Global Burden of Cardiovascular Diseases

Part I: General Considerations, the Epidemiologic Transition, Risk Factors, and Impact of Urbanization

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Abstract—This two-part article provides an overview of the global burden of atherothrombotic cardiovascular disease. Part I initially discusses the epidemiologic transition which has resulted in a decrease in deaths in childhood due to infections, with a concomitant increase in cardiovascular and other chronic diseases; and then provides estimates of the burden of cardiovascular (CV) diseases with specific focus on the developing countries. Next, we summarize key information on risk factors for cardiovascular disease (CVD) and indicate that their importance may have been underestimated. Then, we describe overarching factors influencing variations in CVD by ethnicity and region and the influence of urbanization. Part II of this article describes the burden of CV disease by specific region or ethnic group, the risk factors of importance, and possible strategies for prevention. **(*Circulation*. 2001;104:2746-2753.)**

Key Words: heart diseases ■ epidemiology ■ prevention

For most populations, the last century has witnessed the most dramatic improvements in health in history. Life expectancy at birth has increased from a global average of 46 years in 1950 to 66 years in 1998.[1] The health status and disease profile of human societies have historically been linked to the level of their economic development and social organization. With industrialization, the major causes of death and disability, in the more advanced societies, have shifted from a predominance of nutritional deficiencies and infectious diseases, to those classified as degenerative [chronic diseases such as cardiovascular disease (CVD), cancer, and diabetes]. This shift has been termed "the epidemiologic transition."[2] At any given time, different countries in the world or even different regions within a country are at different stages of the epidemiologic transition. This transition can occur not only between different disease categories (eg, deaths from childhood diarrhea and malnutrition giving way to adult chronic diseases), but also within a specific disease category (eg, rheumatic heart disease of the young giving way to chronic coronary artery diseases of middle age or valve calcification, degeneration, and heart failure of the elderly[3]) (Table 1).

For countries in the earliest stage of development, the predominant circulatory diseases are rheumatic heart disease, those due to other infections, and nutritional deficiency–related disorders of the heart muscle. Geographic regions experiencing this phase include Sub-Saharan Africa (SSA) and the rural areas of South America and South Asia (SA). During the second stage, as infectious disease burdens are reduced and nutrition improves, diseases related to hypertension, such as hemorrhagic stroke and hypertensive heart disease, become more common. Regions experiencing this phase include China and other Asian countries. During the third stage, as life expectancy continues to improve, high-fat diets, cigarette smoking, and sedentary lifestyles become more common. Noncommunicable diseases then predominate, with the highest mortality caused by atherosclerotic CVD, most frequently ischemic heart disease and atherothrombotic stroke, especially at ages below 50 years. This phase is found in urban India,[4] Latin America, and the former socialist countries. For most developing and middle-income countries, the increased incidence of CVD adds to the continuing burden of infectious, nutritional, and perinatal diseases, which has been termed the "double-burden" (Table 2).[1] During the fourth stage, increased efforts to prevent, diagnose, and treat ischemic heart disease and stroke are able to delay these diseases to more advanced ages. The regions that have reached this fourth stage include Western Europe, North America (excluding some parts of Mexico), Australia, and New Zealand.

Previously the fourth stage was considered to be the "final" stage of the epidemiologic transition. However, we propose that a fifth stage be added, where social upheaval or war breaks down existing social and health structures, leading to a resurgence of conditions seen in the first two stages. Diseases of the third and fourth stages persist. This regressive stage is associated with increased deaths due to both cardiovascular (CV) and non-CV causes such as infectious diseases, violence, and consequently a decrease in life expectancy. It is likely that Russia represents such a situation, where in the last

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TABLE 1. Modified Model of the Stages of Epidemiologic Transition as it Pertains to Cardiovascular Diseases

