CVD Prevention and Control (2010) 5, 115–123

available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevierhealth.com/journals/precon

REVIEW

Cardiovascular risk factors in developing countries: A review of clinico-epidemiological evidence

D.S. Prasad [a,*], Zubair Kabir [b], A.K. Dash [c], B.C. Das [d]

[a] Sudhir Heart Centre Main Road, Dharmanagar, Berhampur 760002, Orissa, India
[b] Research Institute for a Tobacco Free Society, The Digital Depot, Thomas Street, Dublin, Ireland
[c] M.K.C.G. Medical College and Hospital, Berhampur 760004, Orissa, India
[d] Kalinga Institute of Medical Sciences, Bhubaneshwar 751024, Orissa, India

Received 25 July 2010; received in revised form 5 September 2010; accepted 8 September 2010
Available online 28 October 2010

KEYWORDS
CVD;
Cardiovascular risk factors;
Ethnicity;
Asians;
South Asians;
Developing countries;
Prevention and control

Summary
Background: Cardiovascular disorders (CVD) are due to a constellation of modifiable and non-modifiable risk factors — some known and others unknown. Such risk factors are reported to vary across ethnicities. CVD will likely become a major public health and clinical problem in Asia such that by the year 2020 Asia will have more individuals with CVD than any other region. However, the current evidence on variations in cardiovascular risk factors both from a clinical and an epidemiological perspective with special reference to developing country settings is limited. In this context, we set out to review the existing evidence and to summarize the findings.
Methods: We did not carry out a systematic review but pursued a similar structure. We abstracted the most appropriate published literature from electronic databases, namely, PubMed, Embase and the Cochrane Library applying specific search terms. We searched grey literature and followed up bibliographic references.
Results: Ethnicity is emerging as an independent risk factor contributing to the rising epidemic of CVD in developing countries. Furthermore, increasing rates of urbanization have led to striking changes in lifestyle patterns resulting in decreasing physical activity, increasing weight and, consequently, increasing rates of diabetes, hypertension and dyslipidemia in urban Asians.
Conclusions: Variations in selected cardiovascular risk factors in developing countries were identified. Prediction tools and risk assessments need to be population-specific and sensitive to ethnic minorities. This summary of evidence could help to shift priorities to populations for targeted cardiovascular prevention and control measures where resources are limited.

* Corresponding author. Tel.: +91 0680 2224278; fax: +91 0680 2225080.
E-mail addresses: drdsprasad@gmail.com, sudhir_heartcare@hotmail.com (D.S. Prasad).

1875-4570/$ - see front matter
doi:10.1016/j.cvdpc.2010.09.001

Contents

Introduction

Cardiovascular disease (CVD) is an important cause of morbidity and premature mortality all over the globe and contributes significantly to the escalating costs of health care [1]. This epidemic has the potential to place a huge socioeconomic load on developing nations, where CVD mainly occurs in the productive age groups [2—4]. The causal pathology for CVD is atherosclerosis, which begins early in life and progresses gradually through adolescence and early adulthood over several years and is usually advanced by the time symptoms occur, generally in middle age [5—7]. Acute coronary and cerebrovascular events frequently occur abruptly, and are often lethal before health care can be arranged [1]. Alteration of risk factors has been shown to reduce disability and death in people with diagnosed or undiagnosed CVD [1] and this concept that CVD can be prevented has become a driving force in cardiovascular medicine [8]. Successful preventive strategies necessitate an assessment of risk to categorize patients for selection of appropriate intervention [9]. Recognition of risk factors lies at the heart of clinical efforts to diminish the risk for CVD [9].

The demographics of cardiovascular risk are altering. We are now facing a democratization of this disease, where individuals of all socioeconomic strata are being affected by cardio metabolic risk and are susceptible to its complications, such as coronary artery disease (CAD) and stroke. Risk factors for CVD are showing a reversal of the social gradient in many developing countries [10,11]. CVD is among the world's important causes of death, and nearly 80% of these deaths occur in developing countries [12]. One of the greatest public health challenges posed to the developing countries is containing the epidemic of non-communicable diseases in the midst of endemic communicable diseases [13]. The fiscal and societal consequences of the CVD epidemics in developing countries will be overwhelming [14]. India, for example, is burdened with 25% cardiovascular-related deaths [15]. It has been predicted that these diseases will rise quickly in India and will be host to more than half the cases of heart disease in the world within the next 15 years [16].

Cardiovascular disease, an important cause of morbidity and premature mortality worldwide is due to a constellation of modifiable and non-modifiable risk factors — some known and others unknown. Such risk factors are reported to vary across ethnicities, especially among South Asians. However, the current evidence on variations in cardiovascular risk factors both from a clinical and an epidemiological perspective with special reference to developing country settings is limited. In this context, we set out to review the existing evidence and to summarize the findings.

Prevalence of risk factors

The World Health Organization (WHO) stated in 2002 that some of the most formidable obstacles to health are combining with the associates of poverty to inflict a double burden of disease, disability and premature death in a large populace of developing nations [17]. This is particularly true for South Asia with a quarter of the global population and about half of them living below the poverty line with limited access to health care. This the population is aging and non-communicable diseases are escalating in the presence of unrestrained infectious diseases [18,19]. Cardiovascular risk factors find place in the Top 10 selected risks to health globally as per the World Health Report 2002 [17]. The same are depicted in Table 1.

