Public Health Nutrition: 5(1A), 231–237 DOI: 10.1079/PHN2001298

Cardiovascular diseases in the developing countries: dimensions, determinants, dynamics and directions for public health action

K Srinath Reddy*
All India Institute of Medical Sciences, Ansari Nagar, New Delhi – 110 029, India

Abstract

The global burden of disease due to cardiovascular diseases (CVDs) is escalating, principally due to a sharp rise in the developing countries which are experiencing rapid health transition. Contributory causes include: demographic shifts with altered population age profiles; lifestyle changes due to recent urbanisation, delayed industrialisation and overpowering globalisation; probable effects of foetal undernutrition on adult susceptibility to vascular disease and possible gene–environment interactions influencing ethnic diversity. Altered diets and diminished physical activity are critical factors contributing to the acceleration of CVD epidemics, along with tobacco use. The pace of health transition, however, varies across developing regions with consequent variations in the relative burdens of the dominant CVDs. A comprehensive public health response must integrate policies and programmes that effectively impact on the multiple determinants of these diseases and provide protection over the life span through primordial, primary and secondary prevention. Populations as well as individuals at risk must be protected through initiatives that espouse and enable nutrition-based preventive strategies to protect and promote cardiovascular health. An empowered community, an enlightened policy and an energetic coalition of health professionals must ensure that development is not accompanied by distorted nutrition and disordered health.

Keywords
Cardiovascular diseases
Developing countries
Health transition
Cardiovascular risk

The second half of the 20th century witnessed major health transitions in the world, propelled by socio-economic and technological changes that profoundly altered life expectancy and ways of living, while creating an unprecedented human capacity to use science to prolong and enhance life. The most globally pervasive change among these health transitions has been the rising burden of non-communicable diseases (NCDs). Epidemics of NCDs are presently emerging, or accelerating, in most developing countries[1]. Cardiovascular diseases (CVDs), cancers, diabetes, neuropsychiatric ailments and other chronic diseases are becoming major contributors to the burden of disease, even as infections and nutritional deficiencies are receding as leading contributors to death and disability.

As the developing countries experience a rapid health transition, the mismatch between healthcare needs and resources is widened by an expanded list of health conditions that vie for policy maker's attention and public health action, while posting competing claims for clinical care. The complexities are compounded when policy has to prioritise on the basis of disease burdens, cost-effectiveness and equity, while the delivery systems have to simultaneously cope with the transformative pressures of economic restructuring and healthcare reforms. The rising burdens of CVD exemplify the high costs that unchecked epidemics of NCDs will impose on healthcare systems, and the adverse effects on development that would result from mid-life death and disability[2].

It is, therefore, essential to comprehend the dimensions, as well as the dynamics, of these advancing epidemics of CVD and provide appropriate public health responses. Such responses cannot be passive responses of merely cataloguing the coming catastrophe with increasing precision, but should be an active response of intervening actively, to telescope the transition and abbreviate the most pernicious phase of the epidemic that imposes the highest disease burdens in mid life.

Rising burden of NCDs

As the engines of health transition gather pace, the epidemics of NCDs are accelerating globally, advancing across the developing regions and involving all social classes. This is reflected in the current high burdens, as well as the estimated escalation of those burdens over the next two decades. The current high burden of NCDs is highlighted by the estimates for 1998[3] that indicate these disorders contributed to 58.8% of global mortality and 43% of the global burden of disease, measured as disability-adjusted life years (DALYs) lost. The contribution of low- and middle-income countries to this burden is large; about 77% of the total mortality and 85% of the total burden of disease attributable to NCDs arises from these countries (Table 1). Even within these regions, which are experiencing a double burden of pre-transitional and post-transitional diseases, NCDs contributed to 53.8% of total

**Corresponding author:* Email cvdresearch@mantraonline.com

Table 1 Global burden of disease (1998): contribution of low- and middle-income countries

	World	High-income countries	Low-income countries plus middle-income countries
Total deaths			
Thousands	53 929	8033	45 897
Percentage		14.9	85.1
Non-communicable diseases (NCDs)			
Thousands	31 717	7024	24 693
Percentage		22.1	77.9
Total disability-adjusted life years (DALYs) lost			
Thousands	1 382 564	108 305	1 274 259
Percentage		7.8	92.2
DALY loss due to NCDs			
Thousands	595 363	87 732	507 631
Percentage		14.7	85.3

