Burden of Cardio- and Cerebro-vascular Diseases and the Conventional Risk Factors in South Asian Population

Tanvir Chowdhury Turin[†], Nahid Shahana[§], Lungten Z. Wangchuk[♥], Adrian V. Specogna[‡], Mohammad Al Mamun[♣], Mudassir Azeez Khan[★], Sohel Reza Choudhury[‖], M. Mostafa Zaman[‖], Nahid Rumana[♣]

Calgary, Alberta, Canada; Dhaka, and Chandpur, Bangladesh; Thimphu, Bhutan; Tabuk Region, Saudi Arabia; Mysore, India; and Otsu City, Shiga, Japan

ABSTRACT

Similar to most populations, South Asian countries are also witnessing the dramatic transitions in health during the last few decades with the major causes of adverse health shifting from a predominance of nutritional deficiencies and infectious diseases to chronic diseases such as cardio and cerebrovascular disease (CVD). We summarized the available information of the burden of CVD and risk factors in the South Asian populations. The prevalence of conventional cardiovascular has been increasing among all South Asian populations. Extensive urbanization, shift in dietary pattern and sedentary daily life style is contributing towards the worsening of the CVD risk factor scenario. The burdens of the chronic cardiovascular risk factors are much prevalent in the South Asian populations. These are also rising alarmingly which ought to influence the already existed heavy CVD burden. Similar to the rest of the world, management for the conventional cardiovascular risk factors is very important for the prevention of CVD in South Asia.

Cardiovascular and cerebrovascular diseases are important causes of morbidity and mortality worldwide and impose a considerable burden on individuals, societies, and healthcare systems. South Asian populations have witnessed a dramatic change in their health during the last few decades because of adverse health shifting from a predominance of nutritional deficiencies and infectious diseases, to chronic diseases such as cardiovascular disease (CVD). This phenomenon, which was observed in the now-developed countries during their developing periods, has been termed "the epidemiologic transition" [1,2]. The demographic features of CVD in the South Asian region are changing. It is not just an epidemiological transition, but previously observed epidemiological polarizations, difference in the health problems between the rich and the poor, are possibly also changing. Populations in the countries of the South Asian region, comprising more than one-fifth of the world population, are currently becoming highly susceptible to cardiovascular problems. A steady increase in buying capacity and influence of the Westernized lifestyle, especially with the rapidly expanding affluent section of the population, are affecting the shift with regard to the factors related to CVD risk.

To be able to develop any successful preventive strategies and initiate an appropriate intervention against the growing epidemic of CVD in South Asia, it is necessary to assess the disease burden and characterize the population at risk. Recognition of the modifiable risk factors is the cornerstone of the clinical as well as population-level efforts to diminish the risk of CVD. In this report, we present features of CVD in South Asian countries and their risk factors based on extensive reviews of different studies.

An extensive literature review was performed focusing on studies on South Asian populations. Apart from the available conventional literature sources, the authors also have extensively searched the local-level literature sources from academia, nongovernment reports, as well as government sources. For mortality data, statistics of the World Health Organization were obtained [3].

MORTALITY AND MORBIDITY FROM CVD IN SOUTH ASIA

The available data from the World Health Organization on age-adjusted mortality for CVD in men and women combined is shown in Figure 1 [3]. The age-adjusted mortality for South Asian countries with some other selected Asian and Western countries in 2002 are shown for comparison. In general, CVD mortality in South Asian countries is higher than in Western countries. In comparison to other Asian countries, the CVD mortality rates in the South Asian countries are much higher than the East Asian countries, such as Japan and Korea. Whereas the CVD mortality in the South Asian countries was lower than in the Central Asian countries.

