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A template for improved prevention and control of cardiovascular disease in sub-Saharan Africa

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Cardiovascular disease (CVD) is rapidly becoming an important public health problem in sub-Saharan Africa, yet the response so far is often minimal and inadequate. While there is, undoubtedly, a 'double burden of disease' (persisting infectious diseases co-existing with emerging non-communicable disease), this is hardly reflected in current health planning, possibly due to a limited appreciation of the changing pattern of CVD and CVD risk factor exposure. In a situation where there are also considerable budget constraints and well-established infectious disease priorities, it is difficult to implement effective interventions for prevention or treatment of CVD. Yet such planning is urgently needed and a template for a comprehensive programme, adaptable to local situations, is presented here. The first step is to raise awareness and create evidence-based commitment among policy-makers, which could lead to the establishment of a multi-sectoral CVD unit at national level. Programmes need to focus on prevention of modifiable risk factors at population level, involving a wide range of institutions and individuals. Recommended strategies include decentralizing the design and implementation of programmes, with appropriate standardized surveillance of major risk factors, all complemented by operational, epidemiological and basic research.

Introduction

Over the past decade, the need to address cardiovascular disease (CVD) in sub-Saharan African (sSA) has become evident.[1] Controversy exists on the priority that a CVD programme deserves in the competition for scarce resources. Although the prevention and control of infectious diseases should remain high on the agenda and its burden on sSA not be underestimated, there is ample evidence for a significant co-existent disease burden from CVD that creates an onerous 'double burden of disease'. Given the small and even shrinking health budgets of many sSA countries, the challenge is to plan and implement complementary cost-effective prevention and control programmes for a wide and diverse range of prevalent diseases.[2] Choices in health care and rationing of provisions are always emotionally charged, but ideally should be objective and based on sound data. Pretending that no choices have to be made obscures reality. In these complex discussions, it is not particularly constructive if people who doubt the relevance of cardiovascular control programmes in sSA, label such efforts as 'medical imperialism',[3] nor if those in support of such programmes label those who criticize these efforts as 'sounding like Albert Schweitzer'.[4]

Spending on CVD is unavoidable and, as CVD prevalence increases, a growing proportion of the health care sector's meagre resources will be used on CVD control, without having a substantial impact on the health of the population as a whole. Currently, by default, most of the investment in CVD goes towards treating established disease and complications and is hidden in a clinical budget. In The Gambia for example, diabetes care for 0.03% of the population already consumed 3.6% of the annual national health budget in the early 1990s.[5] Cooper et al.[6] estimated that preventing one hypertensive death in sSA would involve treating 50 hypertensives (BP ≥160/95 mmHg) and cost US$1800. Treatment of CVD and late complications is only partly effective and clearly expensive. An economic evaluation might find that preventing or postponing CVD and its complications would be more cost-effective. It is certainly feasible to improve cost-effectiveness of hypertension management at health centre level as part of a CVD prevention programme so, even if no additional resources are available, it will be possible to spend the current CVD budget more effectively.[7]

Modification of lifestyle risk factors at population level is the most cost-effective approach towards reducing the CVD burden, in particular if combined with investment in the development of integrated health plans to make spending more coherent. Adapting Cooper et al.'s estimate using local prevalence data and drug costs enables comparison with current expenses of treating (preventable) complications.[6] It is unfortunate that the silent early stages of CVD combine with lack of experience with these emergent diseases. This reduces acknowledgement of the real threat of CVD and inhibits research and planning for programmes focusing on prevention. That there are often unfavourable physiological changes in the pre-CVD phase[8–11] only accentuates the need for early preventive intervention.