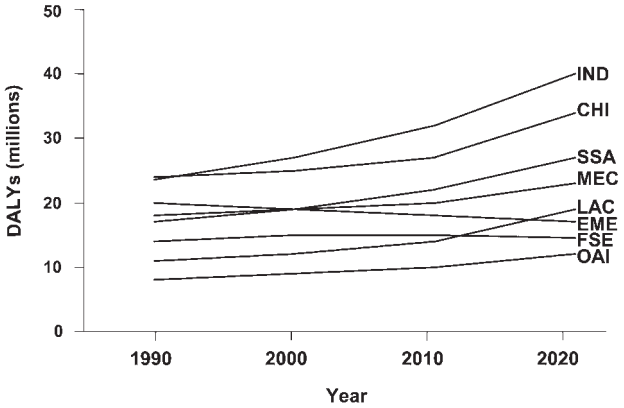

Fig. 1 Burden of CVD, 1990–2020 (IND, India; CH, China; SSA, sub-Saharan Africa; MEC, Middle Eastern crescent; LAC, Latin America; EME, established market economies; FSE, former Socialist economies; OAI, other Asia and islands). *Source*: Murray and Lopez[1]

mortality and 39.8% of the total disease burden. Globally, the mortality attributable to NCDs from 1990 to 2020 is expected to rise from 55.5% to 72.6%, and NCD-related DALY loss from 34.7% to 59.8%[1].

Global dimensions of the CVD epidemic

CVD is a major contributor to the global burden of disease among the NCDs. Coronary heart disease (CHD) is likely to be the most common cause of DALY loss in 2020 as compared with its fifth position in 1990[1]. The World Health Organization (WHO)[3] attributes 30% of all global deaths (i.e. 15.3 million) as well as 10.3% of the total DALYs lost in 1998 to CVD. The low- and middle-income countries, because of their much larger population, accounted for 78% of all deaths and 86.3% of DALYs lost – attributable to CVD – world-wide in 1998. Even in 1990, the developing countries accounted for 63% of all CVD deaths and 73.6% of CVD-related DALY loss (Table 2)[4].

WHO[3] estimated that CVDs accounted for 28.5% of all deaths in the developing countries in 1998. Further increases in the burdens of CVDs are expected in the near future in these countries. According to the Global Burden of Disease Study, a 55% rise would occur in DALY loss attributable to CVD between 1990 and 2020 in the developing countries[1]. This would be in contrast to a 14.3% reduction in the proportion of DALY loss attributable to CVD during the same period in the developed countries (including both established market economies and former Socialist economies). The gap would widen further if the former Socialist economies, which are facing a resurgence in CVD, are excluded. CVD-related deaths in India are expected to rise from 24.2% in 1990 to 41.8% of total deaths in 2020. Thus, the increasing burden of CVD would be borne mostly by the developing countries in the next two decades. (Table 3 and Fig. 1).

The global burden of CVD affects all sections of the society. Cardiovascular deaths in 1998 contributed to 34% of global mortality in women and 28.2% of all deaths in men[3]. Such a scenario also exists within the developing countries, where women are increasingly affected by hypertension, stroke and coronary heart disease. In developing countries where epidemiological transition has advanced, there is evidence of a progressive reversal of the social gradient, with the poor becoming the most vulnerable victims[5]. This parallels the pattern of the cardiovascular epidemics in the developed countries. Risk behaviours, risk factors and disease burdens in the developed countries were initially higher in the 'early adopters' (the higher social classes). However, these factors later became a mass phenomenon as the mediators of risk were abundantly produced for mass consumption and ultimately imposed the highest burdens of disease on the 'late adopters' (lower social classes), as the early adopters reduced their risk in response to new knowledge and new technologies. Evidence of such a reversal of social gradient is available from recent studies in India[6,7].

Table 2 Contributions to global CVD: 1990

Region	CVD mortality (%)	Coronary mortality (%)	Stroke mortality (%)	CVD DALYs (%)
Established market economies	22	30.3	17.0	14.9
Economies in transition (former Socialist economies)	15	21.7	14.3	11.5
Disability-adjusted life years (DALYs)	63	48.0	68.7	73.6

Source: Derived from Murray and Lopez[4].