Stages of Development	Deaths From CVD, % of Total Deaths	Predominant CVDs and Risk Factors	Regional Examples
1. Age of pestilence and famine	5–10	Rheumatic heart disease, infections, and nutritional cardiomyopathies	Sub-Saharan Africa, rural India, South America
2. Age of receding pandemics	10–35	As above+hypertensive heart disease and hemorrhagic strokes	China
3. Age of degenerative and man-made diseases	35–65	All forms of strokes, ischemic heart disease at young ages, increasing obesity, and diabetes	Urban India, former socialist economies, aboriginal communities
4. Age of delayed degenerative diseases	<50	Stroke and ischemic heart disease at old age	Western Europe, North America, Australia, New Zealand
5. Age of health regression and social upheaval	35–55	Re-emergence of deaths from rheumatic heart disease, infections, increased alcoholism, and violence; increase in ischemic and hypertensive diseases in the young	Russia

During Stages 1 to 4, life expectancy increases, whereas in Stage 5 life expectancy decreases compared with stages 4 and even 3.

10 years, life expectancy has shortened with a marked increase in deaths from CV diseases, infectious diseases, accidents, and violence.[5]

Subsets of the population in a country may be at different stages of the CVD epidemic. An "early-adopter" subset of a community (either part or whole), such as one with rapid social and economic development (such as Mexico), may experience an early increase in CVD,[6] and thus have a higher level of CVD than other parts of the population. The decline in CVD burden may also occur earlier for this community. The transition of CVD from being a disease of the wealthy to one of the poor has been documented in the United Kingdom and the United States (US).[7,8] For example, CVD was relatively rare in the African-American community in the 1960s, but now its incidence equals or exceeds that in the white population of the United States.[9] A similar pattern is appearing in some parts of India.[10] Therefore, the pattern of CVD continues to be in transition in most countries; indeed, it may vary within a country by geography or socioeconomic status and is potentially bidirectional.

Global Burden of Cardiovascular Disease

The high current burdens of noncommunicable diseases (NCDs) are highlighted by the estimates provided by the Global Burden of Disease Study (Table 2)[11] and in the World Health Report 1999 (Table 3),[12] which indicate that these disorders together contributed to 59% of global mortality (31.7 million deaths) and 43% of the global burden of disease in 1998. Several NCDs such as cardiovascular diseases (CVD), cancers, diabetes, and chronic obstructive pulmonary disease are linked by common lifestyle determinants such as diet, physical activity, and tobacco consumption. These four disorders together contribute to about 50% of global mortality. Because these conditions tend to affect individuals in middle and old age, they account for a smaller proportion (19%) of the global burden of disease. It is estimated that 30.9% of all deaths in 1998, as well as 10.3% of the total disease related burden, in terms of disability adjusted life year loss (DALY loss) were attributable to CVD (Table 3).[12]

TABLE 2. Deaths (In Thousands) Due to Cardiovascular Disease and to Infectious and Parasitic Diseases in 30- to 69-Year-Olds by Sex and Region in 1990

	Men		Women	
Region	CVD	IPD	CVD	IPD
EME	483	42	227	12
FSE	416	20	253	6
India	611	429	481	240
China	576	158	439	89
OAI	289	147	226	140
SSA	183	215	211	228
LAC	186	62	147	48
MEC	285	56	215	35
Worldwide	3,028	1,128	2,201	798

EME indicates established market economics; FSE, formerly socialist economies; OAI, other Asian and Pacific Island countries; SSA, Sub-Saharan Africa; LAC, Latin American/Caribbean; and MEC, Middle East Crescent.

The Growing Burden of CVD in the Developing (Low and Middle Income) Countries

The World Health Report 1999 estimates that in 1998, 78% of the burden of NCDs and 85% of the CV burden arose from the low and middle income countries (Table 3). The CVD burden afflicts both men and women, with CV deaths accounting for 34% of all deaths in women and 28% in men in 1998.[12] As the epidemics advance, the social gradient also reverses with the poor becoming the most vulnerable victims in both developed and developing countries.[13]