The increasing burden of CVD is largely due to the rising prevalence of many CVD risk factors, particularly hypertension, smoking and older age. Hypertension is the most prevalent CVD risk factor in the world. It is estimated that currently at least 5% of all adult sSA deaths are related to hypertension[6] and the World Health Organization (WHO) predicts this may rise to 20% by 2020 (unpublished). Although comparability between studies is limited due to different methodologies, hypertension is rapidly becoming a major public health problem in sSA, associated with the changing lifestyles that accompany the increasing urbanization.[12–14] At present the prevalence of hypertension (blood pressure ≥160/95 mmHg) among adults ≥25 years of age in West Africa is estimated to be around 8% in rural areas and between 15–20% in urban areas.[15] It may be even higher in southern Africa.[16]

The adaptable template programme outlined here focuses on the prevention and control of CVDs that are related to hypertension and other easily identifiable 'lifestyle' risk factors such as tobacco use, low physical exercise, (central) obesity, and high salt and saturated fat intake. Prevention and control of CVD includes reducing risk factor availability (primordial prevention), reducing the prevalence of risk factor exposure (primary prevention), and limiting the complications of established CVD (secondary prevention by behaviour modification and possibly medication).

A template of strategies to achieve prevention and control of CVD

We have attempted to identify strategies that could enable the development of effective CVD prevention and control within a resource-limited context. We propose a series of iterative steps in the development of a CVD prevention and control programme that has premature morbidity and mortality prevention as its priority. Great care must be taken to produce focused plans, highly relevant to the local situation and with clear details of the programme operation. Although suggestions we make here (and that have been made elsewhere) may appear 'common sense', we recognize that most policy decisions are not driven by 'common sense' alone and do not occur in a political vacuum. We have attempted to respond to this dilemma by grounding these suggestions in available evidence. They should be based on the premises that prevention needs to start sooner rather than later and that priority should be given to risk factor prevention at population level of a range of interrelated CVDs.[17]

Strengthened commitment of policy-makers

Generating the essential commitment of policy-makers to CVD prevention and control first requires local community-based data on prevalence, impact and costs (both current and projected in the future) to convince them that CVD is a relevant problem. Demonstrating a high prevalence of CVD risk factors among influential groups in society can be a powerful motivation for these groups to become involved (McLarty et al., unpublished). For example, in The Gambia, we have shown that CVD was the underlying cause of death for 1 in 5 adults (>14 years) in the capital in the 1990s.[18] Concerns about the continued need to address other health problems at the same time must be addressed in objective and well-informed negotiations.

Presentation of similar data could lead to the establishment of a central CVD/non-communicable disease (NCD) unit by the Ministry of Health to develop and co-ordinate prevention and control. To be successful and sustainable, close co-operation with relevant government departments (such as health, agriculture, education, social development, law), NGOs and the private sector should be stimulated. The establishment of such a multi-sectoral, central unit will give prominence to CVD issues and create pressure to address prevention and control as a priority. This unit can stimulate balanced plans and broad support, with responsibility, resources and budget shared between parties.

Central units should give guidance and support on programme development. This can include a national population-wide approach, through appropriate legislation and health policy; an individual level approach with practical guidelines and protocols assisting people to adjust life styles; and an operational level approach describing how to integrate prevention and control within the health services. School health programmes may assist in reducing future high-risk behaviour in areas where school enrolment rates are high. Among rural, illiterate populations, participatory methods have successfully influenced sexual behavioural change,[19] and this experience can be used as a model for designing CVD programmes. Great potential exists in utilization of the media, since radios are widely used in the most remote areas, thus making use of available resources.[20]

Practical examples of cost-effective interventions will illustrate the feasibility of CVD prevention and control programmes. The Mauritius intervention[21] demonstrated it was possible to ameliorate unhealthy lifestyles through central policy. And although Mauritius is in several respects not a typical sSA country, it is one of the few African countries with a NCD unit within the Ministry of Health and offered a good example of the potential of national health policy to modify lifestyle. National units can adapt such programmes to their own situation. Cost–benefit can be assessed by comparing projected costs and benefits using available data on current expenditures.

