Preventing cardiovascular disease in India – translating evidence to action

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Cardiovascular disease (CVD) threatens to cripple India's workforce and stunt India's growth if timely and appropriate public health measures are not instituted. In this article, we describe the disease trends, disease burden, its upstream and downstream determinants and its economic impact. We then synthesize knowledge from various research studies and delineate evidence-based approaches and pathways to prevent CVD in India.

Policy measures which facilitate at the grassroots level easy availability, affordability, accessibility and desirability of health-promoting foods (fresh fruits and vegetables, whole grains, fish and nuts), increased physical activity in daily living and avoidance of tobacco, across all sections of the society, would have a strong, sustained, long-term impact in preventing CVDs in India. Community organization, strengthening of the existing health-care system, aligning them towards chronic disease care, training of paramedics, quality improvement programmes, setting up of sensitive, context-specific surveillance systems, elimination of artificial trans-fats and decreased use of salt in processed foods, use of mass-media approaches and social marketing for health promotion are measures and initiatives which need to be set in motion. Towards preventing the epidemic of CVD in future generations, marketing and advertising needs to be regulated so as to protect children and migrating/migrated poor from being unwittingly lured into unhealthy behaviours and consequently becoming susceptible to chronic diseases. Such comprehensive measures for effective prevention of CVD in India are national health imperatives which require multi-sectoral, multi-level and multi-disciplinary co-ordination and action.

Keywords: Cardiovascular disease, prevention, public health measures.

EPIDEMIOLOGISTS in India and international agencies such as the World Health Organization (WHO) have been sounding an alarm on the rapidly rising burden of cardiovascular disease (CVD) for the past 15 years[1]. The reported prevalence of coronary heart disease (CHD) in adult surveys has risen four-fold in 40 years and even in rural areas the prevalence has doubled over the past 30 years[1]. In 2005, 53% of the deaths were on account of chronic diseases and 29% were due to cardiovascular diseases alone[2,3]. It is estimated that by 2020, CVD will be the largest cause of disability and death in India. The country already has more than 40.9 million people with diabetes and more than 118 million people with hypertension, which is expected to increase to 69.9 and 213 million respectively, by 2025 unless urgent preventive steps are taken[4–6]. WHO estimates[7] that India lost 9 billion dollars in national income from premature deaths due to heart disease, stroke and diabetes in 2005, and is likely to lose 237 billion dollars by 2015.

Of further concern is the fact that Indians are succumbing to diabetes, high blood pressure and heart attacks 5–10 years earlier than their Western counterparts[4,8,9], in their most productive years. Unfortunately, scientific data also show that socio-economically disadvantaged sections of the population are now the dominant victims of CVD and its risk factors[10–14]. There is also preliminary evidence that the burden of CVD in rural areas is increasing[15]. Therefore, there is a need to initiate urgent action to forestall this grave portent of increasing mortality and morbidity due to CVD.

Risk factors for CVD

Non-communicable diseases are multi-factorial in causation due to both modifiable and non-modifiable risk factors. The World Health Report of 2002 lists six non-communicable disease (NCD)-related risk factors, amongst the 10 most important risk factors accounting for a large proportion of the global burden of chronic disease. These are: elevated blood pressure, high cholesterol, overweight/obesity, low fruit and vegetable intake, physical inactivity and tobacco use. The INTERHEART study, a case-control study, done in 52 countries involving 11,119 cases and 13,648 controls, suggests that more than 90% of the population-attributable risk for myocardial infarction can be explained by nine simple environmentally determined risk factors. Two-thirds of this risk comes mainly from smoking and elevated Apo B and Apo A ratio[16]. Though Indians developed myocardial infarction at a younger age, it was largely due to a higher prevalence of these risk factors[17]. In addition, modelled data

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from cohort studies also suggest that 4–5 simple risk factors explain most of the CVD risks[18]. Although tobacco use, unhealthy diet and physical inactivity[19–22] are amongst the leading causes of CHD, stroke[14,17,21], and diabetes[23–26], their preventive potential as a public health measure remains largely unrecognized and unaddressed.