The high burdens of CVD in the developing countries are attributable to the increasing incidence of atherosclerotic diseases, perhaps due to urbanization and higher risk factor levels (such as obesity, diabetes, dyslipidemia, hypertension, etc), the relatively early age at which they manifest, the large sizes of the population, and the high proportion of individuals who are young adults or middle-aged in these countries. For example, about half of the deaths attributable to CVD in the developing countries in 1990 occurred below the age of 70 years, in contrast to about a quarter in the developed countries.[11] Such a pattern of premature CVD mortality is likely to haunt the developing countries even more in the future. Between 1990 and 2020, the increase in ischemic heart disease (IHD) mortality (120% in women and a 137% in men) in the developing countries is expected to be much greater than among developed countries (29% and 48%, respectively)

TABLE 3. Contribution of Noncommunicable Diseases and Various Individual Diseases to the Global Mortality and Global Burden of Disease* in 1998, Subdivided by Low Income Countries and Middle Income Countries

Disease Category	Contribution of NCD to Total Global Mortality, %	Contributions of LIC+MIC to Global NCD Mortality, %	Contribution of NCD to Total Burden of Disease, %	Contributions of LIC+MIC to NCD Burden of Disease, %
Total NCD	58.8	77.8	43.1	85.3
Total CVD	30.9	78.5	10.3	86.3
Total cancers	13.4	72.1	5.8	79.9
Diabetes	1.1	73.2	0.8	73.2
COPD	4.2	87.5	2.1	91.4

LIC indicates low income country; MIC, middle income country; NCD, non-communicable disease; and COPD, chronic obstructive pulmonary disease.

Data are derived from estimates provided in the World Health Report 1999.[12]

*Burden of disease calculated as Disability-Adjusted Life-Years.

(Table 4).[11] A similar pattern for increases in cerebrovascular disease mortality is predicted (124% and 107% increases among men and women in developing countries versus 78% and 56% increases, respectively, in the developed countries) (Table 5). These projections are largely based on the expected changes in the demographics of the population and do not account for potential increases in risk factor levels.[4,14] However, with urbanization and changing lifestyles the number of people with diabetes, obesity, dyslipidemia, or high blood pressure may increase, suggesting that the increases in CVD based purely on demographic shifts are likely underestimates.

Risk Factors for Atherosclerotic Cardiovascular Disease

A large body of epidemiologic studies has clearly demonstrated a link between certain risk markers and CVD. These can be classified into two categories: (1) those that have been proven to be causal (risk factors), and (2) those that show associations with CVD but for whom a cause and effect association is yet to be proven (risk markers) (Table 6). These markers could be classified as predisposing (eg, obesity which may work through raising blood pressure, glucose, and lipids) or direct (eg, smoking).

Ecological, case-control, and cohort studies in many populations have identified a number of markers which are associated with either an increased or a decreased risk of CVD. Whether or not these associations are causal is decided by applying several criteria. These include the strength and consistency of association, temporal relationship, dose-response relationship, biologic plausibility, experimental evidence, and very importantly, concordant evidence from randomized human trials when available. It is the coherence of information from several different types of studies which has led to our body of knowledge and provides persuasive evidence of the causal link of several risk factors with CVD.

It has been suggested that conventional risk factors only explain about half of the variance in coronary heart disease.[14] However, there may be several reasons why the role of conventional risk factors like tobacco, cholesterol, and high blood pressure may have been substantially underestimated.

Regression Dilution Bias

Earlier cohort studies frequently included only single (as opposed to multiple) measures of a given risk factor. Single measures have a large variance and as a result, are only moderately correlated with subsequent measurements of the same risk factor in the same population. Therefore, relating a single (as opposed to multiple) measure of a risk factor to an outcome leads to substantial underestimation of the strength of association.[15] The degree to which the regression dilution bias leads to underestimation of an association is illustrated as follows: without correction for the regression dilution bias, a 10% difference in cholesterol level was considered to be associated with a 20% difference in coronary heart disease (CHD) rates; after correction, a 10% difference in cholesterol level is estimated to lead to a 30% difference in CHD rates.[16] The regression dilution bias has a similar and substantial impact on the estimates of risk associated with specific differences in blood pressure, glucose levels, etc.