Risk factors for CVD are now important in every population. Even in developing nations with high mortality, such as sub-Saharan Africa, hypertension, hypercholesterolemia, smoking, alcohol use and low vegetable/ fruit intake, already figure among prime risk factors [20]. In developing nations with low mortality, such as China, cardiovascular risk factors appear on the crest [20]. These populations encounter a dual burden of risks, grappling with problems of under nutrition and communicable diseases. In developed countries at least one-third of all CVD is attributable to five risk

Table 1 The top 10 selected risks to health.

1. Under weight	6. Unsafe water, sanitation and hygiene
2. Unsafe sex	7. Iron deficiency
3. High blood Pressure	8. Indoor smoke from solid fuels
4. Tobacco consumption	9. High cholesterol
5. Alcohol consumption	10. Obesity

Source: The World Health Report 2002. Reducing risks, promoting healthy life. World Health Organization, Geneva, 2002.

factors: smoking, alcohol use, hypertension, hypercholesterolemia and obesity [20].

Risk factor and CVD

The term ''Risk factor'' in relation to CVD, and particularly CAD, was used for the first time in 1961 in a paper on the Framingham Study [21]. The risk factors themselves, in particular elevated levels of serum cholesterol, blood pressure and smoking, have been considered in prospective epidemiological studies since their detection in the late 1940s [22—24]. Over the years, much has been learned about risk factors, in terms of both depth of understanding and the recognition of new predictors of risk. More than 300 risk factors have been linked with CAD and stroke [20]. Some of these are not new but need to be more precisely specified and more accurately measured, while others have emerged only recently. But a few risk factors explain this worldwide epidemic and the high cardiovascular risk status of populations as seen in Fig. 1 [20] Social, environmental, economic factors as well as commercial influences are important determinants of these risk factors [25].

Predisposing factors

Those which account for the increased incidence of CVD in developing countries are summarized below:

- Demographic changes with altered population age profiles [26,27].
- Epidemiological transition: The change from a preponderance of infectious diseases to predominance of chronic diseases [28,29].
- Lifestyle changes due to recent urbanization, industrialization and globalization [14,30].
- The *degree* and the *duration* of exposure to cardiovascular risk factors are expected to increase as a result of higher risk factor levels [31] along with a longer life expectancy [14].
- The prevalence of central obesity, diabetes, hypertriglyceredimia, low HDL-c is highest among South Asians [32].
- Possible effects of fetal under nutrition on adult susceptibility to CVD [33,34].
- Probable gene—environment interactions[35] or genetic susceptibility possibly mediated through elevated levels of lipoprotein (a) influencing ethnic diversity [36—38].
- Nutrition transition [39] along with physical inactivity [40] are critical factors contributing to the acceleration of CVD epidemics [31].

Nevertheless, a changing profile of cardiovascular risk factors might provide further insights into the epidemic of CVD in developing countries.

Ethnicity and CVD risk

The prevalence of risk factors and their association with CVD vary markedly by ethnic group [41—43]. Existing knowledge of CVD risk owes to a great extent from studies of Caucasians. But certain ethnic groups experience an unduly larger burden of CVD including CAD and stroke. Age adjusted cardiovascular disease death rates in Canada, UK, China and Indian Subcontinent in 2005 are depicted in Fig. 2 [44].

South Asians have an increased prevalence of CAD and cardiovascular mortality among ethnic groups such as Caucasians, African Blacks, Israeli Jews, Malays, Chinese and Japanese, irrespective of their religious affiliations, life

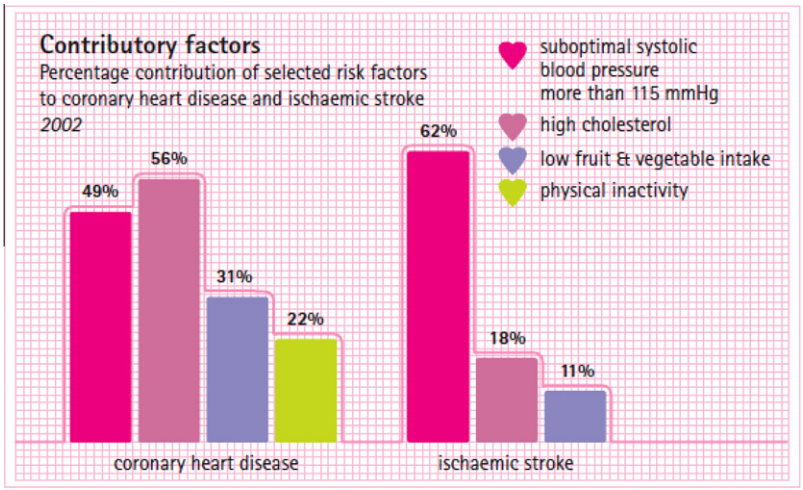

Fig. 1 Percentage contribution of selected risk factors to CAD & ischemic stroke. *Source:* MacKay J, Mensah GA. The Atlas of Heart Disease and Stroke. World Health Organization, Geneva, 2004.

