Hypertension is a major public health problem and a leading cause of death and disability in developing countries. One-quarter of the world’s adult population has hypertension, and this is likely to increase to 29% by 2025. Modeled projections indicate an increase to 1.15 billion hypertensive patients by 2025 in developing countries. There is variability in the global prevalence of hypertension: hypertension is present in ∼35% of the Latin American population, 20%-30% of the Chinese and Indian population, and ∼14% in Sub-Saharan African countries. This heterogeneity has been attributed to several factors, including urbanization with its associated changes in lifestyle, racial ethnic differences, nutritional status, and birth weight. Compounding this high burden of hypertension is a lack of awareness and insufficient treatment in those with hypertension. The public health response to this challenge should drive greater promotion of awareness efforts, studies of risk factors for hypertension, and understanding of the impact of lifestyle changes. Also important are efforts to develop multipronged strategies for hypertension management in developing nations.

**Global Epidemiologic Characteristics of Hypertension**

Hypertension is a key public health issue for developing countries because the complications are diverse (cardiovascular disease [CVD], stroke, and kidney failure) and treatable. Nevertheless, hypertension exacts a considerable human and economic cost. Screening for hypertension is straightforward, and with appropriate measures in place, the disease potentially is preventable, even in countries with limited resources. Kearney et al. have analyzed the global burden of hypertension and noted that 26.4% of the adult population in 2000 had hypertension, representing 972 million adults with hypertension, with one-third of these, or 333 million, from economically developed countries and two-thirds, or 639 million, from economically developing countries. The prevalence of hypertension in the world’s most populous countries, namely India and China, has been analyzed. The overall Indian and Chinese population prevalence rates for hypertension among developing nations. However, because there is a much larger population in the developing world, the absolute numbers of patients affected by hypertension are considerably higher and are likely to grow as increased globalization and economic improvement lead to urbanization and longer life expectancy.}

From the Renal Division, Brigham & Women’s Hospital and Harvard Medical School Dubai Center Institute of Postgraduate Education and Research, Dubai, UAE.

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Address correspondence to Ajay K. Singh, MBBS, MBA, FRCP, Renal Division, Brigham and Women’s Hospital, 75 Francis St, Boston, MA 02115. E-mail: asingh@partners.org

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Hypertension in the Developing World: Challenges and Opportunities

Bharati V. Mittal, MD, and Ajay K. Singh, MBBS, MBA, FRCP
males are 20.6% and 22.6%, respectively. Table 1 lists hypertension epidemiologic data from various countries worldwide. In both India and China, the prevalence is higher in urban compared with rural populations. The prevalence of hypertension in China is increasing. In 1998, a total of 24% of the population in China aged 35-59 years had hypertension, 2.3% higher than that observed from 1992-1994 and higher in men than women. In a recent analysis of the SEEK (Screening and Early Evaluation of Kidney Disease) cohort, a multicenter study in India, prevalence rates of hypertension and prehypertension of 42.5% and 41.5%, respectively, were observed (B.V.M., unpublished data, 2009). This study was modeled on the National Kidney Foundation’s KEEP (Kidney Early Evaluation Program) in the United States. A national survey in Pakistan also showed that 20.7% of the adult population has hypertension. Latin American and Caribbean countries have the highest prevalence of hypertension, especially in men. Schargrodsky et al reported a prevalence of 18% (9%-29%) in a survey of 7 cities in Latin America.

Studies dating back to the 1970s to 1990s from Ghana and Nigeria in West Africa and Lesotho and rural Zulu in South Africa had suggested a low prevalence of hypertension (4%-9%), whereas more recent studies show much higher rates of hypertension (15%-50%). This lower prevalence in the earlier studies appears to be explained at least in