Focus on prevalent, modifiable risk factors

The 1993 'minimal cost public health package' for low-income countries, including most of sSA, already recommended actions against obesity and tobacco and alcohol consumption – major potentially modifiable risk factors for CVD.[1] Nevertheless, implementation doesn't appear to have been very successful yet. Similar risk factors for CVD as in industrialized countries have been observed in sSA. Paradoxically, in sSA some CVD risk factors such as obesity and physical inactivity, associated with urbanized lifestyles, appear to be desirable symptoms of wealth and high social standing, just as these were perceived in industrialized countries in previous times. In African populations,

increasing age, hypertension, obesity, diabetes, smoking, dyslipidaemia, physical inactivity and family history have all been identified as prevalent risk factors, and programmes should address those that are locally relevant. Although the relative risk of cardiovascular morbidity and mortality is highest in urban, elderly people with a CVD family history,[22–24] the majority of people in sSA live in rural areas, are young and do not have a known family history of CVD. The greatest number of CVD cases may therefore actually occur among the vast majority with apparently low risk:[25] their absolute risk of cardiovascular morbidity and mortality is still high.

CVD programmes should design clear, detailed and practical protocols on how to modify prevalent risk factors, modelled on successful programmes elsewhere. Prevention of risk factors should be tailored to the target populations, in particular their readiness to accept new ideas and change; again multi-sectoral commitment will be essential to design appropriate programmes. In traditional, rural communities, individual change is not encouraged. Primordial prevention through public health policies that reduce availability of cigarettes or change the salt and fatty acid content of commonly used foods could be effective. Recent migrants congregate in many urban areas in sSA and their struggle to adopt a new lifestyle makes them vulnerable and open to outside messages. This makes cigarette advertising highly effective, but it also offers opportunities to influence smoking and dietary habits through fiscal and legislative policies. On the other hand, affluent urban inhabitants might be most inclined to change their lifestyle when provided with information on the consequences of different lifestyle options, with an appeal to their ability to make reasoned judgements and appropriate adjustments.

A comprehensive CVD programme will be most acceptable and effective if it combines prevention with offering treatment and advice to those who have already developed risk factors, as this is important for credibility. To circumvent a 'prevention paradox'[26] a population prevention strategy should be complemented by a high-risk strategy.[27] Health workers could be trained to be aware of CVD risk factors among high-risk groups, such as urban populations in general, and the elderly population and first-degree family members of known CVD patients in particular. Members of high-risk groups could be encouraged to have regular check-ups, which should include measurement of body mass index and BP, and a urine dipstick test for glycosuria and proteinuria.[23] Furthermore, geographical areas where risks appear higher might be identifiable on which to focus interventions.[28] Advice must be given on modification of any lifestyle risk factors identified and specific treatment protocols should be based on a limited number of affordable, available drugs. Flexibility will be essential to tailor programmes to specific community needs.

Decentralization

Decentralization is often reduced to the delegation of tasks to a less central level, but without the transfer of the authority or resources needed to execute them. True decentralization can be a powerful mechanism to enhance people's commitment to take responsibility for their own lives, including health, but decentralization will not work if it does not include training, resource reallocation and managerial responsibility.

Decentralization towards the primary health care (PHC) level requires: an awareness among PHC workers of the need to prevent CVD risk factors and its complications, a supported management plan of how to integrate this task in the overall work, availability of necessary equipment and drugs, training, and regular supervision. Optimizing existing primary care services has been shown to have a marked impact on adherence to treatment and on adequate control of CVD.[29] Improved convenience to the patient and increased compliance also increases cost-effectiveness; hypertension patients who only intermittently collect or take their medication will add to the costs, not to the benefits, of a CVD programme.

However, most health workers' education curricula is weak in risk factor intervention techniques and in training towards long-term planning. This will need to be addressed at national level; capacity building and training of health staff is essential. Their participation in the development of ideas for overcoming their own and other's perceived obstacles will assist them in offering effective, targeted health education, and even leading by example. Training can incorporate role-play to develop arguments and expertise in appropriate and effective health education on behaviour modification. A next step will be the dissemination of these facts to potential local counterparts. Since a programme with a focus on prevention will have greatest impact on premature morbidity and mortality, the community benefits of a successful programme would be particularly high and therefore attractive at a PHC level. Decentralization will enable health staff to involve community leaders and other people accepted by the community as reliable sources of information, including village health workers, traditional leaders, teachers, shopkeepers and agricultural extension workers in implementing prevention and control programmes. Health care workers should be in the front line of control and secondary prevention, while others might be in a better position to shape and promote primary prevention. Local volunteers such as shopkeepers have successfully been involved in tuberculosis control programmes[30] and cost-effectiveness evaluation of such programmes compared very favourably to the standard approach.[31] Furthermore, the short term or unstable nature of many jobs in health makes wide dissemination of information vital to the sustainability of the prevention programme.