Tobacco is the most important preventable cause of premature disability and death, and is responsible for a myriad of harmful effects[27,28]. There are currently 250 million tobacco users and every year about 800,000–900,000 Indians die due to tobacco use[29]. Unfortunately, the poor, the uneducated and marginalized sections of the society are the dominant victims of the adverse socio-economic and health consequences tobacco[30–37]. Almost half (48%) of the acute myocardial infarctions, 22% of the strokes and 14.8% of the ischaemic heart disease have been attributed to tobacco[38]. The attributable risk in India due to hypertension is 16% for ischaemic heart disease, 21% for peripheral vascular disease, 24% for acute myocardial infarction and 29% for stroke[38]. For diabetes, the attributable risk is 9% for acute myocardial infarction, 4% for stroke, 2% for neuropathy and 32% for cataract among Indians[38]. Since curative therapy is expensive and largely palliative, prevention appears to be a natural choice to reduce chronic diseases[39]. To combat this epidemic preventive strategies that address the upstream determinants such as globalization, urbanization and socio-economic determinants, need to be addressed.

Effects of globalization and urbanization on CVD

With an average GDP growth of 8.6% for the last 3 years, India is one of the fastest growing economies of the world[40,41]. It was the second highest contributor to world growth in 2006. Rapid economic growth, globalization, urbanization, rural–urban migration and aggressive marketing are all leading to a dramatic shift in the diet and living behaviours of individuals, families and communities. Consequently, adverse dietary changes in the population, sedentary activity, increasing tobacco use with consequent changes in the CVD risk factors are accruing at great speed and at earlier stages than other countries[42–45].

Urbanization is inevitable in all societies and countries. However, urbanization in counties like India occurs in a disorderly and chaotic fashion. Many rural poor come to cities, usually in distress, in search of jobs, due to failure of crops or being unable to make a living in the villages. They live in over-crowded and unclean environments in urban slums. Among other ailments they are prone to infectious diseases, stress, inadequate housing and indoor pollution. In addition, smoking prevalence is high among slum-dwellers along with inappropriate diet due to inaccessibility and high costs of healthy foods, resulting in an increased propensity to CHD. Among the well-off group, obesity is increasing amongst children. This is largely fuelled by the aggressive marketing strategies of the food industry targeting children, who then get attracted towards aerated beverages and salted wafers, leading to an increase in childhood obesity. There has been an alarming increase in childhood obesity in the last few years[46–48], and childhood obesity is a major risk factor for adult onset chronic disease and diabetes.

Other socio-economic determinants

Among Indians, poverty, maternal malnutrition and early life changes provide conditioning effects which enhance an individual's risk to CVDs. Neonates with low birth weights have higher insulin levels and insulin resistance, a trend which continues into later life[49,50]. Also early-life effects such as increase in weight in early childhood result in greater insulin resistance and diabetes in low birth weight infants at 30 years of age, than those without such effects[49,51].

Thus, we need to take cognizance of the fact that the root causes of chronic diseases are the environmental, behavioural and societal determinants which lead up to risk factors which result in the disease. Unfortunately, though there is much emphasis on treatment of CVD, the root causes or the upstream determinants of CVD are not adequately addressed. In the ensuing sections, we delineate the theoretical framework and evidence-based strategies which need to be implemented for prevention of CVD in India.

Principles of CVD prevention

The cardiovascular risk factors, which are blood pressure, blood glucose and tobacco use and blood lipids, operate in a continuum (higher the values higher the risk without any threshold effects), are largely preventable and often cluster together in individuals and populations. Benefits of risk reduction strategies also operate across this continuum. The 'risk factor' concept provides the scientific basis for prevention and control of NCDs. Today's unhealthy daily living behaviours are tomorrow's risk factors. These risk factors exert a steadily rising effect on the risk of disease and interact with each other to increase the overall risk.