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Region</th>
<th>Age Group (y)</th>
<th>Sample Size</th>
<th>Definition of Hypertension (mm Hg)</th>
<th>Total Hypertension (%)</th>
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<tr>
<td>Wang et al6</td>
<td>1992-1994</td>
<td>China, urban</td>
<td>35-59</td>
<td>8,889</td>
<td>≥140/90</td>
<td>23.1</td>
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<tr>
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<td>1992-1994</td>
<td>China, rural</td>
<td>35-59</td>
<td>9,857</td>
<td>≥140/90</td>
<td>22.1</td>
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<td></td>
<td>1998</td>
<td>China, urban</td>
<td>35-59</td>
<td>6,235</td>
<td>≥140/90</td>
<td>25.4</td>
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<td></td>
<td>1998</td>
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<td>35-59</td>
<td>7,269</td>
<td>≥140/90</td>
<td>22.8</td>
</tr>
<tr>
<td>Gupta &amp; Sharma2</td>
<td>1994</td>
<td>India, rural Rajasthan</td>
<td>≥18</td>
<td>1,609</td>
<td>SBP ≥ 140</td>
<td>40.9</td>
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<tr>
<td>Gupta et al3</td>
<td>1995</td>
<td>India, urban Rajasthan</td>
<td>20-80</td>
<td>2,212</td>
<td>≥140/90</td>
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<td>Malhotra et al4</td>
<td>1999</td>
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<td>16-70</td>
<td>2,599</td>
<td>≥140/90</td>
<td>4.5</td>
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<td>Das et al5</td>
<td>2005</td>
<td>India, urban Kolkata</td>
<td>≥18</td>
<td>8,392</td>
<td>≥140/90</td>
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<td>Ahmad &amp; Jafar7</td>
<td>2005</td>
<td>Pakistan</td>
<td>≥18</td>
<td>5,928</td>
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<tr>
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<td>1,431</td>
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<td>Ibrahim8</td>
<td>1995</td>
<td>Egypt</td>
<td>≥25</td>
<td>7,915</td>
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<td>Mbanya et al9</td>
<td>1998</td>
<td>Cameroon</td>
<td>25-74</td>
<td>1,798</td>
<td>≥160/95</td>
<td>15.0b</td>
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<td>Agyemang10</td>
<td>2006</td>
<td>Ghana</td>
<td>—</td>
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<td>≥140/90</td>
<td>29.4</td>
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<td>Schargrodsky et al11</td>
<td>2008</td>
<td>7 Latin American cities</td>
<td>25-64</td>
<td>11,550</td>
<td>≥140/90</td>
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<td>KEEP data12</td>
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<td>United States</td>
<td>≥18</td>
<td>53,662</td>
<td>≥140/90</td>
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<td>NHANES13</td>
<td>1988-1991</td>
<td>United States</td>
<td>≥18</td>
<td>9,901</td>
<td>≥140/90</td>
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</tbody>
</table>

Abbreviations: DBP, diastolic blood pressure; KEEP, Kidney Early Evaluation Program; NHANES, National Health and Nutrition Examination Surveys; SBP, systolic blood pressure; SEEK, Screening and Early Evaluation of Kidney Disease.

aMulticenter study in 13 centers including a rural and urban population (B.V.M., unpublished data, 2009).
bAge adjusted prevalence rate as quoted in reference 1.
part by the use of more liberal definitions of hypertension (a cutoff value for systolic and diastolic blood pressure > 160/95 mm Hg), as well as the possibility of measurement bias by the use of an aneroid apparatus. Mbanya et al9 more recently have observed a prevalence of 15% in Cameroon (West Africa). Similar data have emerged from Ghana, where the prevalence rate was reported to be 29.4%.10 In Egypt, the estimated prevalence of hypertension was 26.3%, higher in older participants and slightly more common in women than men (26.9% vs 25.7%, respectively).8 In Africa, the prevalence of hypertension in the urban population was observed to be higher than in the rural population.9,18 Kearney et al1 observed a prevalence of 26.9% in men and 28.3% in women, higher than that observed in Asian countries. Kearney et al1 have projected an increasing prevalence of hypertension in Sub-Saharan Africa in 2025 compared with 2000 (primarily based on population data from Cameroon in West Africa and Tanzania and Zimbabwe in South Central Africa). Compared with earlier reports of hypertension prevalence from the 1970s to 1990s from West and South Africa,14,15 later surveys from rural and semi-urban West Africa found the overall prevalence of hypertension to be in the range of 16.4%-25.7%, and 36.4%-50% in subjects ≥65 years.19 Steyn et al noted that the awareness of hypertension in South Africa was 41%-67% among those with hypertension.20