Further decentralization can be achieved by involvement of the family of a patient identified as at high risk for CVD. Not only are these family members at increased risk of becoming patients themselves, but strong community ties and family coherence are essential for an individual or a group to integrate lifestyle changes. Where familial ties are very strong, individual behaviour changes will be impossible to consolidate if not accepted as a family commitment. With increasing westernization and urbanization, family ties become looser,

but this is a slow process and there remains a window of opportunity to engage families in implementation of health promotion and prevention of CVD.[24]

Surveillance

To assess the magnitude of CVD requires an estimation of the prevalence of diseases and of associated morbidity and mortality.[27] Questions on mortality can be added to population surveys and census, while usage of verbal autopsies can give an indication of the distribution of causes of death. However, the limited scope of most demographic and health statistics makes it difficult to assess disease incidence or prevalence of disease in most of sSA. Proper surveillance requires considerable resources. Cohort studies would be an acceptable alternative, but these are also expensive and complicated to maintain over time. Sometimes it will be possible to integrate monitoring of CVD in existing population-based cohort studies. More affordable alternatives could be repeated cross-sectional surveys or sentinel surveillance. Evaluation of the impact of prevention and control strategies requires monitoring of CVD changes; the most cost-effective method is by proxy through surveys of well-defined cardiovascular risk factors.[32] Surveillance could be limited to measuring blood pressure, anthropometry, urine dipstick testing and (self-reported) smoking. A selection of health facilities, and communities without such a facility, could be surveyed in stratified samples at regular intervals[33] to document trends in prevalence, and to evaluate programmes geared to high-risk areas or groups.

Such surveys do not require extensive expertise, but do need good planning and assimilation of data if they are to be used to the greatest effect. A validated automated electronic BP machine is gradually becoming common practice in population-based studies. Non-professionals are easily trained in its use, validation is simple, observer bias is low, and it enhances comparability between different surveys.[22,34,35] Monitoring glycosuria and proteinuria by urine dipstick, basic anthropometry (height and weight, waist and hip circumferences) and self-reported smoking are feasible, affordable and relevant in low technology environments. In the future, surveillance strategies could be developed to improve data on vital statistics, costs, burden of disease, demographics and health service utilization. This can be developed by region.

Research

Challenging questions remain. Operational research is required to assess the cost-effectiveness of risk factor interventions and management protocols in different situations. A cost-utility analysis of the number of 'disability adjusted life years'[1] saved per Euro invested, compared to other health problems for which interventions are available and which are considered 'good value for money', is essential.[36] Such economic analysis should take account of the current and expected CVD burden, and concentrate on premature morbidity and mortality. Operational research will assist in identifying barriers to the development of effective prevention and control programmes.[37]

Current medical treatment of hypertension in adults aims to lower BP to <140/90 mmHg; while the optimum BP is <120/80 mmHg.[38] It appears beneficial to reduce individual BP below this threshold, and thus reduce the relative risk of an adverse cardiovascular event. Population level benefits, however, are limited as long as the absolute risk of an adverse event (determined by the individual's combined risk factor exposure) in an individual is low, regardless of the relative risk. Age-, sex- and risk assessment-dependent thresholds for pharmacological treatment might be more appropriate.[39] A compromise must be sought in which treatment is deemed worthwhile for the individual, has an impact on public health and represents a reasonable use of limited resources. An algorithm was developed which determined a BP ≥160/95 mmHg as an appropriate treatment threshold in sSA, based on individual and population attributable risk and a number-needed-to-treat analysis.[6] The paucity of data on appropriate intervention thresholds demands further studies to identify those most at risk of target organ damage and to establish locally appropriate thresholds for interventions. There is some evidence of target organ damage at a lower BP threshold in sSA populations, due to greater pressure load arising from a blunting of the nocturnal fall in BP.[40] Further follow-up will hopefully yield information on long-term complications.