The majority of cardiovascular events (death, myocardial infarction and stroke) arise from individuals with modest elevations of many risk factors, rather than in individuals with marked elevation of a single risk factor. Strategies for prevention must address 'multiple risk factors' to reduce the 'risk' across the 'whole population'. Public health interventions which influence lifestyle behaviours through policy, public education or a combination of both, have been demonstrated to yield rich dividends in reducing the risk of NCDs in populations as well as in individuals. For example, a study in the UK has revealed

that a reduction in risk factors, at the population level, made a much greater contribution (70%) to the decline of overall mortality and coronary mortality than improved technologies for clinical care (30%)[52].

Approaches to prevention

Two strategies or approaches have been conventionally advocated for CVD prevention. These are the population-based approach and the high-risk approach. The 'population-based approach' aims at reducing the risk factor levels in the population as a whole. As mentioned earlier, since there is a continuum of risk associated with most CVD risk factors, this mass change will result in mass benefits across a wide range of risks. While individual benefits are relatively small, the cumulative societal benefits are large, in terms of reducing national disease burdens[53,54].

The high-risk approach aims at identifying persons with the highest risk of diseases, those with markedly elevated risk factors and also people who have already had an event. These individuals are then targeted for interventions to reduce the risk factor levels. The individual benefits are large, but since the number of such persons is proportionately small, the overall benefits to the society are limited in terms of death or disability avoided.

The population strategy has the advantage of being lifestyle-linked, inexpensive and behaviourally more appropriate. The high-risk approach is often pharmacological and more expensive, but the large quantum of projected individual risk and anticipated personal benefit elicits better motivation in both patients and health-care providers[53].

Comprehensive community-based approach

In reality, a balance of the population-wide and high-risk approach is often desirous with priorities set by the efficacy and cost-effectiveness of the interventions[55]. This is best illustrated by the reduction in mortality from CHD between 1968 and 1978 in the United States[56], in which population-wide changes in blood cholesterol (accruing from changes in the diet) and reduction in cigarette smoking accounted for 54% of the decline, while changes in health care, including treatment of hypertension, emergency coronary care and revascularization, accounted for another 39.5%. Only a small part of the decline could not be explained. This illustrated that a mix of population-wide and individual-based interventions has seen CVD mortality fall significantly and is also cost-effective[57].

Policy measures

Well-designed policy measures can be powerful tools in effecting changes in population behaviour related to tobacco and alcohol control, diet and physical activity, especially among the poor and those with low levels of education. Laws, treaties, policies and regulations have played important roles in the prevention and control of disease[58]. In the ensuing sections we elaborate on evidence of policies to decrease tobacco use, increase nutrition and consumption of health-promoting foods and physical activity in daily living among the populations.

Policies for tobacco

Tobacco control requires a reduction in both demand and supply[59]. It has been clearly demonstrated that countries that have implemented comprehensive bans on tobacco advertising and promotion have reduced tobacco use much more quickly, and to lower levels than other countries[60]. Tax increases are the single most effective intervention to reduce the demand for tobacco. The World Bank has estimated that a 10% increase in tobacco prices can save millions of lives across the world[61]. Banning of smoking in public places can also result in remarkably quick changes. For example, a smoking ban in Helena, Montana, USA, during 2002, reduced heart attack hospitalizations by 40%. This trend reversed within six months of the ban being lifted[58]. National health concerns necessitate large-scale public health measures to tackle tobacco use in India.