Table 3 Contribution of CVD to DALY loss (% of total)

Region	1990 Total disability-adjusted life years (DALYs) (% of total)	2020 Total disability-adjusted life years (DALYs) (% of total)
World	10.8	14.7
Developed countries	25.7	22.0
Developing countries	8.9	13.8

Source: Derived from Murray and Lopez[1].

In addition to the increasing incidence of CVD, the early age at which it manifests in these populations is also contributing to the high CVD burden. Thus in 1990, 46.7% of CVD-related deaths in developing countries occurred below the age of 70 years, in contrast to only 22.8% in the high-income industrial countries[4]. The Global Burden of Disease Study projected that 6.4 million deaths would occur due to CVD in the developing countries in 2020, in the age group of 30–69 years[1].

The profile of CVD, however, varies among the developing countries. Countries in the earliest phases of epidemiological transition have a large burden of rheumatic heart disease, as well as infectious and nutritional cardiomyopathies. Hypertension emerges as a public health problem in the next phase, as salt consumption rises, and adds haemorrhagic stroke and hypertensive heart disease to the burdens of rheumatic heart disease. As countries advance further in their demographic and socio-economic transitions, these are largely replaced by thrombotic strokes and coronary heart disease, with increased fat intake and rising blood lipids contributing to atherothrombotic vascular disease[8]. Rheumatic heart disease is still an important problem in regions that are at an early stage of demographic and developmental transition, although a decline is evident in regions experiencing rapid health transition[9]. The transition to the atherothrombotic phase of the epidemic may be preceded by a sharp fall in the burden of haemorrhagic strokes. The recent decline in CVD mortality reported from South Korea reflects such a fall in the contribution from haemorrhagic strokes, while thrombotic stroke and coronary heart disease burdens have just begun to rise[10]. Large developing countries may have different regions in different phases of health transition, with urban areas usually experiencing higher CVD burdens at this stage. This phenomenon is evident in Latin America, parts of Africa, China and India[11]. The risk factors for cardiovascular diseases also vary regionally and are themselves in transition.

Most of the developed countries have entered the phase of delayed degenerative disease, where cardiovascular diseases remain the leading contributors to death and disability, but mostly manifest at a late age, and with an overall decline in mortality. The task before the developing countries is to shorten the phase of large and escalating cardiovascular disease burdens in mid life and rapidly transit to the phase of delayed and stable cardiovascular disease burdens.

Determinants and dynamics of the CVD epidemic in the developing countries

There are several factors that explain the recent emergence, and underlie the projected escalation, of the CVD epidemic in the developing countries[8]. First, there has been a global surge in life expectancy, especially in the developing countries. Many more individuals are exposed to risk factors of CVD for sufficient duration, for clinical consequences to manifest as a greater proportion of the population survives into older decades. This epidemiological transition – due to changing demographic profiles and a decline in the competing causes of death from infectious and nutritional disorders – characterises the advent of the CVD epidemic, along with those of other chronic diseases. This has been clearly demonstrated in urban China, where mortality attributable to CVD increased from 86.2 per 100 000 (12.1% of total deaths) in 1957 to 214.3 per 100 000 (35.8% of all deaths) in 1990[12]. Similar projections of a demographic transition, and an accompanying rise in CVD burdens, exist for India as well[13].

Second, delayed industrialisation and recent urbanisation have been associated with alteration in living habits, with deleterious changes in diet, physical activity and tobacco addiction. These environmental changes lead to acquisition or accretion of risk factors. The increased 'dose' of risk factor exposure, coupled to longer duration of exposure due to demographic changes, leads to an enhanced risk of CVD. In China, the Sino-MONICA study demonstrated that the body mass index (BMI), hypertension and blood cholesterol levels in the population, age group 35–64 years, rose from 1984–86 to 1988–89[12].

There are also possible adverse effects of poor childhood nutrition[14] that, if conclusively proven, would have an enormous impact on the developing countries, which still have a substantial fraction of the population that was underweight at birth. The possibility of such programming, or as yet unascertained genetic factors, may underlie the enhanced susceptibility of some ethnic groups (e.g. South Asian migrants) to CHD[15]. This excess risk may be explained by gene–environment interactions or foetal programming in these groups, but public health action must focus on the environmental changes that trigger the expression of susceptibility.