Recently, the hypothesis of 'thrifty phenotype' origin of CVD has been developed, proposing that foetal under-nutrition at critical periods of growth increases the susceptibility to CVD,[41] maybe in particular if exposed to adequate or excessive food in later life. Studies in sSA offer a unique opportunity to test this hypothesis prospectively, avoiding the bias and confounding factors inherent to the variety of retrospective studies available, mainly from industrialized countries.

Local environmental factors in the development of hypertension and CVD still need to be unravelled. Specific dietary factors, such as sodium, potassium, calcium and polyunsaturated fatty acid ratios, could be important contributors. Infectious or inflammatory factors contributing to CVD are postulated, particularly as association between *Chlamydia pneumoniae* infection and atherosclerosis.[42–44] Also, several inflammatory cytokines are secreted by adipose tissue, which suggests that chronic inflammation may interact with obesity and thus initiate and contribute to CVD.[45]

Conclusions and recommendations

There is an urgent need to raise awareness on the unfolding double burden of disease in sSA. An effective response is required to the rapidly emerging problem of CVD even while the control of many infectious diseases still needs improvement. Hypertension has become very common in all sectors of society, while obesity and smoking are becoming more and more prevalent as well.

Once commitment grows for intersectoral CVD prevention and control programmes the focus should be on population-level interventions of modifiable risk factors. Sustainability and coherence of programmes, diffusion of effective health education and community endorsement are essential to

achieve behaviour change in populations. There are examples of successful initiatives in sSA that could be models for others to adapt to local circumstances,[20,21,32] so it is not the theoretical framework which is lacking, but practical experience. Developing this demands the commitment of resources to central and local capacity-building and careful evaluation of the strengths and weaknesses of specific programmes.

Globalization of economics and health means that CVD has become an international issue. This challenges the international community to support interventions that address the growing burden of CVD in sSA.[46,47] Support can come in several forms. Financial support may be needed for initiation of national NCD/CVD units, baseline studies, pilot interventions, and to train and support local staff. External technical and human support may be essential to develop resources for sustainable prevention and control programmes. Co-ordination of databases, health education materials, protocols and maybe even models of CVD prevention and control programmes, which can be adapted locally, may prevent the need to re-invent wheels and save time and effort in trying to trace scattered, fragmented information.

The following recommendations are made:

(1) The need and feasibility for the development of CVD prevention and control programmes in sSA can be demonstrated by using appropriate local data on prevalence of risk factors, with data on current expenditure and estimated future costs.
(2) A central, intersectoral CVD unit should be established at national level, which includes a wide and relevant array of people. Their primary goals should be to highlight the urgency of preventing CVD risk factors and to initiate the development of training and programme policies.
(3) The focus of CVD programmes in sSA should be on primordial and primary prevention of risk factors at population level, tailored to the possibilities and needs in the different groups in a society.
(4) Training and capacity-building at all levels, including primary care, are a priority to generate a favourable setting for a CVD control programme; development of practical guidelines should be the backbone of these activities.
(5) Secondary prevention of CVD among people at high risk can be focused initially towards urban populations. Health staff should be sensitized to the opportunities of secondary prevention among high-risk groups attending their clinics.
(6) Initiation of pharmacological hypertension treatment in sSA should only be considered for people with a BP ≥160/95 mmHg.
(7) The cost-effectiveness of specific CVD programmes needs to be assessed in relation to current expenditure and other (health) priorities.