**WHY IS THE PREVALENCE OF HYPERTENSION INCREASING IN DEVELOPING NATIONS?**

**Lifestyle Changes Associated With Urbanization**

Several studies from different continents have documented the higher prevalence of hypertension in the urban versus rural population.1,3,6,9,18 Tribal populations in India have been observed to have a significantly lower prevalence than in other nontribal rural centers.21 Furthermore, when tribal populations migrate to urban areas, a higher prevalence is observed.21 Urbanization often is associated with increased income and adoption of an unhealthy lifestyle. In general, risk factors underlying the emergence of hypertension and related complications in the developing countries follow the same pattern as those identified in the developed world.22-24 Education and greater wealth appear to have a strong influence on the risk of hypertension, although this relationship may be confounded by lifestyle factors. With urbanization and increased income, there is a desire for modern conveniences, such as the adoption of unhealthy food habits with the transition from traditional rural diets (with a low glycemic index and a higher fiber content) to a diet rich in salt, saturated fats, and poor-quality carbohydrates (such as fast foods). Additionally, reduced physical activity and sedentary occupations may be important risk factors for hypertension. This is true in both South Asian countries and Sub-Saharan Africa.22,25 Excess body weight is an important independent risk factor for hypertension and related complications of CVD.23 This factor may account for differences in standardized hypertension prevalence rates among the black populations in West Africa (~16%), urban West Africa (~20%), the Caribbean (~26%), and the United States (~33%).26

The impact on hypertension rates of widespread tobacco use in the developing world is worthy of consideration. Tobacco ingestion is one of the major avoidable causes of CVDs. The INTERHEART Study explored the risks associated with tobacco use (both smoking and nonsmoking) and second-hand tobacco smoke worldwide in 27,089 participants in 52 countries (12,461 cases, 14,637 controls). Current smoking was associated with a greater risk of nonfatal acute myocardial infarction.27

**Racial and Ethnic Differences**

Several reports suggest that in the Chinese, South Asian, and aboriginal populations higher prevalence rates of dyslipidemia, metabolic syndrome, type 2 diabetes mellitus, and CVD are observed at a much lower body mass index than in Europeans.28-30 The normal range of body mass index cutoff values derived in the Western population may be misleading when used for these ethnic groups.30 The International Diabetes Federation consensus group
in 2004 defined an Asian cut-off for obesity in different ethnic populations. This cut-off was much lower for the Chinese, Japanese, and South Asian populations compared with the European population.\(^\text{31}\) In the Middle East, abdominal obesity, judged by waist-to-hip ratio, correlated well with cardiovascular risk.\(^\text{32}\) Increased salt consumption (associated with fast food and canned food consumption), tobacco and alcohol use, and increased psychological stress, which are inevitable with urbanization, also are associated with hypertension. Hypertension in the black population in the United States and West Indies is higher than in the white population and also is much higher than that observed in Sub-Saharan Africa. It has been hypothesized that this is related to the effect of urbanization during > 300 years compared with the acculturation of a more recent origin in the latter.\(^\text{33}\) Although the population in Sub-Saharan Africa is defined as black, there could be differences between African Americans and Africans living in Africa who have never emigrated. Also, within the African continent, there could be ethnic differences between West compared with East African tribes.\(^\text{35}\) The black population in South Africa also has shown a genetic predisposition for hypertension; for example, the polymorphism in the promoter region of the angiotensinogen gene has been shown to cause a greater than expected increase in systolic blood pressure for any given body mass.\(^\text{34}\) Touyz et al\(^\text{35}\) observed a lack of stimulation of plasma renin activity by nature with furosemide that confirmed a hyporesponsive renin-angiotensin system in hypertensive urban Zulu. Campese et al\(^\text{36}\) found that most whites have a salt-resistant state, whereas blacks show a salt-sensitive state in participants studied in Los Angeles.

**Rate of Growth and Development in In Utero, Infancy, and Early Childhood**

Nutritional and other exogenous environmental factors during development may permanently influence the fetus in utero. There is evidence, mostly from developed countries, that low birth weight and intrauterine growth restriction are associated with a greater risk of hypertension.\(^\text{37,38}\) Studies have reported higher blood pressures in adults born with low birth weight, even after adjusting for parental blood pressure, current weight, smoking, oral contraceptive use, and sex.\(^\text{39,40}\) Similar associations in individuals of varied ethnic and geographic origins have been documented, additionally emphasizing the importance of birth weight in risk of adult disease.\(^\text{41,42}\) It is believed that low birth weight leading to reduced nephron number may be a major factor in the development of hypertension in later life.\(^\text{43}\) Compensatory adaptation mechanisms resulting from reduced nephron numbers include glomerular hyperfiltration, glomerular hypertension, sclerosis, and premature nephron death.\(^\text{43}\) These might be aggravated further by programmed changes in vascular structure and function and alterations in endocrine and metabolic homeostasis.\(^\text{38}\) Additionally, Barker et al\(^\text{44}\) have suggested that low birth weight may have longer term effects on the risk of hypertension. In developing countries, nutritional deficit frequently persists into early childhood and even later. Eriksson et al\(^\text{45}\) have suggested that early childhood growth patterns influence blood pressure in adulthood. Hypertension at age 62 was linked to size at birth and growth and development during early childhood. Eriksson et al\(^\text{45}\) correlated 2 different patterns of childhood growth in adults with hypertension. In 1 group, during early childhood growth documented from birth to 11 years, growth was stunted and children were small until the age of 2 years, but later showed a growth spurt. Eriksson et al\(^\text{45}\) hypothesized that this group of children had hypertension that was associated with an altered response to renin-angiotensin system due to insulin resistance. Reduced nephronal mass also was a feature of this form. In contrast, in the second pattern of childhood growth, there was persistent stunting of growth with small size throughout childhood. In this second group, Eriksson et al\(^\text{45}\) proposed that hypertension was associated with altered liver function, with an increased prevalence of lipid abnormalities and atherosclerosis.
Poverty