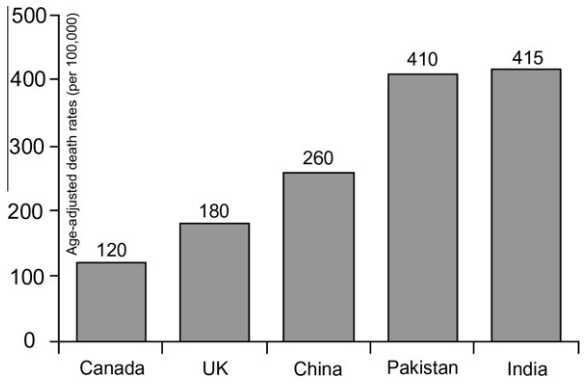

Fig. 2 Age adjusted cardiovascular disease death rates in Canada, UK, China and Indian Subcontinent in 2005. *Source:* World Health Organization. The World Health Report 2005. Preventing Chronic Diseases: A Vital Investment, 2005. Geneva, WHO.

style, diet or the country of residence[45,46]. Excess predilection of CAD in Indians is due to nature i.e. genetic predisposition [36—38] due to high lipoprotein (a) and nurture (risk factors influenced by environment or life style) [30,35]. India had 35 million people afflicted with CAD in 2005 and this number is projected to increase to 62 million by 2015 [47]. The CAD rates in rural populations in India have increased to 6% from 2% and in urban populations up to 12% from 4% in about 30 years [48].

African-Americans demonstrate an elevated rate of CAD and stroke while African Caribbeans in the UK have lesser CAD rates and elevated stroke rates than British Europeans. Chinese and Japanese demonstrate an elevated rates of stroke but not CAD, while Mexican Americans have an elevated prevalence of both stroke and CAD, and North American native Indians also have high rates of CAD [41].

Thoroughly assessing and quantifying modifiable cardiovascular risk factors is vital in these populations. Improved understanding of the disparity of cardiovascular risk factors by race and ethnicity may help clinicians and public health professionals build up culturally sensitive interventions, prevention programs, and services explicitly targeted toward risk burdens in each of these populations [42].

Conventional cardiovascular risk factors such as smoking, hypertension and dyslipidemias calculate risk among these ethnic groups. They do not entirely explain the differences in risk between ethnic groups, suggesting that alternative explanations might exist. Ethnic groups show variations in levels of visceral adiposity, insulin resistance, and novel risk markers such as C-reactive protein (CRP), adiponectin and plasma homocysteine [41].

The striking variations across racial and ethnic groups in disease risk are likely due in part to each of genetic-host vulnerability and environmental factors. They can offer important etiological clues to differences in patterns of disease presentation, therapeutic needs and response to treatment. Current studies should enhance understanding of ethnicity as a probable independent risk factor, thus enabling better recognition of treatment goals and choice of therapy in particular populations [41].

Predicting heart disease and risk scores

In the current climate of a busy clinical practice, it is important that prediction tools and comprehensive risk assessments tailored to specific populations are validated, adapted and easily accessible. CVD is now the most predicable, preventable and treatable of all the chronic diseases [46].

Clinical assessment of cardiovascular risk should be conducted with the following aims: [1].

- to look for all cardiovascular risk factors and clinical conditions that may influence prognosis and treatment
- to establish the presence of target organ damage
- to recognize those at elevated risk and in need of pressing intervention
- to recognize those who need special investigations

Utilizing prediction charts to estimate total cardiovascular risk is a major advance over the earlier practice of identifying and treating individual risk factors [1]. Risk status in persons without clinically apparent CAD or other clinical forms of atherosclerotic disease is determined by multivariable risk formulas, such as the Framingham risk score. They have been developed to help in assessing an individual's absolute risk for CAD over 10 years and over a hundred risk scoring methods have been proposed to direct management decisions for primary prevention of CVD [46]. Consideration should be given to absolute lifetime risk for CVD for younger persons in whom 10-year risk is expected to be small. The concept of the ''lifetime risk'' of CVD conveys the absolute burden of the CVD in the population and compares absolute lifetime risks of common diseases. It also measures cumulative risk of developing the same during the remainder of an individual's life [49]. The intensity of preventive therapy should match the level of estimated absolute risk. Many cardiovascular risk factors tend to appear in clusters and combining risk factors to predict total cardiovascular risk consequently is a logical approach in deciding who should receive treatment [1].

For the most part the cardiovascular risk assessment is dependent upon equations derived from the Framingham heart study and includes classical risk factors [50]. No disease prediction model applies equally well to all populations [46]. Similarly the predictive power of the Framingham risk score is extremely variable between populations [51] - in non Americans with under prediction of risk in a high risk population and over prediction in a lower risk population [50]. This is because the absolute mortality rate from heart disease varies from population to population for any given level of traditional risk factors and no single risk prediction model can take all the regional differences into account [46]. Hence for Indians it is recommended to multiply 10 year risk of CAD by a factor of two [48] when using the American model of Framingham risk score or European algorithm of SCORE [52] (the systematic coronary risk evaluation), except in UK or other countries, where specific guidelines for Asian Indians already exist [48].

The World Health Organization (WHO) MONICA Project was well-known for determine how trends in event rates for CAD and stroke were related to trends in classic coronary

risk factors [53]. The majority of the quantifiable risk factors recognized to date confer augmented risk in a continuous, graded fashion across the spectrum of values that arise in the populace. Moreover there are no threshold values above or below which the risk for occurrence CAD increases dramatically. However, clinical practice strategies help clinicians by providing normative values and targets for management of various modifiable risk factors. These factors of risk can be readily assessed by routine laboratory tests. By means of aggregating them into a composite risk profile, or ''global risk assessment,'' the combined outcome can be projected, and a section of population recognized that is at high risk for development of CAD [54].

CVD risk equivalents

It is now recognized that several categories of patients without heart disease are at an elevated short term (10-year) risk for coronary events as those with established CVD [55]. The disease states known to confer this high risk status are termed as above by the National Cholesterol Education Program (NCEP) ATP-III [56]. They include patients with diabetes mellitus, symptomatic carotid atherosclerosis, aortic aneurysmal disease and peripheral vascular disease.