Lag Effect

The effect of several risk factors for vascular disease may take several years to fully manifest. Cohort studies of relatively short duration may therefore only identify a part of this effect, while extended studies may uncover a larger effect. For example, the study of cigarette smoking in British doctors revealed a stronger relative risk in the 40 year followup than in the initial 20-year followup.[17] Similarly, trials of lipid lowering interventions have demonstrated only a modest impact in preventing CHD during the first year or two of the trials, but there was a substantially greater impact in the fourth and fifth years,[18,19] with the possibility that larger differences may have been evident with more prolonged intervention.

Dichotomous Categorization of Risk Factors

Often, studies have categorized cholesterol as "normal" or "abnormal", blood pressure as "hypertensive" or "normotensive" or glucose as "diabetic" or "nondiabetic". However, the risks associated with these and other risk factors operate on a continuum. Arbitrary categories tend to ignore the substantial risks contributed by these factors below the clinical threshold, ie, even within the so called normal range.[20–22]

Inability to Recognize or Quantify Exposures in the Unexposed Group

The inability to quantify exposure to a risk factor in the individuals classified as unexposed leads to an underestima-

TABLE 4. Estimate of Ischemic Heart Disease Mortality (Thousands) by Region and Sex and Projected Changes Between 1990 and 2020

	Women			Men		
Region	1990	2020	% Increase	1990	2020	% Increase
EME	838	1107	32	829	1209	46
FSE	559	702	26	468	712	52
Total developed countries	1397	1809	29	1297	1921	48
India	556	1197	115	619	1405	127
China	377	684	81	386	811	110
OAI	227	552	143	233	581	149
SSA	117	263	125	92	222	141
Latin America	169	412	144	179	444	148
Middle East	291	717	146	319	874	174
Total developing countries	1737	3825	120	1828	4337	137
World	3134	5634	80	3125	6258	100

Abbreviations as in Table 2.

tion of the differences in exposure, between those exposed to a risk factor compared with those unexposed, as in the case of tobacco smoke. For example, nonsmokers, in most studies, include passive smokers.[23] The risks of the active smoker, compared with the true nonsmoker are likely to be underestimated when passive smokers are included in the latter category.

The four methodological issues discussed above suggest that the total risk attributed to a particular risk factor may have been considerably underestimated, so that the true impact of fully modifying currently proven risk factors is likely to be much greater than currently recognized.

While future research may identify further causal risk factors, several of the markers currently being explored (eg, inflammatory markers) may be the consequence of the underlying disease. Genetic studies offer a fertile ground for spurious associations, which may arise by chance alone when many polymorphisms of multiple candidate genes are studied in relation to several outcomes in large epidemiological data sets. Stringent statistical guidelines and very large sample sizes are therefore required to limit such false-positive results in studies describing genetic associations.[24] These considerations suggest that while further efforts at identifying new risk factors will be useful, one should recognize that the vast body of available data form a firm basis to implement preventive strategies.

Variations in Disease Rates by Ethnicity and Geography: General Considerations

Ethnicity (unlike race) is a construct that encompasses both genetic and cultural (eg, language, religion, diet) differences.[25] Because individuals of different ethnic backgrounds tend to live in distinct regions and societies, variations in disease rates by ethnicity are also intertwined with geographic dif-

TABLE 5. Estimates of Cerebrovascular Disease Mortality (Thousands) by Region and Sex and Projected Changes Between 1990 and 2020

	Women			Men		
Region	1990	2020	% Increase	1990	2020	% Increase
EME	467	618	32	322	477	59
FSE	400	495	24	239	364	52
Total developed countries	867	1113	28	539	841	56
India	220	463	104	227	493	124
China	601	1087	81	672	1413	110
OAI	200	458	129	190	446	135
SSA	231	521	126	152	356	134
Latin America	127	302	138	121	297	145
Middle East	113	269	138	99	255	158
Total developing countries	1499	3100	107	1454	3260	124
World	2366	4213	78	1993	4101	106

Abbreviations as in Table 2.