Surveys of socioeconomic factors affecting the prevalence of chronic kidney disease and hypertension show the role of several factors in addition to urbanization. These include sedentary lifestyle, obesity, physical inactivity, smoking, and increased alcohol consumption. However, lack of awareness, partly linked to lower levels of education, lower social class, and lack of health care facilities observed in the poorer strata of individuals, also seem important in predicting a higher prevalence of hypertension.46 Schneider et al47 observed that exposure to lifestyle factors, such as smoking, domestic exposure to “smoky” fuels, and alcohol dependence, were associated with poverty in the South African population.

UNDERRECOGNITION OF HYPERTENSION IN DEVELOPING COUNTRIES

Many studies show that awareness of hypertension in the developing world population is low. In part, this likely reflects a low level of literacy and education, but also seems to reflect a low level of access to medical care. In South Asian countries, awareness correlated with poor access to treatment and therefore to control of hypertension.48 The challenge posed by low levels of awareness must be overcome through strategies targeted at education and promotion. In the SEEK study in India, 57.3% of participants with hypertension had an income ≤ $125/mo, 39% had a < 8th grade education, and 46% responded in the negative to the question, “Have you ever been told that you have hypertension?” (B.V.M., unpublished data, 2009). Results from the National Health Survey of Pakistan from 1990-1994 showed that one-third of the general population aged 40 years had hypertension, and awareness of hypertension was 35.6%.49 In China, Wang et al6 reported that although the rate of awareness in 1998 was 5.3% higher compared with 1992-1994, only 42.6% of the population were aware of their hypertension. In Sub-Saharan Africa, Addo et al18 observed that 40% of people with hypertension previously had hypertension diagnosed, and of these, < 30% were receiving medication and < 20% had hypertension under control. In comparison, in the developed world, Burt et al13 reported an awareness rate of 73% in NHANES (National Health and Nutrition Examination Surveys [1988-1991]). In 1 study from the Sub-Saharan Africa region, Metcalf et al50 noted an interesting finding that 1 year after participants in the study were given a diagnosis and referred to a health facility for treatment, almost 27% claimed to be unaware of having hypertension. Awareness of hypertension in hypertensive individuals from different regions is shown in Fig 1.

DEVELOPING MULTIPRONGED STRATEGIES FOR HYPERTENSION MANAGEMENT

Hypertension and its cardiovascular complications are major contributors to the global burden of disease and account for 8.1% of disability-adjusted life-years in the less developed world.51 Population trends show that CVD is becoming
the leading cause of disability. In the 1990s, CVD ranked fourth after infectious and parasitic diseases, neuropsychiatric disorders, and injuries. However, in 2020, it is projected that CVD will become a major cause of disability and death worldwide.

Optimal management of hypertension is important to prevent the risk of CVD and kidney disease. Assessment of estimated glomerular filtration rate, along with urine protein, preferably albumin, particularly in patients with hypertension, is important for the early detection of kidney disease. Aggressive treatment, particularly targeting systolic blood pressure, has been advocated. Population-based interventions have included salt reduction through voluntary agreements with industry, legislation to mandate population-wide reductions in salt intake, health education through mass media, and the combination of the latter 2 interventions. Individualized interventions have included guideline-based treatment strategies, aiming for systolic blood pressure < 140 mm Hg with a β-blocker and diuretic and education, treatment of high cholesterol levels (>5.7 mmol/L with medications) and education, and drug treatment of systolic blood pressure ≥ 140 mm Hg and cholesterol level > 6.2 mmol/L and the absolute risk approach. Murray et al observed that the effectiveness of health policy implementation by governmental agencies aimed at reducing the salt content of packaged foods was very effective and arguably responsible for reducing an estimated 21 million disability-adjusted life-years per year worldwide.