Association of risk factors with pathogenesis of specific CVD

As already mentioned over 300 risk factors have been associated with CAD and stroke. They can be summarized as follows: see Table 2 [20] The major conventional risk factors for CAD include dyslipidemia, diabetes mellitus, hypertension, tobacco smoking, male sex, postmenopausal female and family history of premature CVD. Significant variations exist in the impact of these risk factors on precise cardiovascular outcomes. All the key cardiovascular risk factors add together for the development of CAD, whereas hypertension appreciably for stroke and lipid levels confer only modestly increased risk. For peripheral arterial disease, smoking and diabetes are most significant. Similarly hypertension, left ventricular hypertrophy (LVH), preexisting CAD, and diabetes are vital for congestive heart failure [57,58].

These common risk factors function at all ages but with diverse degrees of influence in both genders. Diabetes or a low high-density lipoprotein (HDL) cholesterol abolish the advantage of women over men in terms of risk for CAD [59]. Smoking is significant in males, it is non-cumulative, and its effect is reversible after cessation. Several risk factors like dyslipidemia, diabetes, fibrinogen, reduce in impact with advancing age [60]. But reduced relative risks are offset by higher absolute risks for disease, resulting in a large attributable risk. These risk factors are also pertinent in the elderly. Isolated systolic hypertension is a significant risk factor that is mostly prevalent in the elderly. Obesity and overweight prop up all the major atherogenic traits and physical inactivity promotes cardiovascular risk factors at all ages [40,61].

Though the relative significance of these risk factors may differ in diverse populations, these conventional risk factors

Table 2 Cardiovascular risk factors.

Major modifiable risk factors	Other modifiable risk factors
High blood pressure	Low socioeconomic status (SES)
Abnormal blood lipids	Mental ill-health
Tobacco use	Psychosocial stress
Physical inactivity	Alcohol use
Obesity	Use of certain medication
Unhealthy diets	Lipoprotein (a)
Diabetes mellitus	Left ventricular hypertrophy (LVH)
Non-modifiable risk factors	''Novel'' risk factors
Advancing age	Excess homocysteine in blood
Heredity or family history	Inflammation
Gender	Abnormal blood coagulation
Ethnicity or race	

Source: MacKay J, Mensah GA. The atlas of heart disease and stroke. World Health Organization, Geneva, 2004.

explain 75% of the CVD epidemic globally [62]. We recognize the causal pathways linking these risk factors and CVD. There is extensive evidence that, when action is taken against these risk factors, the disastrous consequences of this epidemic can be halted [63]. In this regard epidemiological research on risk factors, taken together with clinical and laboratory research is important in establishing causal pathways to disease. The contributory chain can be traced from genes and the environment through biochemical and other bodily changes to pathological alterations and clinical disease [64].

Strategies for prevention and control of CVD

Successful strategies for preventing and controlling CVD must include specific medical treatment plus prevention and control of various risk factors. The majority of cardiovascular risk reducing modalities have been found to be both medically acceptable and effectual [65,66]. There is an immense need to augment the potential for CVD prevention in the whole community. More the number of risk factors detected to be etiologically linked to disease, the greater the power to decrease the disease burden in the community by reducing the levels of such pathogenic risk factors [64]. Generally populations containing several high-risk individuals are characterized as high-risk populations [67]. Moreover the major risk factors also exert pathogenic effects at levels below those arbitrarily selected as indicators of high risk. In assessment of the preventive potential of screening and controlling risk factors, account must be taken of the fact that coexistence of multiple risk factors confers a magnified risk which is multiplicative rather than additive [64,68]. However most often, the center of attention is on single risk factors, rather than on comprehensive cardiovascular risk assessment. For CVD prevention and control activities to attain the greatest impact, a paradigm shift is essential from the ''treatment of risk factors in isolation'' to ''comprehensive cardiovascular risk management'' [69]. This concept of clustering of

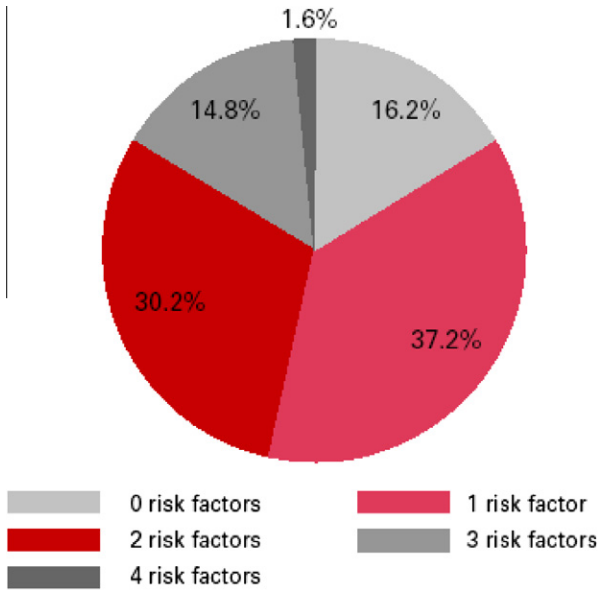

Fig. 3 Clustering of major risk factors, all countries (smoking, high blood pressure, high blood sugar and high blood cholesterol). *Source:* Cardiovascular disease prevention. Translating evidence into action. Geneva, World Health Organization, 2005.

cardiovascular risk factors is depicted in Fig. 3 from a multination WHO pilot project [70].