Policies for enhancing nutrition

There is a strong rationale for policy interventions to enhance the supply of healthier food choices and curtail the availability of unhealthy food. (The consumption of fresh fruits and vegetables, whole grains, whole pulses, nuts and fish needs to be increased; saturated fats, salt and refined carbohydrates need to be decreased; and artificial trans-fats need to be eliminated[62].) Food prices are critical determinants of the food we eat[63–65]. What type of food people, families and communities buy and consume is determined by the relative food pricing in the market[63,65,66]. Systematically altering the relative prices of different food stuffs will favourably affect food consumption which will bring down obesity, blood pressure, serum cholesterol and blood glucose at the population level[67], and thereby save millions of people from chronic diseases. Food prices together with the shopping environment significantly contribute towards people becoming overweight and obese[45,66,68].

Blood cholesterol levels are largely determined by the proportion of dietary energy derived from trans-fats, saturated fats, poly-unsaturated fats and refined carbohydrates[69–71]. Diet determines cholesterol concentration, which in turn determines the prevalence of heart disease, heart attack and stroke in the population[67]. In a meta-analysis of all international studies, 80% of the interna-

tional variation in ischaemic heart disease was attributed to the variation in the serum cholesterol levels. The average blood cholesterol concentration accurately predicts the occurrence of ischaemic heart disease[72]. A rise of 0.6 mmol/l (23.4 mg/dl) is associated with a 38% increase in ischaemic heart disease deaths; an equivalent fall results in a 25–30% fall in the incidence of ischaemic heart disease within 5 years[72]. In countries where average cholesterol concentrations have come down, the occurrence of ischaemic heart disease has fallen by the predicted amount. Lowering of cholesterol from any initial value has benefits at the entire population level. Diet also determines the intake of antioxidants and protective factors present in fresh fruits and vegetables, which in turn determines the prevalence of heart disease, heart attack, stroke, cancer and other chronic diseases in the population. Policies can have a profound influence on food and nutrition of the entire population.

For example, a single policy measure instituted by the Government of Mauritius in 1987, changing the composition of the commonly used cooking oil from being mostly palm oil (high in saturated fatty acids) to being wholly soybean oil (high in unsaturated fatty acids) led to a significant reduction in the plasma cholesterol levels of its population[73]. Similarly, policy measures have been successful in Poland. Between 1960 and 1990, Poland experienced a serious increase in death rates from heart disease among young and middle-aged men and women. This dramatically reversed after 1991, with an annual decline rate of 6.7%. These results have been attributed principally to the replacement of dietary saturated fat with polyunsaturated fat – vegetable fat, and oil consumption increased (primarily in the form of rape-seed and soybean oil products), while animal fat consumption, mainly butter, declined. These trends were associated with the removal of price subsidies on butter and the availability of cheaper vegetable oils. Similarly, policy measures also supported the increased consumption of fruits and vegetables[74].

In India, commercial foods such as biscuits, namkeens (which are rich in trans-fats and saturated fats, salt/refined carbohydrates) are sold at rock-bottom prices and are positioned as 'entry-level' products in the food market[75]. These foods unfortunately, are much more affordable than the healthy options, making the poor vulnerable to chronic diseases. In September 2006 the WHO, recommended phasing out of artificial trans-fats from all foods. The process has begun in many countries. Legislation has virtually eliminated the intake of artificial trans-fats in Denmark, California and many other states[76]. Another important public health measure is decreasing salt in processed foods, which significantly reduces high blood pressure, stroke and CHD among the populations.

Incentives (like taxes subsidies) need to encourage the production of healthier foods for positive health effects at the population level[75,77]. There is a case for combining taxes of unhealthy food with subsidies of healthy food[77,78], and promoting fresh and minimally processed food produced in ways that are sustainable to the environment[79]. These food policies are beyond the ambit of the health sector and encompasses agriculture, pricing of foods, tax incentives for improving storage and transportation of fruits and vegetables, and measures and regulations which discourage and prohibit the use of artificial trans-fats in bakery products and other food items, among others. In India, the unorganized food sector is large and forms the mainstay of at least one meal consumed outside home, especially amongst people from the middle and the low socio-economic backgrounds in urban areas. Measures are required to promote healthy and hygienic food in the unorganized sector. Further, among the affluent there is a trend towards increasing use of processed foods and aerated drinks. In the subsequent sections we touch upon two other aspects which need attention – food labelling and advertising targeting children.