TABLE 6. Proven and Putative Risk Markers for Cardiovascular Diseases

Risk factors that are causally linked:

1. Tobacco consumption
2. Elevated LDL
3. Low HDL
4. High blood pressure
5. Elevated glucose
6. Physical inactivity*
7. Obesity*
8. Diet*

Risk markers that show associations:

1. Low socioeconomic status*
2. Elevated prothrombotic factors: fibrinogen, PAI-1
3. Markers of infection or inflammation
4. Elevated homocysteine
5. Elevated lipoprotein(a)
6. Psychological factors (depression, anger proneness, hostility, stress, acute life-events) and breakdown in social structures (loss of social support and cohesion)*

*Predisposing risk factors: A predisposing risk factor is presumed to work, at least in part, through an impact on other risk factors that act directly. For example, obesity raises blood pressure, causes dyslipidemia, and increases blood glucose. It is likely that some of the predisposing risk factors also have direct effects.

PAI indicates plasminogen activator inhibitor.

ferences. Furthermore, specific ethnic groups within one location adopt certain lifestyles, whereas the same ethnic group in another location may adopt substantially different lifestyles. Consequently, any study of variations in disease by different ethnic groups is also intertwined by additional variations in lifestyle, geography, socioeconomic status, etc.

Often the first clue that ethnic variations in disease burden exist comes from observed differences in their rates and risk factors between countries. For example, in the Seven Countries Study,[26] low CHD rates were observed in Japan and the Mediterranean countries, and high CHD rates in Finland and the US These differences were in large part explained by differences in diet, serum cholesterol, and blood pressure. Recent databases on a revised World Health Organization (WHO) standard population demonstrates a greater than 10-fold difference in age standardized mortality rates among men and women in different countries (Figure 1).[27]

Several factors may contribute to these observed interpopulation differences in the CVD profile. Firstly countries may be experiencing different stages of the epidemiologic transition, with varied life expectancy, diverse demographic profiles, and differing contributions from competing causes of death. Thus, the total burden of CVD, as well as the composition of the CVD spectrum, will vary according to the dynamics of health transition. Secondly, environmental factors related to CVD risk differ widely across populations and may be partly related to culture as well as the stage of industrialization. Thirdly, genetic factors explain variance in the risk of incident CVD within populations by providing the basis for differences in individual susceptibility in a shared and relatively homogenous environment. They also contribute to interpopulation differences, due to variable frequencies of one or more genetic determinants of risk in different ethnic groups. Genetic contributions to lipid disorders, obesity, salt sensitivity, insulin resistance, coagulation derangements, and endothelial dysfunction are being explored.[28] Fourthly, the "programming" effect of factors promoting selective survival may also determine individual responses to environmental challenges and, thereby, contribute to the population differences in CVD. The thrifty gene hypothesis has been postulated to be a factor in promoting selective survival, over generations, of persons who encountered an adverse environment of limited nutritional resources.[29] Although this may have been advantageous in surviving the rigors of a spartan environment over thousands of years, the relatively recent and rapid changes in environment accompanied by higher life expectancies may have resulted in a metabolic mismatch. Thus the salt-sensitive person whose forefathers thrived despite a limited supply of salt reacts to a salt-enriched diet with high blood pressure.[30] Similarly, an insulin-resistant individual whose ancestors may have survived because a relative lack of insulin sensitivity in the skeletal muscle ensured adequate blood glucose levels for the brain in conditions of limited calorie intake and demanding physical challenges may now respond to a high-calorie diet and a sedentary lifestyle with varying degrees of glucose intolerance and hyperinsulinemia.

Fifth, other programming factors which may underlie population differences in CHD are the state of intrauterine, infant, and early childhood nutrition.[31] An adverse intrauterine growth environment due to poor maternal nutrition may confer a selective survival advantage to the fetus who has