The World Health Organization (WHO) has taken a lead role in the development of global strategies for the prevention of noncommunicable diseases, such as hypertension, and their risk factors. The WHO Stepwise approach to Surveillance (STEPS) program is low cost and aimed at promoting CVD risk factor surveillance in developing countries. WHO STEPS has been adopted in a number of regions. The WHO also provides information about costs and health effects at a regional level (CHOICE [Choosing Interventions That Are Cost-Effective] project).

Salt intake around the world far exceeds physiologic requirements, and most adult populations have a mean sodium intake > 100-200 mmol/d. Sources include cereal, baked goods, pickled foods, soy sauce, and other items used in cooking. Akpolat et al have recommended evaluation of salt in commonly consumed foods, as well as patient education programs. Additionally, the role of potassium has been extensively reviewed by Adrogué and Madias, and they have observed an inverse relationship between potassium intake and urinary potassium-sodium ratio and hypertension in population studies, as in the INTERSALT (International Study of Salt and Blood Pressure). Adrogué and Madias emphasize potassium-sodium ratio and recommend a diet that provides an adequate intake of potassium and is low in sodium. In particular, they recommend adding natural forms of potassium that do not contain chloride, such as those in fruits, vegetables, and other foods that have been observed to have a large antihypertensive effect.

### RECOMMENDATIONS FOR ADDRESSING HYPERTENSION IN THE DEVELOPING WORLD

In developing countries, inadequate funds, inexperience, and lack of infrastructure are important barriers to hypertension diagnosis and therapy. There frequently is competition for limited financial resources with other important communicable causes of morbidity and mortality, for example, HIV/AIDS, malaria, and tuberculosis. Furthermore, money allocated to public health initiatives is much less than that in Western nations. Collectively, these explanations for the limited progress achieved to date should justify a more intensive collaborative approach to managing hypertension. The Ministry of Health in developing nations should develop strategies to bring together the medical community and other nongovernmental organizations in devising comprehensive public health strategies targeted at hypertension. The Ministry of Health in each developing country should promote awareness, education programs, and implementation of treatment paradigms. The Ministry of Health and other governmental agencies also could lobby the pharmaceutical industry to support generic hypertension drugs being made
available at less expensive rates. Other approaches should include the following interventions.

Early Detection and Primary Prevention

Lifestyle changes, such as increasing exercise and decreasing consumption of calorie-dense and fat-rich foods, salt, tobacco, and alcohol, will help prevent the development of advanced stages of hypertension. Smoking is a preventable cause of hypertension, and increasing awareness of the harmful effects of smoking should be more vigorously promoted.

Educating and Training General Physicians in Hypertension Management

Previous reports from both developed and developing countries have shown gaps in the knowledge of hypertension management guidelines, contributing to suboptimal care of patients. Qureshi et al have shown the effectiveness of simple targeted training of general practitioners in the management of hypertension in a community-based randomized control trial in a developing nation. Strategies targeted at primary care physicians should be encouraged.

Increasing the Availability and Adherence to Antihypertensive Drug Treatment

Strategies aimed at the use of less expensive generic versions of antihypertensives and the use of drug combinations to improve treatment adherence should be pursued aggressively. In India, Mani has reported the use of inexpensive generic medicines, such as reserpine and hydrochlorothiazide, to effectively control hypertension to < 140 mm Hg or lower in 96% of participants reported in a large ongoing study during 8 years in a South Indian village. A meta-analysis of 354 trials (56,000 participants) has shown that blood pressure reduction using major classes of drugs at standard doses was similar. The effectiveness of a polypill with the combination of 3 blood pressure-lowering drugs at low doses (a thiazide, a β-blocker, and an angiotensin-converting enzyme inhibitor) with a statin, aspirin, and folic acid to reduce cardiovascular events has been established. The “Polycap” (Cadila Pharmaceuticals Ltd, www.cadilapharma.com) reduced systolic and diastolic blood pressure, heart rate, low-density lipoprotein cholesterol level, and 11-dehydro-thromboxane B2 level.

Researching Racial Differences in the Effectiveness of Antihypertensive Therapies

Although the field of pharmacogenomics is relatively new, research suggests that responsiveness to various drugs, including antihypertensive medications, may be influenced by genetic and/or racial differences. The cost-effectiveness of these genetic tests needs to be explored further within cohorts in the developing world.

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