Food labels

The level of baseline technical nutritional knowledge of people in India is highly variable and inadequate in marginalized groups. Most people cannot make technical nutritional interpretations from food labels, even if the labels are technically precise! Simple colour-coded labels on basic nutrients and simple health implications of the food can provide information to the common man. This will also diminish the social inequity in benefits accrued from food labels[75]. For example, Canada and USA saved 5.3 and 4.2 billion dollars respectively, in 20 years due to health benefits accruing from appropriate labelling of foods[80]. By contrast, it was estimated that Australia and New Zealand lost 47–67 millions dollars and lost 320–460 lives, each year due to delay in appropriate food labelling[80].

Marketing which targets India's children

Children of ages 8 years and under do not effectively comprehend the persuasive intent of marketing messages or the difference between commercial and non-commercial intents. Those as old as 11 years, also unless explicitly taught, may not be able to do so[81]. Appropriate regulations are needed to restrict advertisements which lure small children towards unhealthy behaviours, etching such behaviours for life, making them unwittingly prone to CVD, cancer and diabetes[75].

Policies for enhancing physical activity

There is clear scientific evidence that policy and environmental changes increase the physical activity levels of

the entire population and have a tremendous impact on preventing CVDs[82–85]. Even if there are small increases in daily physical activity in communities, it will translate to large national and population benefits[45,83,85–87]. Community design, transportation and even time spent in traffic jams have strong relationships to physical activity and obesity[88,89]. When environmental structural facilitators are not in place, even well-designed health promotion programmes are ineffective[90].

Promoting increased use of walking and bicycling for transportation, through dedicated, safe, well-networked walking and cycling paths, and making communities walkable should be of high national priority in urban design[82,86,91–94]. In the Indian context (in view of the heat) these need to be lined with trees for shade. There is a critical need for policy-level facilitation to increase walking and cycling for transportation. Promoting walking in all communities, cities, workplaces and educational institutes closes the gap between the low income, socially excluded and the high income groups[93]. The National Urban Transport Policy gave impetus to improving of the public transport systems[95]. Under the National Urban Renewal Mission launched in 2005, the Government proposes to construct bicycle lanes and pedestrian paths. Such initiatives need to be further strengthened and implemented[96].

Staircases need to be well-lit, painted, pleasant and well maintained to be used more often[92,93,97]. Simple motivational signs at the bottom of a staircase promote its use in workplaces, public places and educational institutions[98–100]. Science has shown that green spaces, well-maintained parks and open spaces with trees, promote health, physical activity and prevent diseases in all age groups, across all socio-economic strata[82,92,101–105]. There is a critical need for policy-level facilitation to make physical activity in daily living in all age groups in all sections of the society accessible, affordable, available, desirable and safe.

Mass-media campaigns

Media, in today's society, has by far the strongest impact on behaviour of children, individuals, families, communities and the society at large. It plays a critical role in today's society[75]. Media can be the most important watchdog too and a strong rationale exists for using the media in promoting healthy lifestyle in India. However, health messages through the media have not been shown to be consistently effective in reversing adverse lifestyle changes or promoting healthy lifestyles. In a meta-analysis of several studies, Sellers *et al.*[106] have shown that health promotion (involving health education, mass media, community organization) does not reduce mortality significantly, but leads to small but potentially beneficial reductions in risk-factor levels[106]. The power of the media however lies in making people accept policy changes and in this regard will be a useful tool. It can also promote community organization, which again is helpful in influencing policy makers. Further, social marketing could be an effective tool in achieving healthy dietary and physical activity behaviours[107]. The advertising industry in India is the most creative and advertisements have a strong and powerful impact on the behaviour of people. These can be utilized for mass-media campaigns[75].