References

1 World Bank. *World Development Report 1993: Investing in Health*. New York: Oxford University Press for the World Bank, 1993.
2 Gwatkin DR, Guillot M, Heuveline P. The burden of disease among the global poor. *The Lancet* 1999; **354**: 586–89.
3 Montgomery RW. Amount spent on health care per capita is same as cost of a McDonald's. *British Medical Journal* 1998; **317**: 76.
4 Cooper R, Muna W. Hypertension treatment and control in sub-Saharan Africa: authors reply. *British Medical Journal* 1998; **317**: 77.
5 Rolfe M, Tang CM, Walker RM, Bassey E, George M. Diabetes Mellitus in The Gambia, West Africa. *Diabetic Medicine* 1992; **9**: 484–88.
6 Cooper RS, Rotimi CN, Kaufman JS, Muna WF, Mensah GA. Hypertension treatment and control in sub-Saharan Africa: the epidemiological basis for policy. *British Medical Journal* 1998; **316**: 614–17.
7 Edwards PR, Lunt DW, Fehrsen GS, Lombard CJ, Steyn K. Improving the cost-effectiveness of hypertension management at a community health centre. *South African Medical Journal* 1998; **88**: 549–54.
8 Ezenwaka CE, Akanji AO, Osei K et al. Glucose and insulin responses to intravenous glucose challenge in relatives of Nigerian patients with non-insulin-dependent diabetes mellitus. *Diabetes Research and Clinical Practice* 1993; **20**: 175–81.
9 Muldoon MF, Terrell DF, Bunker CH, Manuck SB. Family history studies in hypertension research. Review of the literature. *American Journal of Hypertension* 1993; **6**: 76–88.
10 Allemann Y, Weidmann P. Cardiovascular, metabolic and hormonal dysregulations in normotensive offspring of essential hypertensive parents. *Journal of Hypertension* 1995; **13**: 163–73.
11 Harris MI. Epidemiologic studies on the pathogenesis of non-insulin-dependent diabetes mellitus (NIDDM). *Clin Invest Med* 1995; **18**: 231–39.
12 Kaufman J, Barkey N. Hypertension in Africa: an overview of prevalence rates and causal risk factors. *Ethn Dis* 1993; **3**: S83-101.
13 Kaufman JS, Rotimi CN, Brieger WR et al. The mortality risk associated with hypertension: preliminary results of a prospective study in rural Nigeria. *Journal of Human Hypertension* 1996; **10**: 461–4.
14 Poulter NR, Khaw K, Hopwood BEC, Mugambi M, Peart WS, Sever PS. Determinants of blood pressure changes due to urbanisation: a longitudinal study. *Journal of Hypertension* 1985; **3**: 5375–7.
15 Cooper R, Rotimi C, Ataman S et al. The prevalence of hypertension in seven populations of West African origin. *American Journal of Public Health* 1997; **87**: 160–8.
16 Mufunda J, Scott LJ, Chifamba J et al. Correlates of blood pressure in an urban Zimbabwean population and comparison to other populations of African origin. *Journal of Human Hypertension* 2000; **14**: 65–73.
17 Vaughan P, Gilson L, Mills A. Diabetes in developing countries: its importance for public health. *Health Policy and Planning* 1989; **4**: 97–109.
18 Van der Sande MAB, Inskip HM, Jaiteh KO et al. Changing causes of death in a West-African town: 1942–1997. *Bulletin of the World Health Organization* 2001; **79**: 133–41.
19 Welbourne A. Stepping Stones. A package for facilitators to help you run workshops within communities on HIV/AIDS, communication and relationship skills. 1995, ACTIONAID, UK.
20 Rossouw JE, Jooste PL, Chalton DO et al. Community-based intervention: the coronary risk factor study. *International Journal of Epidemiology* 1993; **22**: 428–38.
21 Dowse GK, Gareeboo H, Alberti KGMM et al. Changes in population cholesterol concentration and other cardiovascular risk factor levels after five years of the non-communicable disease intervention programme in Mauritius. *British Medical Journal* 1995; **311**: 1255–125.
22 Van der Sande MAB, Milligan PJM, Nyan OA et al. Blood pressure patterns and other cardiovascular risk factors in rural and urban Gambian communities. *Journal of Human Hypertension* 2000; **14**: 489–96.
23 Van der Sande MAB, Walraven GEL, Bailey R et al. Is there a

