to improving data collection in future outbreaks of Ebola or other infectious diseases is the use of internet-based surveillance systems (Millonovich *et al.*, 2015). Sufficient infrastructure already exists in many African countries to develop digital infectious disease surveillance and early warning systems. Mobile phone-based systems can be used as an educational tool for behaviour change, as well as for disease mapping and tracking population movements (O'Donovan, 2015).

3. Strengthen collaboration for early and coordinated response from the international community, based on internationally agreed strategies. This requires policy development to boost support for investment and for the international funds already pledged to be paid more rapidly. Various options have been proposed for new sources of funding. WHO has discussed a dedicated contingency fund to support rapid response and the World Bank with WHO and other UN agencies is developing the concept of a financial pandemic facility to strengthen preparedness and responsiveness.
4. Vaccines and antiviral agents are urgently needed and there are encouraging signs of innovative approaches to testing vaccines and then delivering them, if proved effective (Mohammedi, 2015). Experimental medicines and vaccines may need to be supplied to affected countries as part of the coordinated international effort. Precautionary measures to prepare for future outbreaks should include the stockpiling of sufficient quantities of vaccines and antiviral drugs. There is continuing need to accelerate R&D to identify novel approaches and translate them to proof-of-concept, recognising that such research must be subject to appropriate biocontainment to ensure safety for laboratory workers and the general public. Investment in the discovery and development of vaccines and antivirals cannot solely be subject to market economy principles. Public sector commitment by NGOs, foundations and governments in partnerships is also necessary to develop novel products and services ready for future outbreaks.
5. Medical and social science research must continue because another outbreak is highly probable. There is need for detailed infection biology characterisation of the current Ebola virus and of the pathogenicity, transmissibility, host adaptation and ecology of different virus strains. One key question is whether the multiple genetic changes separating the current Ebola virus from its predecessors may be relevant to enhanced infectivity or potentially result in enhanced pathogenicity, with implications for diagnosis and treatment. The experience from genomic analysis of the West African outbreak emphasises the importance of: making data available in public repositories as soon as possible; providing clinical and epidemiological context to interpret genomic data; and capacity building for genetic epidemiology locally, with global collaboration. This work must take place within the broader context of multidisciplinary research to gain better understanding of other determinants, including climate change, trends in urbanisation and mobility. The agenda for the social sciences relating to future pandemic surveillance, response, community preparedness and health system strengthening will likely need to include expertise in anthropology (Abramowitz, 2015).
6. Protection and training of health professionals. This includes training of medical staff in the treatment of highly pathogenic viruses. Health care workers themselves have often been at very high risk for Ebola. Improving their protection requires development of standard operating procedures for recruiting and training staff, procuring materials and equipment, as well as infection control procedures (Anon., 2014).
7. Understanding and addressing the immediate and longer-term implications for food security. A recent report from the European Commission's Joint Research Centre uses FAO and other data to analyse the negative consequences for crop production arising from the impact of the Ebola outbreak on normal daily activities in agriculture.

In the developing the content for this document, the report team wishes to greatly appreciate and acknowledge the participants of the following three events:

1. Joint Academies' Symposium by the German National Academy of Sciences Leopoldina, the Ghana Academy of Arts and Sciences (GAAS) and the Network of African Science Academies (NASAC) on Changing Patterns of Health Problems in Sub-Saharan Africa: Impact of Communicable and Non-Communicable Diseases held in Hamburg, Germany at the Bernhard Nocht Institute on 1–3 November 2012.
2. IAMP Conference on Changing Patterns of Non-Communicable Diseases and 4th General Assembly, Crowne Plaza, Johannesburg, South Africa 13–16 August 2013.
3. Editorial Group Meeting held under the NASAC-Leopoldina cooperation in Pretoria, South Africa on 11–12 September 2014 and hosted by the Academy of Sciences of South Africa.

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