While the determinants of health transition in the developing countries are similar to those that charted the

course of the epidemics in the developed countries, their dynamics are different. The compressed time frame of transition in the developing countries imposes a large, double burden of communicable and non-communicable diseases. Unlike in the developed countries where urbanisation occurred in prospering economies, urbanisation in developing countries occurs in settings of high poverty levels and international debt, restricting resources for public health responses. Organised efforts at prevention began in developed countries when the epidemic had peaked, and often accelerated a secular downswing, while the efforts in the developing countries are commencing when the epidemic is on the upswing. Strategies to control CVD in the developing countries must be based on recognition of these similarities and differences. Principles of prevention must be based on the evidence gathered in developed countries, but interventions must be context-specific and resource-sensitive.

Risk behaviours and risk factors

The 'lag-time' effect of risk factors on CVD means that present mortality rates are the effect of exposure to risk factors in past decades. Present public health strategies, which intend to reduce future CVD burdens, must focus on current levels of risk behaviours, biological risk factors (which relate principally to those behaviours) as well as the proximate social determinants of those risk behaviours and risk factors. Inappropriate nutrition, reduced physical activity and tobacco consumption are among the behaviours most associated with an increased risk of CVD while overweight, central obesity, high blood pressure, dyslipidaemia and diabetes are among the risk factors which principally contribute to the manifestation of that risk.

A rise in total fat intake and a decline in carbohydrate consumption (especially the complex variety), excess energy intake coupled with micronutrient deficiencies, reduced physical activity with energy–activity mismatch leading to obesity and excess salt intake characterise the nutrition transition that is becoming increasingly well documented in many developing countries[16]. The falling price of vegetable fat in the international market and the rising price of dietary fibre (fruit and vegetables) in the domestic markets are economic factors propelling this change. The proportion of Chinese citizens consuming >30% fat as an energy source in their daily diet rose steeply across all income classes between 1989 and 1993. The forces of urbanisation and globalisation – which shift production from the small farmer to the large corporation, distribution from the shopkeeper to the supermarket, consumption from fresh to processed foods and supply from local to export markets – are the dynamos of this change in dietary patterns[17]. World-wide, food is becoming part of a 'common culture' that reflects the dominant forces in globalisation.

While nutrition is an essential need, tobacco is an entirely avoidable external agent that contributes greatly to the risk of CVD. The proportion of all deaths attributable to tobacco is estimated to rise in India from 1.4% in 1990 to 13.3% in 2020, and from 9.2 to 16.0% in China during the same period. The overall global escalation would be from 6.0 to 12.3% in this 30-year period[18]. Of the 10 million lives that would be lost globally in 2025 due to tobacco, 7 million would be from the developing countries. The declining tobacco consumption patterns and the tactical, albeit limited, retreat of the tobacco industry in the developed countries are accompanied by aggressive marketing and rising consumption patterns in the developing countries. CVD would be the largest contributor to these tobacco-related deaths.

Recent reports from many developing countries chronicle rising rates of sedentarianism, overweight, high blood pressure, dyslipidaemia, diabetes and tobacco consumption in their populations[4,19]. These presage a sharp rise in future CVD events, unless effective public health interventions to prevent, recognise and reduce risk factors are urgently introduced and implemented[20].

Prevalence of hypertension varies according to the definition used in different studies. Recent surveys in China, as well as in India, confirm higher urban prevalence of hypertension compared with rural populations[21]. The overall prevalence in China, with threshold values of 140/90 mmHg, was 12.5% in adults aged 35–64 years. Recent Indian studies estimate a prevalence of adult hypertension to be 27.3% in an urban setting and 12.2% in a rural setting. Based on these estimates, the number of adults with hypertension in India and China together would exceed 100 million. Prevalence estimates of hypertension in adults in sub-Saharan Africa are in the range of 10–15%, and as high as 20% in some large studies. The number of hypertensive adults in this region, according to these studies, has been estimated to be between 10 and 20 million[22,23]. Prevalence of hypertension, in a 1993 national survey of adults in Mexico, was found to be 26.6%[24].

The developing countries are currently contributing to three-quarters of the global burden attributable to diabetes. The anticipated rise in the number of diabetics in the world, from 135 million in 1995 to 300 million in 2025, would principally be related to a sharp rise in diabetes prevalence in the developing countries, exemplified by a 195% rise in India[25]. This, in turn, would impact adversely on the CVD-attributable burden of disease in the developing countries. While urban diabetes prevalence rates are three- to fourfold higher than rural prevalence rates in most parts of India, urban prevalence of glucose intolerance (diabetes or impaired glucose tolerance) rose in urban Madras (Chennai) from 16.9% in 1988–89 to 20.7% in 1994–95[26]. Increases in BMI as well as central obesity contribute to the rising rates of glucose

intolerance. Both of these, in turn, are determined by changing patterns of diet and physical activity.