Community-based interventions

Community empowerment is essential for the success of prevention programmes. Public health interventions need to combine educational interventions which influence social norms, health beliefs and behaviours of the community with policy interventions which provide a supportive physical and social environment that enables people to adopt healthy behaviour (with respect to healthy diet, physical activity and tobacco avoidance). However, community-based studies have not had a huge impact in the Western societies. Ebrahim and co-workers[108,109] in their meta-analysis concluded that there were no significant reductions in mortality. Several reasons have been attributed to these equivocal results – shorter duration of intervention, improper design to evaluate the benefits, 'contamination' (adoption of components of health intervention by the control community) and an already declining trend of CVD in developed countries during the intervention period[108,109]. By contrast, currently, in developing countries the prevailing secular trend appears to be of rapidly increasing the burden of CVD and its risk factors. Therefore, it is likely that a community-based approach may show the desired results of reducing CVD risk factors in a developing country setting. Examples of successes in community-based health promotion strategies[110,111] are provided in Box 1.

Community organization

Special interest groups in the community that aim to mobilize, organize or empower their members are crucial in developing and fostering capacity for CVD control. Such groups may evolve and operate from multiple settings such as neighbourhood groups, self-help groups, work sites, schools, etc. and act as channels to diffuse the intervention effects to the target community. For example, the CATCH study in the United States improved the quality of nutrient intake in school children through a programme of school-based health intervention[112]. Similarly, the HRIDAY programme of school-based health education in India, successfully reduced the rates of both experimentation with tobacco and offer of tobacco by peers, as demonstrated in a cluster randomized trial[113]. A worksite-based health promotion in ten sites across India

Box 1. Community-based health promotion strategies.

INTERHEALTH was an international collaborative project in which participating nations worked towards prevention and control of common risk factors, for a group of non-communicable diseases, using strategies that emphasize community involvement, health promotion activities, behavioural interventions, and prevention and control activities implemented through existing primary health-care systems and other community structures[110]. The aim was to demonstrate how an integrated programme could be implemented in populations, in all regions of the world, at every stage of the demographic and epidemiological transition.

In the framework of the INTERHEALTH programme, special activities were undertaken among school children in Chile and the United Republic of Tanzania. Large-scale community programmes were launched in Mauritius and China. The Tianjin Project was launched in China as part of the INTERHEALTH programme in 1984 and aimed at reducing high sodium intake among the entire population, decreasing smoking, especially among men, and providing hypertension care by reorganizing the existing primary health care services. After 7 years of the programme, the prevalence of hypertension and obesity decreased among people aged 45–64 years in both genders[110]. However, smoking rates increased among men, especially those with higher education. Body mass index remained unchanged in both genders.

Changes in population cholesterol concentrations and other cardiovascular risk factor levels after five years of the non-communicable disease intervention programme in Mauritius showed significant reduction in population blood pressure and serum lipid concentrations, increased leisure exercise, and decreased smoking and alcohol consumption[111]. This national healthy lifestyle intervention programme in Mauritius, through extensive use of the mass media, fiscal and legislative measures and community health promotion, demonstrated that lifestyle intervention programmes can be implemented and can have positive impacts in developing countries.

and a pilot community programme in southern India have been shown to be successful in reducing risks for CVD[114,115].

High risk strategy

Individuals at high risk of disease must be detected and stratified according to their risk using methods which are appropriate to low resource settings. As against resource intensive 'mass screening', 'opportunistic screening' for risk factors (tobacco and alcohol habits, blood pressure, overweight, abdominal obesity, past and family history of CHD) is preferred. Furthermore, such strategies should be complimented by 'targeted screening' among vulnerable or 'high risk' individuals (having past and family history of CHD). Based on the risk profile, cost-effective interventions should be provided to reduce the risk.