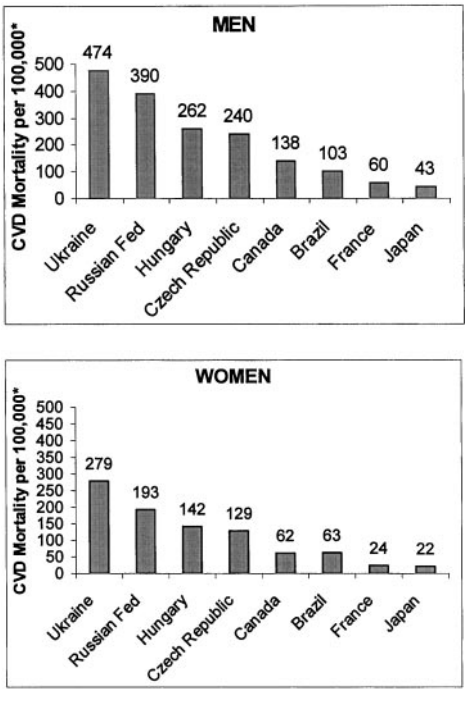

Figure 1. CHD mortality in selected countries[42] demonstrating marked international variations. *Rates adjusted to WHO Standard Population.

TABLE 7. Percentages of Individuals Living in Urban Settings in 1970 and 2025

Region	1970	1994	2025
World	36.6	44.8	61.1
Developed countries	67.5	74.4	84.0
Economies in transition*	25.1	37.0	57.0
Developing countries	12.6	21.9	43.5

*Current term for Eastern Europe.

been programmed for reduced insulin sensitivity. However, as the child is exposed to overnutrition in later childhood and early adulthood, such programming could lead to high blood pressure, glucose intolerance, and dyslipidemia. It has been suggested that the susceptibility of South Asians to diabetes may be modified by improving intrauterine growth.

Therefore, differences in demographic profiles, environmental factors, early childhood programming influences as well as differences in gene frequency or expression can all contribute to variations in CVD between different populations. These variations are perhaps best illustrated by the knowledge gained from studies in migrant groups, where environmental changes due to altered lifestyles are superimposed over genetic influences. The classical Ni-Hon-San study of Japanese migrants revealed how blood cholesterol levels and CHD rates rose from relatively low levels among those in Japan, to intermediate levels in Honolulu, and to high levels in San Francisco.[32] Comparison of Afro-Caribbeans, South Asians, and Europeans in the UK indicate marked differences in central obesity, glucose intolerance hyperinsulinemia, and related dyslipidemia, despite similar blood pressure, body mass index, and total plasma cholesterol.[33] In Canada, there are marked differences between different ethnic groups in the prevalence and death rates from CHD, with the highest rates being among those of European and South Asian origin, but lowest among those of Chinese origin.[34,35] There was a greater rate of clinical events among South Asians compared with the other two ethnic groups for similar degrees of atherosclerosis, suggesting that the propensity to plaque rupture may vary in different ethnic groups.[35] Thus, where the environment is common but gene pools differ, the nonconventional risk factors may be explanatory of risk variance; whereas when the same gene pool is confronted with different environments, the conventional risk factors play a major role. The challenge of preventing CV diseases lies in identifying and addressing the components most relevant to each community at their present and projected levels of the epidemiologic transition.

Urbanization and Changing Diets

One of the most marked societal and environmental changes has been associated with urbanization. The rates of urbanization are increasing globally, from 36.6% of the world population living in urban areas in 1970, to 44.8% in 1994. This proportion is projected to increase to 61.1% by 2025 (Table 7).[14] With urbanization (or migration to Western environments), there is a marked increase in consumption of energy rich foods, a decrease in energy expenditure (through less physical activity,) and a loss of the traditional social support mechanisms. In addition to increased migration of individuals from rural to urban areas, rural areas are themselves also being transformed. For example, increased mechanization in agriculture and increased use of automobile and bus transportation in rural areas are leading to a decrease in physical activity. Concomitantly, global influences (via television or increased availability of processed food) on lifestyles perceived to be desirable or modern are changing the types of food consumed in both urban and rural areas.