A variety of approaches might be considered to reduce the population wide burden of CVD. An all-inclusive community health strategy must amalgamate policies and programs that successfully impact on multiple cardiovascular risk factors and provide protection over life span through primordial, primary and secondary prevention [14]. The distinction between primary and secondary prevention has become increasingly difficult, due to the ability to identify subclinical disease at early stages with increasingly sensitive technologies [71]. Hence primary prevention could be redefined as prevention of atherosclerosis itself, with secondary prevention being treatment of the atherosclerotic disease process [72].

Decisions about whether to set off specific preventive actions and with what degree of intensity should be guided by estimation of the risk of any such vascular event [1]. Even though cardiovascular endpoints are less likely to occur in people with small levels of risk, no point of risk can be considered ''safe'' [73]. A considerable proportion of this morbidity and mortality could be prevented through a population based stratagem, and by making cost-effective interventions accessible and affordable, both for people with established disease and for those at high risk of developing disease [74–76]. In all populations it is indispensable that the high-risk approach is complemented by population-wide public health strategies [70]. See Fig. 4.

Potential reasons crippling CVD control in developing countries

Lack of advancement in prevention and control of the CVD epidemic is definitely not due to lack of information and scientific evidence about what works to prevent CVD [25]. Substantial declines in CVD mortality in Finland, United Kingdom, USA and Australia [77,78] show that an incorporation of risk factor control and effectual treatment can make a considerable impact.

- Unrealistic use of assets for high technology/tertiary CVD care in view of influential business and professional lobbies. These approaches are not sustainable in the long term and will not generate anticipated results [25].

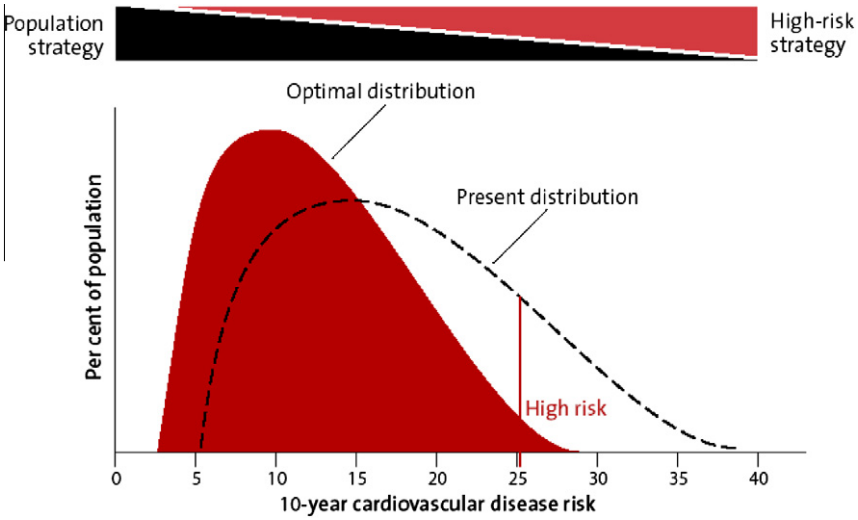

Fig. 4 The total risk approach to prevention of cardiovascular disease. A combination of population-wide and risk strategies are required to reduce the cardiovascular disease risk distribution of the population (to shift the cardiovascular risk distribution to the left). *Source:* Prevention of cardiovascular disease: Guidelines for assessment and Management of total cardiovascular risk. World Health Organization, 2007.

- Insensitivity of governments to prioritize prevention, negligible investment in strategies that have a most cost-effective impact, lack of concern for appropriate policy development [79], pressure of dominant commercial interests that block action at the policy level [80,81] and inconsistency at the level of policy implementation [82,83].
- Communication gap: The lack of a public response to the escalating burden of CVD is due mostly to a perception among policy makers and the public that cardiovascular disease is mostly a problem of the urban affluent and accordingly the governments of developing countries accord a low priority [12]. So global and regional indifference towards non-communicable forms of CVD adds to the complexity of issues to consider when establishing cost effective prevention programs [84].
- Enormous research gap: The lack of aptitude for research, meager financial allocation, pitiable quality of research, language barriers and omission of journals edited in developing countries from Medline [85—87].
- Low levels of literacy, gender inequality, religious beliefs and poverty [25] are responsible for healthy behaviors and usual medications for the prevention of CVD events in the populace [70] in addition to inadequate media concern in propagating risk modification and health promotion [70].
- Inequitable allocation of health resources among regions of developing countries leading to poor access of health care by the rural populace.
- Inadequate knowledge of doctors in CVD management due to the insufficiency of undergraduate medical courses [70] and lack of reorientation of medical education towards the needs of the community that they are supposed to serve.
- Lack of organized preventive cardiology programmes in our institutional practice and shortage of physicians interested in this subspecialty as a primary career in the developing world [88].

Conclusion

This review attempted to summarize the evidence in relation to variations in cardiovascular risk factors in low-income population settings and dealing with approaches, including both clinical and epidemiological to prevent and reduce the cardiovascular burden. Consistent with emerging evidence, ethnicity is indeed an independent cardiovascular risk factor. It was also evident that clinical prediction tools and cardiovascular risk assessments should be population-specific and tailored to local needs similar to the ETHRISK for British black and minority ethnic groups. The evidence also lends support to a preventive cardiovascular approach that is driven by a robust clinico-epidemiological knowledge base. Because of limited resources in low-income countries, innovative approaches to curbing the cardiovascular burden, targeting modifiable risk factors, are imperative. In this continuum of knowledge discovery and scientific innovations we have definite information and scientific evidence about what works to prevent CVD. However, it is the moral responsibility of physicians, institutions, professional bodies, regulatory authorities and governments to work together towards the alleviation of this preventable human suffering.