Many effective interventions have been identified for reducing cardiovascular risk, in high-risk individuals through primary as well as secondary prevention. Cost-effective interventions like diet and physical activity regimens have been demonstrated, in a recent clinical trial in Chennai, to markedly reduce the risk of developing diabetes in high-risk individuals[116].

The imbalance from the wide variability in management of patients with CVD in India – from patients being treated at tertiary and teaching hospitals, who receive the best possible evidence-based care, to patients who have poor or even no access to specialist care and whose condition, therefore, is poorly treated, needs to be corrected[117]. A study by WHO, on prevention of recurrence of myocardial infarction and stroke in developing countries, including India, reported under-utilization of evidence-based, cost-effective and appropriate medications[118]. Further, the CREATE registry has shown that there are considerable delays in access to hospitals and significant gaps in affordable treatments after a heart attack. Such delays and gaps were highest among the poor leading to higher mortality (at 30 days after a heart attack) compared to the rich and middle class[119]. Evidence-based low-cost solutions like the use of aspirin for first-aid of chest pain need to be implemented on a large-scale basis[120]. Similarly, lifestyle measures (such as diet, physical activity, smoking cessation) and drugs (aspirin, beta-blockers, angiotensin converting enzyme inhibitors, statins and diuretics) can bring about substantial reductions in the risk for coronary events[121].

Similarly, disease management programmes and rehabilitation after a cardiac event are sub-optimal has been documented that even small interventions can have a substantial impact in improving the quality of life in patients[122]. Further, implementation of an essential drug policy to control the pricing of prohibitively costlier CHD-related drugs would lead to better compliance to drug therapy and risk factor management, especially among low-income groups.

Surveillance

Surveillance is crucial for advocacy, policy-making, planning and programme implementation. Surveillance is defined by WHO as 'ongoing systematic collection, collation, analysis and interpretation of health data and the timely dissemination of such data to policy makers and others for the planning, implementation and assessment of disease control'[123]. The surveillance systems

have four elements – (i) occurrence of health event, (ii) process of collecting data, (iii) process of data management and interpretation, and finally (iv) utilization of information for action. Risk-factor surveillance tracks the changes in health behaviours related to the epidemiologic transition, assesses their impact on morbidity, and provides evidence of changes taking place over time. It tracks the changes that have occurred as a response to population-based public health interventions.

Stakeholders of a surveillance system are a diverse group of policy makers, academicians, community members and social-action organizations, all of whom must be involved in the surveillance system. Developing a surveillance system requires meticulous planning, careful implementation and critical evaluation. We need to invest in surveillance, and trained manpower and infrastructure are essential for a responsive surveillance system. NCD surveillance systems cover deaths, disease and risk factors, but collecting data on NCD risk factors is more important. Standard NCD surveillance tools are now available, the most notable being WHO STEPwise approach[124]. Countries can adopt/adapt these tools to their needs. Competing demands on meagre finances for health make it inevitable that a cost-effective, locally applicable surveillance system be evolved. Surveillance systems need to be evaluated periodically to check whether they are responding to the public health needs and to identify needs for research.

Systems strengthening

Medical education and hospital care in India traditionally has been geared towards diagnosis, treatment and management of acute diseases with minimal emphasis on community-based chronic care. The medical education needs to incorporate chronic disease management and primary care in its curriculum.

A prerequisite for effective implementation of prevention strategies and identification of high-risk individuals is a functioning and equitable primary health-care system. Due to severe shortage of physicians in the rural areas, non-physician health-care workers should be trained to reliably and effectively assess and manage cardiovascular risks in primary health-care settings, even when there are no attending physicians. The role of such service providers needs to be studied through well-designed studies.

It is essential to integrate the core components of prevention, surveillance, screening and management of CVD into the primary and secondary health care, along with enhancement of skills of both the health-care providers and planners. Evidence from a Quality Improvement Programme (QIP) carried out at secondary health-care settings in Kerala involving the use of a service delivery package and formal education, in the detection and optimal management of acute coronary syndromes for health-care professionals, has shown estimable results and can be replicated[121].