Between the 1940s and the late 1970s, the main challenge that several countries like China, India, Indonesia, and South Korea faced was to provide their population with sufficient food to meet their basic energy and nutrient requirements.[36] For example, in 1959, the average daily energy intake per capita was 2060 Kcal in China.[37] The average daily protein intake per capita was 57 grams, which accounted for about 80% of the Chinese Recommended Daily Allowance (RDA). Undernutrition was evident, with about 20% to 40% of preschool children demonstrating stunting and 15% demonstrating rickets. By contrast in 1982, the average daily energy intake per capita increased to 2485 Kcal and daily protein intake had increased to an average of 66.8 grams. While the total energy consumption remained relatively stable between 1982 and 1992, the diet composition continued to change, with a larger proportion of energy provided by fat (18% of energy in 1982 compared with 22% in 1992) and lower consumption of carbohydrates (80% of energy in 1982 compared with 72% in 1992). Animal products contributed 7.9% of total energy intake in 1982 compared with 9.3% in 1992. However, marked regional variations exist (largely related to variations in economic development). For example, in Beijing between 1982 and 1992, the percent of energy from cereals decreased from 72.5% to 54.4% (−18.2%), the intake of food from animal sources increased from 10% to 16.4% (+6.4%), animal sources of protein increased from 12.7% to 30.6% (+18.2%), and fat intake increased from 21.6% of

TABLE 8. Changes in Dietary Patterns in China Between 1982 and 1992, Overall and Subdivided by Urban and Rural

	National Average					
	1982			1992		
Dietary Pattern	Total	Urban	Rural	Total	Urban	Rural
Energy by food source						
Cereals	71.3	65.0	74.6	66.8	57.4	71.7
Tubers	6.4	2.3	9.0	3.1	1.7	3.9
Legumes	2.8	3.2	2.6	1.8	2.1	1.7
Animal	7.9	12.4	4.2	9.3	15.2	6.2
Energy from fat	18.4	25.0	14.3	22.0	28.4	18.6
Protein by food source						
Legumes	10.3	10.8	10.0	5.1	5.8	4.8
Animal	11.4	16.9	6.3	18.1	31.5	12.4

Note the overall increase in energy from fat and increased consumption of animal protein and decrease in consumption of cereals and tubers. These trends are observed in both urban and rural areas. However, in urban areas there are higher rates of consumption of animal proteins and fats with lower levels of consumption of cereals and tubers.

Information in Table 8 was obtained from Reference 44.

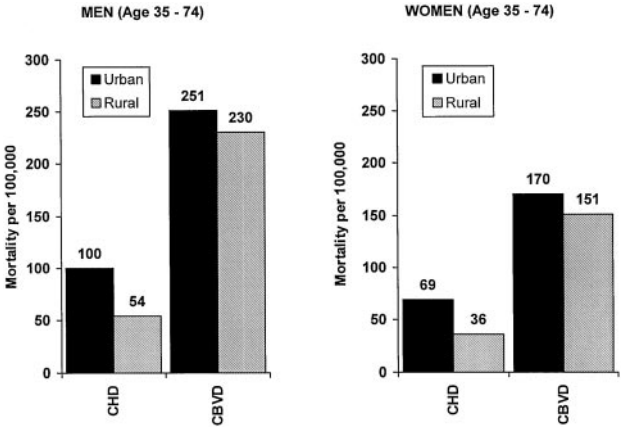

Figure 2. CHD and CBVD mortality in urban and rural China.[43] Rates were adjusted to European Standard Population and, therefore, are not directly comparable to estimates provided in Figure 1.

total energy to 30.6% (+9.0%). By contrast in the poor Ganshu province there was only a modest decline in energy from grain sources from 84.8% to 77.8% (−7%), with little change in consumption of animal foods or fats (Table 8). Similar changes have occurred in Korea,[38] India,[39] Indonesia,[40] Philippines,[41] and several other countries and have led to increasing rates of obesity, higher blood pressure, cholesterol, and glucose levels, and a decrease in insulin sensitivity. These changes are associated with higher rates of CHD and strokes in urban areas in several countries (Figure 2).

Therefore, variations in CVD rates between different parts of the world reflect interactions between genetic susceptibility and marked environmental changes usually secondary to urbanization, increasing affluence, and a range of other influences from early childhood to adulthood.

The second part of this article will summarize the knowledge of risk factors in various ethnic groups and by geographic regions as well as provide recommendations for prevention. Whenever possible, we have described the disease burden, outlined important risk factors, and suggested strategies for prevention. Additionally, we have explored the impact of urbanization and migration.

Acknowledgments

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