Conflicts of interest

None declared.

Acknowledgements

To copyright department World Health Organization, Geneva for their permission to use Figs. 1—4 and Tables 1 and 2.

References

[1] Prevention of cardiovascular disease: guidelines for assessment and management of total cardiovascular risk. World Health Organization 2007.
[2] Gaziano TA. Reducing the growing burden of cardiovascular disease in the developing world. Health Aff 2007;26:13—24.
[3] Sharma M, Ganguly NK. Premature coronary artery disease in Indians and its associated risk factors. Vascular health and risk management 2005;1:217—25.
[4] Enas EA, Singh V, Munjal YP, Bhandari S, Yadave RD, Manchanda SC. Reducing the burden of coronary artery disease in India: challenges and opportunities. Indian Heart J 2008;60: 161—75.
[5] Berenson GS, Srinivasan SR, Hunter SM, Nicklas TA, Freedman DS, Shear CL, et al. Risk factors in early life as predictors of adult heart disease: the Bogalusa heart study. Am J Med Sci 1989:298.
[6] Zieske AW, Malcom GT, Strong JP. Natural history and risk factors of atherosclerosis in children and youth: the PDAY study. Pediatr Pathol Mol Med 2002;21:213—37.
[7] Mendis S, Nordet P, JEn Fernadez-Britto, Sternby N. For the Pathobiological Determinants of Atherosclerosis in Youth (PBDAY) Research group. Atherosclerosis in children and young adults: an overview of the World Health Organization [WHO] and International Society and Federation of Cardiology Study on Pathobiological Determinants of Atherosclerosis in Youth study (1985—1995). Prevention and Control 2005;1:3—15.
[8] Grundy SM. Primary prevention of coronary heart disease: integrating risk assessment with intervention. Circulation 1999;100:988—98.
[9] Grundy SM, Pasternak R, Greenland P, Smith Jr S, Fuster V. Assessment of cardiovascular risk by use of multiple-risk-factor assessment equations: a statement for healthcare professionals from the American Heart Association and the American College of Cardiology. J Am Coll Cardiol 1999;34:1348—59.
[10] Murray CJL, Lopez AD. Global comparative assessments in the health sector. Geneva: World Health Organisation 1994.
[11] Gupta R, Gupta VP, Sarna M, Prakash H, Rastogi S, Gupta KD. Serial epidemiological surveys in an urban Indian population demonstrate increasing coronary risk factors among the lower socioeconomic strata. J Assoc Physicians India 2003;51:470—7.
[12] Ramaraj R, Alpert JS. Indian poverty and cardiovascular disease. Am J Cardiol 2008;10:102—6.
[13] Mensah GA. Ischaemic heart disease in Africa. Heart 2008;94: 836—43.
[14] Reddy KS. Cardiovascular diseases in the developing countries: dimensions, determinants, dynamics and directions for public health action. Public Health Nutr 2002;5:231—7.
[15] A new initiative for a healthy nation: National Programme for Prevention and Control of Diabetes, Cardiovascular Diseases and Stroke (NPDCS). http://mohfw nic in/NPDCS htm accessed on -2-2-2010.