role for glycosuria testing in sub-Sahara Africa? *Tropical Medicine and International Health* 1999; **4**: 506–13.
[24] Van der Sande MAB, Walraven GEL, Milligan PJM et al. Family history: an opportunity for early intervention and improved control of hypertension, obesity and diabetes. *Bulletin of the World Health Organization* 2001; **79**: 321–8.
[25] Rose G. Strategy of prevention: lessons from cardiovascular disease. *British Medical Journal* 1981; **282**: 1847–51.
[26] Rose G. Sick individuals and sick populations. *International Journal of Epidemiology* 1985; **14**: 32–8.
[27] Forrester T, Cooper RS, Weatherall D. Emergence of Western diseases in the tropical world: the experience with chronic cardiovascular diseases. *British Medical Journal* 1998; **54**: 463–73.
[28] Van der Sande MAB, Milligan PJM, Walvaren GEL et al. Geographical variation in prevalence of hypertension within The Gambia. *Journal of Human Hypertension* 2001; in press.
[29] Coleman R, Gill G, Wilkinson D. Non-communicable disease management in resource-poor settings: a primary care model from rural South Africa. *Bulletin of the World Health Organization* 1998; **76**: 633–40.
[30] Wilkinson D, Davies GR, Connolly C. Directly observed therapy for tuberculosis in rural South Africa, 1991 through 1994. *American Journal of Public Health* 1996; **86**: 1094–7.
[31] Wilkinson D, Floyd K, Gilks CF. Costs and cost-effectiveness of alternative tuberculosis management strategies in South Africa – implications for policy. *South African Medical Journal* 1997; **87**: 451–55.
[32] Metcalf CA, Hoffman MN, Steyn K, Katzenellenbogen JM, Fourie JM. Design and baseline characteristics of a hypertension intervention program in a South African village. *Journal of Human Hypertension* 1996; **10**: 21–6.
[33] Razum O. Monitoring cardiovascular disease in Zimbabwe: a review of needs and options. *Central African Journal of Medicine* 1996; **42**: 120–4.
[34] Van der Sande MAB, Bailey R, Faal H et al. Nationwide prevalence study of hypertension and related non-communicable diseases in The Gambia. *Tropical Medicine and International Health* 1997; **2**: 1039–48.
[35] Cooper R, Puras A, Tracy J et al. Evaluation of an electronic blood pressure device for epidemiological studies. *Blood pressure monitoring* 1997; **2**: 35–40.
[36] Mills A, Gilson L. *Health economics for developing countries: a survival kit*. EPC publications series. London: London School of Hygiene and Tropical Medicine, 1992.
[37] Seedat YK. Hypertension in developing nations in sub-Saharan Africa. *Journal of Human Hypertension* 2000; **14**: 739–47.
[38] 1999 World Health Organization – International Society of Hypertension guidelines for the management of hypertension. *Journal of Hypertension* 1999; **17**: 151–83.
[39] Port S, Demer L, Jennrich R, Walter D, Grafinkel A. Systolic blood pressure and mortality. *The Lancet* 2000; **355**: 175–80.
[40] Kaplan NM. Ethnic aspects of hypertension. *The Lancet* 1994; **344**: 450–2.
[41] Barker DJP. The fetal and infant origins of disease. *European Journal of Clinical Investigation* 1995; **25**: 457–63.
[42] High KP. Atherosclerosis and infection due to Chlamydia pneumoniae or Cytomegalovirus: weighing the evidence. *Clinical Infectious Diseases* 1999; **28**: 746–49.
[43] Korner I, Blatz R, Wittig I, Pfeiffer D, Ruhlmann C. Serological evidence of Chlamydia pneumoniae lipopolysaccaride antibodies in atherosclerosis of various vascular regions. *Vasa* 1999; **28**: 259–63.
[44] Shor A, Phillips JI. Chlamydia pneumoniae and atherosclerosis. *Journal of the American Medical Association* 1999; **282**: 2071–3.
[45] Schmidt MI, Duncan BB, Sharrett AR et al. Markers of inflammation and prediction of diabetes mellitus in adults (Atherosclerosis Risk in Communities study): a cohort study. *The Lancet* 1999; **353**: 1649–52.
[46] Howson CP, Fineberg HV, Bloom BR. The pursuit of global health: the relevance of engagement for developed nations. *The Lancet* 1998; **351**: 586–90.
[47] Walt G. Globalisation of international health. *The Lancet* 1998; **351**: 434–7.

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