At present, urban populations in most developing countries have higher levels of cardiovascular risk factors that are related to diet and physical activity (overweight, hypertension, dyslipidaemia and diabetes), while tobacco consumption is more widely prevalent in rural populations[27,28]. This suggests that tobacco consumption is influenced more by education and is the earliest risk factor to demonstrate a reversal of the social gradient. The other risk factors are influenced by more complex social interactions affecting diet and exercise and their social gradients reverse relatively slowly. This variation indicates the need for specifically targeted prevention programmes addressing the needs of different social groups. It also offers an opportunity for policy-linked social engineering to influence the dynamics of an advancing epidemic at an early stage.

Societal effects of the global CVD epidemic

The economic and social consequences of the CVD epidemics in the developing countries will be devastating. The social gradient will reverse as the epidemics mature, as has happened in other nations that have experienced their fury in full form. Even at present, several of the risk factors of chronic diseases are showing a reversal of the social gradient in many developing countries[4]. The poor will become progressively vulnerable to the ravages of these diseases and will have little access to the expensive and technology-intensive management that clinical care demands. Also, the diversion of scarce societal resources to the treatment of these disorders dangerously depletes the resources available for the 'unfinished agenda' of infectious and nutritional disorders that almost exclusively afflict the poor.

Public health responses

The imperatives of CVD prevention in the developing countries are, therefore, clear and urgent. Population-based, lifestyle-linked, primordial and primary prevention strategies are especially relevant and likely to be cost-effective, avoiding much of the economic and biological costs of pharmacological interventions used in industrial countries (where the initial efforts were focused on reducing markedly elevated risk factors rather than on preventing their rise in the first place).

Geoffrey Rose[29] elegantly enunciated and eloquently espoused the 'population approach' for accomplishing substantive and sustainable reductions in the risk of chronic disease. This was based on distribution shifts within individual populations. It is now time to extend the population approach to the global community as a whole. Over the last 30 years, the global distributions of risk factors like serum cholesterol, blood pressure, body mass index and tobacco consumption have shifted rightwards. This is because the risk reduction in industrial countries was more than offset by the risk augmentation in the developing countries. The 'population-attributable risk' of the total world population for chronic diseases has, therefore, risen. Risk reduction only in the small group of 'high-risk' developed countries, without addressing the risk levels of the many and populous 'moderate-risk' developing countries, will not favourably impact on the global burden of chronic disease. Can we reverse this trend and shift the global distribution leftwards in the next 30 years? Therein lies the challenge of the global health transition.

Prevention must aim at risk reduction across the life span and apply core principles:

- risk operates across a continuum for most variables;
- many more events arise from the 'moderate' middle of the distribution than from the 'high-risk' tail;
- risk is multiplicative when risk factors coexist, which they often do;
- the majority of CVD events arise in persons with modest elevations of multiple risk factors rather than in persons with marked elevation of a single risk factor;
- 'comprehensive' or 'absolute' CVD risk (which profiles the cumulative risk of multiple factors operating in a continuum) is the best guide for individual interventions, while 'population-attributable risk' must direct mass interventions to maximise benefits from modest distributional shifts;
- synergistically complementary blends of cost-effective 'population-wide' and 'high-risk' interventions must extend from primordial prevention in children to secondary prevention in older adults[4,29,30].

Control of tobacco and hypertension are the highest priorities because they are the risk factors contributing to high burdens of CVD, and also because they are currently relevant to all developing countries, irrespective of their present stage of health transition. Promotion of physical activity and advocacy of healthy diets (moderation of fat and salt intake, and adequate fruit and vegetable consumption) are also necessary.

Community empowerment through education (mass and targeted) and policy change (to provide an enabling environment) are essential for health promotion in populations at all stages of health transition. The success of such comprehensive programmes has been demonstrated in the varied settings of developed, as well as developing, countries[31,32].

In addition, populations at high risk need strategies and services for early detection and effective control of risk. Opportunistic screening (for tobacco use, overweight and high blood pressure) and targeted screening (for diabetes and dyslipidaemia) must be followed by stepwise risk stratification and management. Acute care of manifest CVD must promote:

- recognition and ready response by the community along with the enhancement of resuscitation skills;
- use of chest pain algorithms and cost-effective interventions like aspirin in primary care;
- application of rational pharmacotherapy in secondary care and rational use of diagnostics and interventions in tertiary care.