[16] Gupta R, Joshi P, Mohan V, Reddy KS, Yusuf S. Epidemiology and causation of coronary heart disease and stroke in India. Heart 2008;94:16–26.
[17] World Health Organization. The world health report 2002. Reducing risks, promoting healthy life. 2002. Geneva: WHO.
[18] World Health Organization. Noncommunicable diseases in South-East Asia region. A profile. 2002. New Delhi: WHO.
[19] World Health Organization. Health situation in South-East Asia region 1998–2000. 2002. New Delhi: WHO.
[20] Mackay J, Mensah GA. The atlas of heart disease and stroke. Geneva: World Health Organization in collaboration with the Centres for Disease Control and Prevention 2004.
[21] Kannel WB, Dawber TR, Kagan A, Revotskie N, Stokes III J. Factors of risk in the development of coronary heart disease-six-year follow-up experience. Ann Intern Med 1961;55:33–60.
[22] Dawber TR, Meadors GF, Moore Jr FE. Epidemiological approaches to heart disease: the Framingham Study. Am J Public Health Nations Health 1951;41:279–86.
[23] Measuring the risk of coronary heart disease in adult population groups: a symposium. Am J Public Health 1957;47: 1–63.
[24] Keys A, Taylor HL, Blackburn H, Brojek J, Anderson JT, Simonson E. Coronary heart disease among Minnesota business and professional men followed fifteen years. Circulation 1963;28:381–95.
[25] Mendis S. Controlling the cardiovascular disease epidemic in developing countries: urgent need for evidence-based action. In: Rao GHR, Thanickachalam S, editors. Coronary artery disease: risk promoters, pathophysiology and prevention. 1st ed. New Delhi: South Asian Society on Atherosclerosis and Thrombosis; 2005, 345–352.
[26] Ôunpuu S, Negassa A, Yusuf S. INTER-HEART: a global study of risk factors for acute myocardial infarction. Am Heart J 2001;141:711–21.
[27] Neal B, Chapman N, Patel A. Managing the global burden of cardiovascular disease. Eur Heart J Suppl 2002;4(Suppl F): F2–6.
[28] Yusuf S, Ounpuu S. Tackling the growing epidemic of cardiovascular disease in South Asia. J Am Coll Cardiol 2001;38(3): 688–9.
[29] Omran A. The epidemiologic transition: a theory of epidemiology of population change. Millibank Q 1971;49:509–38.
[30] Mohan V, Deepa R. Risk factors for coronary artery disease in Indians. J Assoc Physicians India 2004;52:93–5.
[31] Gupta R. Recent trends in coronary heart disease epidemiology in India. Indian Heart J 2008;suppl B:B4–B18.
[32] Bhopal R, Hayes L, White M, Unwin N, Harland J, Ayis S, et al. Ethnic and socio-economic inequalities in coronary heart disease, diabetes and risk factors in Europeans and South Asians. J Public Health 2002;24:95–105.
[33] Hales CN, Barker DJ. Type 2 (non-insulin-dependent) diabetes mellitus: the thrifty phenotype hypothesis. Diabetologia 1992;35:595–601.
[34] Osmond C, Barker DJ. Fetal, infant, and childhood growth are predictors of coronary heart disease, diabetes, and hypertension in adult men and women. Environ Health Perspect 2000;108:545–53.
[35] Williams B. Westernised Asians and cardiovascular disease: nature or nurture? Lancet 1995;345:401–2.
[36] Neel JV. Diabetes mellitus: a ''thrifty'' genotype rendered detrimental by ''progress''. Am J Hum Genet 1962;4:353–62.
[37] Scanu AM. Lipoprotein (a) a genetic risk factor for premature coronary artery disease. JAMA 1992;267:3326–9.
[38] Neel JV, Weder AB, Julius S. Type II diabetes, essential hypertension and obesity as ''syndromes of impaired genetic homeostasis'': the ''thrifty genotype'' hypothesis enters the 21st century. Perspect Biol Med 1998;42:44–74.
[39] Griffiths PL, Bentley ME. The nutrition transition is underway in India. J Nutr 2001;131(10):2692–700.
[40] Prasad DS, Das BC. Physical inactivity: a cardiovascular risk factor. Indian J Med Sci 2009;63:33–42.
[41] Forouhi NG, Sattar N. CVD risk factors and ethnicity – a homogeneous relationship? Atheroscler Suppl 2006;7:11–9.
[42] Kurian AK, Cardarelli KM. Racial and ethnic differences in cardiovascular disease risk factors: a systematic review. Ethn Dis 2007;17:143–52.
[43] Amin AP, Nathan S, Evans AT, Attanasio S, Mukhopadhyay E, Mehta V, et al. The effect of ethnicity on the relationship between premature coronary artery disease and traditional cardiac risk factors among uninsured young adults. Prev Cardiol 2009;12:128–35.
[44] World Health Organization. The World Health Report 2005. Preventing Chronic Diseases: a vital investment. 2005. Geneva, WHO.
[45] Anand SS, Yusuf S, Vuksan V, Devanesen S, Teo KK, Montague PA, et al. Differences in risk factors, atherosclerosis, and cardiovascular disease between ethnic groups in Canada: the Study of Health Assessment and Risk in Ethnic groups (SHARE). Lancet 2000;356:279–84.
[46] Enas EA. How to beat the heart disease epidemic among South Asians. 1st ed. Downers Grove, IL: Advanced Heart Lipid Clinic; 2008.
[47] Indrayan A. Vascular diseases: forecasting vascular disease cases and associated mortality in India. NCMH Background Papers-Burden of Disease in India. New Delhi: National Commission on Macroeconomics and Health, Ministry of Health & Family Welfare, Government of India; 2005. 197–218.
[48] Enas EA, Singh V, Munjal YP, Gupta R, Patel KCR, Bhandari S, et al. Recommendations of the second Indo-US health summit on prevention and control of cardiovascular disease among Asian Indians. Indian Heart J 2009;61:165–274.
[49] Lloyd-Jones DM, Larson MG, Beiser A, Levy D. Lifetime risk of developing coronary heart disease. Lancet 1999;353:89–92.
[50] Jurgensen JS. The value of risk scores. Heart 2006;92:1713–4.
[51] Brindle P, Beswick A, Fahey T, Ebrahim S. Accuracy and impact of risk assessment in the primary prevention of cardiovascular disease: a systematic review. Heart 2006;92:1752–9.
[52] Conroy RM, Pyorala K, Fitzgerald AP, Sans S, Menotti A, De Backer G, et al. Estimation of ten-year risk of fatal cardiovascular disease in Europe: the SCORE project. Eur Heart J 2003;24:987–1003.
[53] Evans A, Tolonen H, Hense HW, Ferrario M, Sans S, Kuulasmaa K. Trends in coronary risk factors in the WHO MONICA project. Int J Epidemiol 2001;30(Suppl 1):S35–40.
[54] Lloyd-Jones DM, Kannel WB. Coronary risk factorss: an overview. In: Willerson JT, Cohn JN, Wellens HJJ, Holmes DR, editors. Cardiovascular medicine. London: Springer–Verlag; 2007.
[55] Brook RD, Greenland P. Secondary prevention. In: Wong ND, Black HR, Gardin JM, editors. Preventive cardiology: a practical approach. New Delhi: Tata McGraw-Hill; 2006.
[56] Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) Final Report. Circulation 2002;106:3143–3421.
[57] Cupples LA, D'Agostino RB, The KielyD. The Framingham Study: an epidemiological investigation of cardiovascular disease, section 34: some risk factors related to the annual incidence of cardiovascular disease and death using pooled repeated biennial measurements. Framingham heart study 30 year follow-up 1987. Bethedsa, MD: National Heart Lung and Blood Institute; 1987.
[58] Levy D, Larson MG, Vasan RS, Kannel WB, Ho KKL. The progression from hypertension to congestive heart failure. JAMA 1996;275:1557–62.