Sustainable and positive changes in the heath systems aimed to improve the equity, efficiency and quality of the health services will have tremendous impact on the health outcomes. The experience from both the North Karelia project and Tianjin project emphasize the important role of primary care workers. Systematic involvement of primary health-care centres can be one of the most effective intervention tools, particularly to deal with biological risk factors such as hypertension, diabetes and dyslipidemia in developing countries. Involvement and collaboration with various sectors of the community involving non-governmental organizations and self-help groups was considered to be a key component of the North Karelia project. A system's strengthening is thus required to enhance the availability, accessibility and affordability of primary, secondary prevention and rehabilitation facilities for prevention of CVD at primary and secondary care centres.

Indigenous systems for lifestyle advice

For lifestyle advice, Indians are familiar with many indigenous systems which are part of the cultural fabric of the country and facilities for the same are locally available. These can be used to get both patients and normal individuals to espouse a healthy diet, physical activity, tobacco cessation and an overall healthy lifestyle. In order to be accepted by the wider scientific community, we need clinical trials of yoga in the primary and secondary prevention of CVD. Small studies have suggested the potentially useful role of yoga, especially in individuals with overt coronary disease and hypertension[125–127].

Concluding note

CVD is rising at an alarming speed, threatening to stunt India's growth, productivity and its youth in the coming years due to a substantial loss of potentially productive years of life. Many advances have taken place for preventing CVDs. We need to translate these benefits for reducing the burden of CVD in India. The risk factor concept forms the scientific basis for prevention of control of NCDs. Six risk factors are modifiable and responsible for majority of the disease burden.

A comprehensive public health response to this expanding epidemic of chronic diseases needs a 'life-course approach'. Such a response needs to be integrated and implemented through coordinated mechanisms of regulation, environment modification, education and health-care responses. It needs to integrate public-health interventions, which can profoundly influence the non-personal determinants of chronic disease risk at the population level, with cost-effective clinical interventions for

early detection and reduction of chronic disease risk factors in individuals at high risk. Public health interventions need to combine policy interventions with community empowerment. Interventions influencing health behaviours through health promotion strategies and policy reforms have been successful in reducing the burden of chronic diseases. Such measures are found to be cost-effective, sustainable and reduce risk in entire populations.

Several types of partnerships among different stakeholder groups are required to provide effective pathways for the design and delivery of programmes for CVD prevention and control. Inter-sectoral cooperation between different stakeholders, media and civil society is crucial for the success of the programmes. The civil society should include NGOs, consumer groups, labour unions, schools, colleges and technical experts from various fields.

Multi-sectoral, multidisciplinary and multilevel coordination and initiatives are an essential prerequisite to effective implementation of the programmes for NCD prevention and control. This would involve setting up a suitable institutional mechanism to enable active partnership of the following Ministries in the Government: Health, Human Resource Development, Industry and Commerce, Urban Development, Rural Development, Women and Child Development, Food and Agriculture, Food Processing, Environment and Forests, Roads and Transport, Labour, Social Welfare, National Commission for Women and State Commissions for Women in different states, Home Affairs, Information Technology, and Ministry of Science and Technology[77].

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MEETINGS/SYMPOSIA/SEMINARS

National Seminar on 'Frontiers in Nanotechnology'

Date: 17–18 September 2009
Place: Madurai

The thrust areas include: Nanobiotechnology, DNA-nanostructures, nano-medicine-drug delivery systems, protein nanoengineering, environmental nanotechnology, nanodevices and biosensors. The seminar will also provide a forum for discussion on all aspects of nanoscience and will foster the exchange of ideas, techniques, experiments and applications.

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Brainstorming Session on Nanogeoscience

Date: 20–21 August 2009
Place: Tiruchirappalli

Themes include: Primer, Realms, Instrumentation, Nanomineraology, Applications, Environmental significance, Education and research.

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