Chronic care must effectively integrate secondary prevention into primary care, improve the management of left ventricular dysfunction in secondary care and promote rational use of high-cost technology in tertiary care. The centre of gravity of chronic care must shift closer to the community through promotion of care by self, family, community health workers and other non-physician care providers.

Health systems need to be reoriented to accept the expanded mandate of chronic disease control. Access to life-saving drugs and technologies must be promoted through private–public partnerships. Sustainable surveillance systems and dependable delivery systems need to be established through the synergy of public, private and voluntary agencies.

Research must also progress apace, in order to:

- enable the application of existing knowledge of risk factors and scientific content of preventive cardiology to the specific context of the developing countries;
- fill critical information gaps related to the established as well as putative risk factors, as relevant to different developing countries;
- strengthen the surveillance systems for measuring and monitoring CVD events and risk factors;
- evaluate cost-effective population strategies for primary and primordial prevention; and
- develop algorithms for appropriate clinical care.

Dealing with development

It would be unrealistic to urge the developing countries to retain their traditional ('primitive') rural lifestyles. Urbanisation and globalisation are inexorable forces and modernisation has an irresistible appeal. Development has its own health rewards in the form of augmented life expectancy and better health care. However, if the fruits of development are not to be frittered away by the costs of chronic disease, the goal has to be development without distortions, and progress without perils.

Even as globalisation offers opportunities that may offset its harmful effects, it must be recognised that the power for determining the desirability and the direction of change rests with the people. Markets are not autonomous entities and can be moulded by consumer consciousness. Creating and cultivating such consciousness is clearly the responsibility of all stakeholders in health at the community level.

The power of the people to determine their destinies must also extend to health-promoting behaviours. Rural communities, for example, should be able to attain, and retain, self-sufficiency in the production, distribution and local consumption of nutrient-rich foods like fresh fruits and vegetables. National food policies must encourage and enable such decentralisation. Urban planning should create environments friendly to physical activity, like protected cycle lanes. The process of disease prevention and health promotion can only be participative. Community empowerment is the key element in the strategy for chronic disease control and decentralisation is indispensable even in the era of globalisation.

All of these efforts will require an empowered community, an energetic profession and an enlightened policy which, together, constitute the most potent prescription for prevention at the national level. They will also need international co-operation, not only to combat global threats like tobacco, but also to benefit from shared experiences and expertise in CVD prevention. The epidemics of CVD in the industrial nations advanced and peaked at a stage when the knowledge of CVD causation was inadequate and the tools for their prevention were untested. It is a challenge to human intellect and enterprise to ensure that the currently available knowledge and tools are adequately utilised to anticipate and abort the CVD epidemics in the developing countries.

The challenge of epidemiological transition is not whether it will occur at all in the developing countries, but whether we can respond in time to telescope the transition and avoid the huge burden in young and middle-aged adults. The question is not whether we can afford to invest in CVD control in the developing countries, but whether we can afford not to.

References

1 Murray CJL, Lopez AD. *Global Health Statistics*. Global Burden of Disease and Injury Series. Boston, MA: Harvard School of Public Health, 1996.
2 Chockalingam A, Balaguer V. *Impending Global Pandemic of Cardiovascular Diseases*. Barcelona: Prous Science, 1999.
3 World Health Organization (WHO). *The World Health Report*. Geneva: WHO, 1999.
4 Murray CJL, Lopez AD. *Global Comparative Assessments in the Health Sector*. Geneva: World Health Organization, 1994.
5 Reddy KS, Yusuf S. Emerging epidemic of cardiovascular disease in developing countries. *Circulation* 1998; **97**: 569–601.
6 Pais P, Pogue J, Gerstein H, *et al*. Risk factors for acute myocardial infarction in Indians: a case control study. *Lancet* 1996; **348**: 358–63.
7 Gupta R, Gupta VP, Ahluwalia NS. Educational status of coronary heart disease and coronary risk factor prevalence in rural population in India. *Br. Med. J.* 1994; **307**: 1332–6.
8 Pearson TA, Jamison DT, Trejo-Gutierrez H. In: Jamison DT, ed. *Disease Control Priorities in Developing Countries*. New York: Oxford University Press, 1993; 577–99.
9 Krishnaswamy S, *et al*. Demands on tertiary care for