[59] Kannel WB, McGee DL. Diabetes and glucose tolerance as risk factors for cardiovascular disease: the Framingham Study. Diabetes Care 1979;2:120.
[60] Navas-Nacher EL, Colangelo L, Beam C, Greenland P. Risk factors for coronary heart disease in men 18 to 39 years of age. Ann Intern Med 2001;134:433–9.
[61] Kannel WB. Bishop lecture. Contribution of the Framingham Study to preventive cardiology. J Am Coll Cardiol 1990:206–11.
[62] Magnus P, Beaglehole R. The real contribution of the major risk factors to the coronary epidemics; time to end the ''only-50%'' myth. Arch Intern Med 2001;161:2657–60.
[63] Integrated management of cardiovascular risk. Report of a WHO meeting, 9–12 July 2002, editors. 1–33. 2002. Geneva: World Health Organization.
[64] Cardiovascular disease risk factors: new areas for research. WHO Technical report series 841 ed. Geneva: World Health Organization; 1994.
[65] Goldman L, Phillips KA, Coxson P, Goldman PA, Williams L, Hunink MGM, et al. The effect of risk factor reductions between 1981 and 1990 on coronary heart disease incidence, prevalence, mortality and cost. J Am Coll Cardiol 2001;38: 1012–7.
[66] Daviglus ML, Stamler J. Major risk factors and coronary heart disease: much has been achieved but crucial challenges remain. J Am Coll Cardiol 2001;38:1018–22.
[67] Rose G. Sick individuals and sick populations. Int J Epidemiol 1985;14:32–8.
[68] Deedwania P, Singh V. Coronary artery disease in South Asians: evolving strategies for treatment and prevention. Indian Heart J 2005;57:617–31.
[69] WHO CVD-risk management package for low and medium resource settings. 2002. Geneva: World Health Organization.
[70] Cardiovascular disease prevention. Translating evidence into action. Geneva, World Health Organization 2005.
[71] Wison MA, Pearson TA. Primary prevention. In: Wong ND, Black HR, Gardin JM, editors. Preventive cardiology: a practical approach. 2nd ed. New Delhi: Tata McGraw-Hill; 2006, p. 493–510.
[72] Swan HJ, Gersh BJ, Graboys TB, Ullyot DJ. 27th Bethesda conference: matching the intensity of risk factor management with the hazard for coronary disease events. Task Force 7. Evaluation and management of risk factors for the individual patient (case management). J Am Coll Cardiol 1996;27:1030–9.
[73] Jackson R, Lynch J, Harper S. Preventing coronary heart disease. BMJ 2006;332:617–8.
[74] World Health Organization. Prevention of recurrent heart attacks and strokes in low and middle income populations. Evidence-based recommendations for policy makers and health professionals. Geneva: 2003.
[75] Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray CJ. Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data. Lancet 2006;367(9524): 1747–57.
[76] Manuel DG, Lim J, Tanuseputro P, Anderson GM, Alter DA, Laupacis A, et al. Revisiting rose: strategies for reducing coronary heart disease. BMJ 2006;332:659–62.
[77] Cooper R, Cutler J, Desvigne-Nickens P, Fortmann SP, Friedman L, Havlik R, et al. Trends and disparities in coronary heart disease, stroke, and other cardiovascular diseases in the United States: findings of the national conference on cardiovascular disease prevention. Circulation 2000;102:3137–47.
[78] Nissinen A, Berrios X, Puska P. Community based non communicable disease interventions: lessons from developed countries for developing ones. Bull World Health Organ 2001;79: 963–70.
[79] Alwan A, Maclean D, Mandil A. Assessment of national capacity for noncommunicable disease prevention and control: the report of a global survey. 2001. Geneva: World Health Organization.
[80] Yach D. Unleashing the power of prevention to achieve global health gains. Lancet 2002;2(360):1343–4.
[81] Abraham J. The pharmaceutical industry as a political player. Lancet 2002;360:1498–502.
[82] Chantornvong S, Collin J, Dodgson R, Lee K, McCargo D, seddon D, et al. Political economy of tobacco control in low-income and middle-income countries: lessons from Thailand and Zimbabwe. Global analysis project team. Bull World Health Organ 2000;78:913–9.
[83] Chaturvedi P. India needs stricter implementation of antitobacco law. Indian J Cancer 2007;44:129–30.
[84] Stewart S, Sliwa K. Preventing CVD in resource-poor areas: perspectives from the 'real-world'. Nat Rev Cardiol 2009;6:489–92.
[85] Rosselli D. Geography of biomedical publications. Lancet 1999;354:517.
[86] Horton R. North and south: bridging the information gap. Lancet 2000;355:2231–6.
[87] Mendis S, Yach D, Bengoa R, Narvaez D, Zhang X. Research gap in cardiovascular disease in developing countries. Lancet 2003;361:2246–7.
[88] Yusuf S, Jain P. Guest editorial for 'Preventive Cardiology' focus issue. Indian Heart J 2008;Suppl B:B2–3.