cardiovascular diseases in India: analysis of data for 1960–89. *Bull. World Health Org.* 1991; **69**: 325–30.
10 Suh I. Cardiovascular mortality in Korea: a country experiencing epidemiologic transition. *Acta Cardiol.* 2001; **56**: 75–81.
11 Reddy KS. In: Yusuf S, Cairns JA, Camm AJ, eds. *Evidence Based Cardiology*. London: BMJ Books, 1998; 147–64.
12 Yao C, Wu W, Wu Y. The changing pattern of cardiovascular disease in China. *World Health Stat. Quart.* 1993; **46**: 113–8.
13 Bulatao RA, Stephens PW.*Global Estimates and Projections of Mortality by Cause*. Preworking Paper 1007. Washington, DC: Population Health and Nutrition Department, World Bank, 1992.
14 Barker DJP, Martyn CN, Osmond C, *et al*. Growth in utero and serum cholesterol concentrations in adult life. *Br. Med J.* 1993; **307**: 1524–7.
15 Enas EA, Mehta J. Malignant coronary artery disease in young Asian Indians. Thoughts on pathogenesis, prevention and therapy. *Clin. Cardiol.* 1995; **18**: 131–5.
16 Drewnowski A, Popkin BM. A dietary intervention trial for nutritional management of cardiovascular risk factors. *Nutr. Rev.* 1997; **55**: 3–4.
17 Lang T. The public health impact of globalisation of food trade. In: Shetty PS, McPherson K, eds. *Diet, Nutrition and Chronic Disease*. Chichester: Wiley, 1997; 173–87.
18 World Health Organization (WHO). *Tobacco or Health: First Global Status Report*. Geneva: WHO, 1996.
19 InterAmerican Heart Foundation. *Heart Disease and Stroke in the Americans 2000*. Dallas, TX: InterAmerican Heart Foundation, 2000.
20 McMahon S. Blood pressure and the risk of cardiovascular disease. *N. Engl. J. Med.* 2000; **342**: 50–2.
21 Reddy KS. Hypertension control in developing countries: generic issues. *J. Hum. Hypertens.* 1996; **10**: S33–8.
22 Cooper R, Rotimi C, Kaufman J, *et al*. Hypertension treatment and control in sub-Saharan Africa: the epidemiological basis for policy. *Br. Med. J.* 1998; **316**: 614–7.
23 Fuentes R, Ilmaniemi N, Laurikainen E, *et al*. Hypertension in developing economies: a review of population-based studies carried out from 1980 to 1998. *J. Hypertens.* 2000; **18**: 521–9.
24 Arroyo P, Fernandez V, Loria A, *et al*. Hypertension in urban Mexico: the 1992–93 national survey of chronic disease. *J. Hum. Hypertens.* 1999; **13**: 671–5.
25 King H, Aubert RE, Herman WH. Global burden of diabetes, 1995–2025. Prevalence, numeric estimates and projections. *Diabetes Care* 1998; **21**: 1414–31.
26 Ramachandran A, Snehlatha C, Latha E, *et al*. Rising prevalence of NIDDM in an urban population in India. *Diabetologia* 1997; **40**: 232–7.
27 Reddy KS. Cardiovascular disease in India. *World Health Stat.* 1993; **46**: 101–7.
28 Ramachandran A, Snehlatha C, Dharmaraj D, *et al*. Prevalence of glucose intolerance in Asian Indians. Urban–rural difference and significance of upper body adiposity. *Diabetes Care* 1992; **15**: 1348–55.
29 Rose G. Sick individuals and sick populations. *Int. J. Epidemiol.* 1985; **14**: 32–84.
30 Stamler J, Stamler R, Neaton JD. Blood pressure, systolic and diastolic and cardiovascular risks: US population data. *Arch. Intern. Med.* 1993; **153**: 598–615.
31 Puska P, Tuomilehto J, Aulikki N, *et al*. *The North Karelia Project 20 Years Results and Experiences*. Helsinki: National Public Health Institute, 1995.
32 Dowsen GK, Gareboo H, George K, *et al*. Changes in population cholesterol concentrations and other cardiovascular risk factor levels after five years of non-communicable disease intervention programme in Mauritius. *Br. Med J.* 1995; **311**: 1255–9.