Among CVD subtypes, Figure 2 shows the age-adjusted mortality of stroke in South Asian countries as well as few other selected populations. In comparison to other Asian countries, stroke mortality in the South Asian countries is much higher than in the East Asian countries and is lower
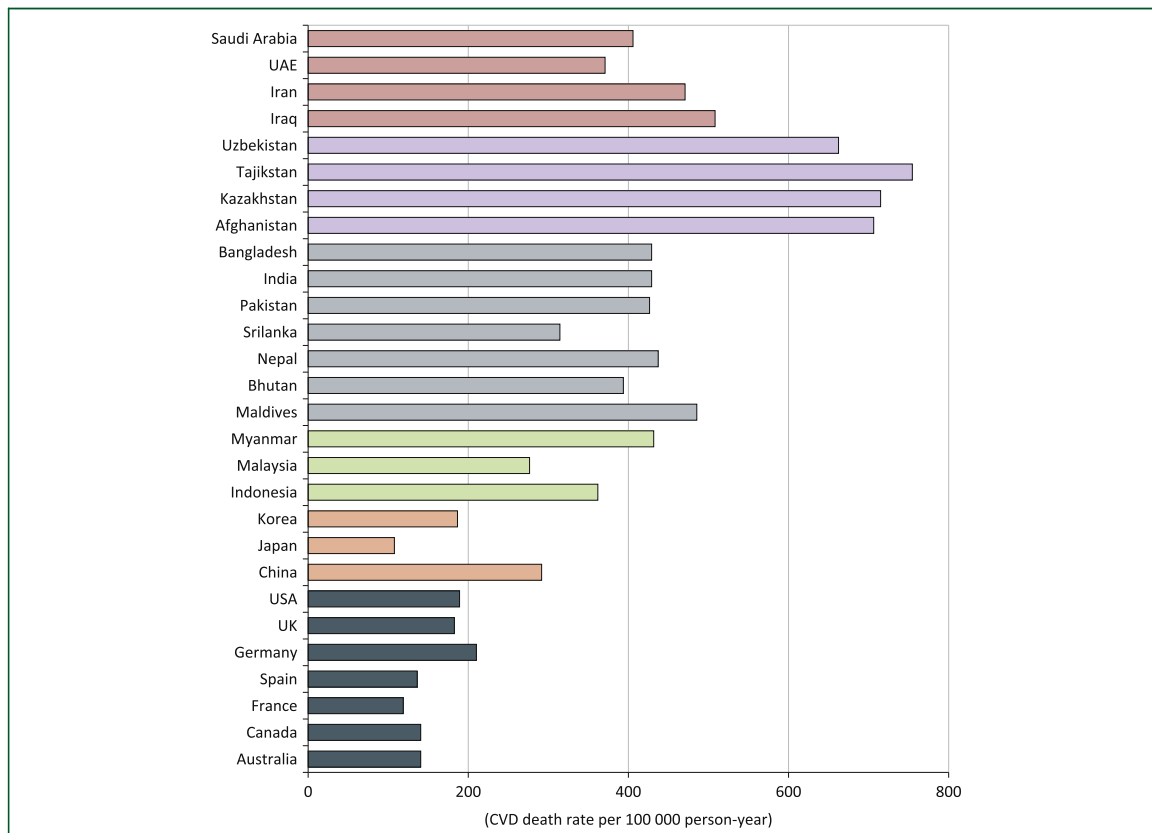
FIGURE 1. Age-standardized death rates per 100,000 for cardiovascular diseases (CVD) across countries of different regions of Asia in 2002. Bar colors represent different regions: Middle Eastern countries (pink), Central Asian countries (purple), South Asian countries (grey), Southeast Asian countries (green), East Asian countries (peach), and non-Asian countries (blue-grey). UAE, United Arab Emirates; USA, United States of America; UK, United Kingdom.

than in the Central Asian countries. It is worth mentioning that Japan had the highest stroke mortality in the world in 1965. It rapidly decreased by about 80% during the period 1965—1990 [4,5]. When examining the age-adjusted coronary heart disease (CHD) mortality, it is evident that the East Asian countries have lower mortality than the South Asian countries do (Fig. 3). The CHD mortality in the South Asian populations is higher than the stroke mortality. Except for the East Asian populations [6], similarly high CHD mortality and relatively lower stroke mortality was observed among the other populations.

Contrary to decline in the incidence of the CVD in the developed country populations, the burden of the CVD in South Asian countries is expected to rise. But no large-scale, methodologically sound, epidemiological studies are available in these populations to estimate the true incidence of cardiovascular events. Estimates from the Global Burden of Disease Study suggest that by the year 2020, India alone will have more individuals with CVD than in any other region [7]. The estimated annual incidence of stroke was 250 per 10^5 persons in 2006 in Pakistan [8]. In a study among the migrant Pashtun community in Karachi, one of the biggest urban centers in Pakistan, a very high prevalence (4.8%) of stroke was reported [9]. But the results of this study are not generalizable to the Pakistani population due to the very selective nature of this study sample. Using hospitalized case series to identify the burden of stroke in Pakistan, Vohra et al. [10] reported that of 12,454 consecutive patient admissions to medical units, 6.4% suffered from stroke. The first population-based data from India on stroke incidence was coordinated by the World Health Organization (WHO) between 1971 and 1974 [11]. The survey showed that the age-adjusted incidence rate of stroke was 48 per 10^5 populations. In India, during the past couple of decades, the crude incidence rates of stroke were between 136 and 247 per 10^5 populations [12—16]. The estimated age standardized annual incidence rate of first-ever-in-a-lifetime stroke was reported to be 145 per 10^5 persons during 2003—2005 in Kolkata, an urban center in eastern India [15]. The WHO-coordinated survey for stroke incidence [11] reported the incidence of stroke in Sri Lanka to be 41 per 10^5 populations during the survey period of 1971—1974. However, there is no clear understanding of the current incidence of stroke in Sri Lanka, as there is no adequate current data on incidence and
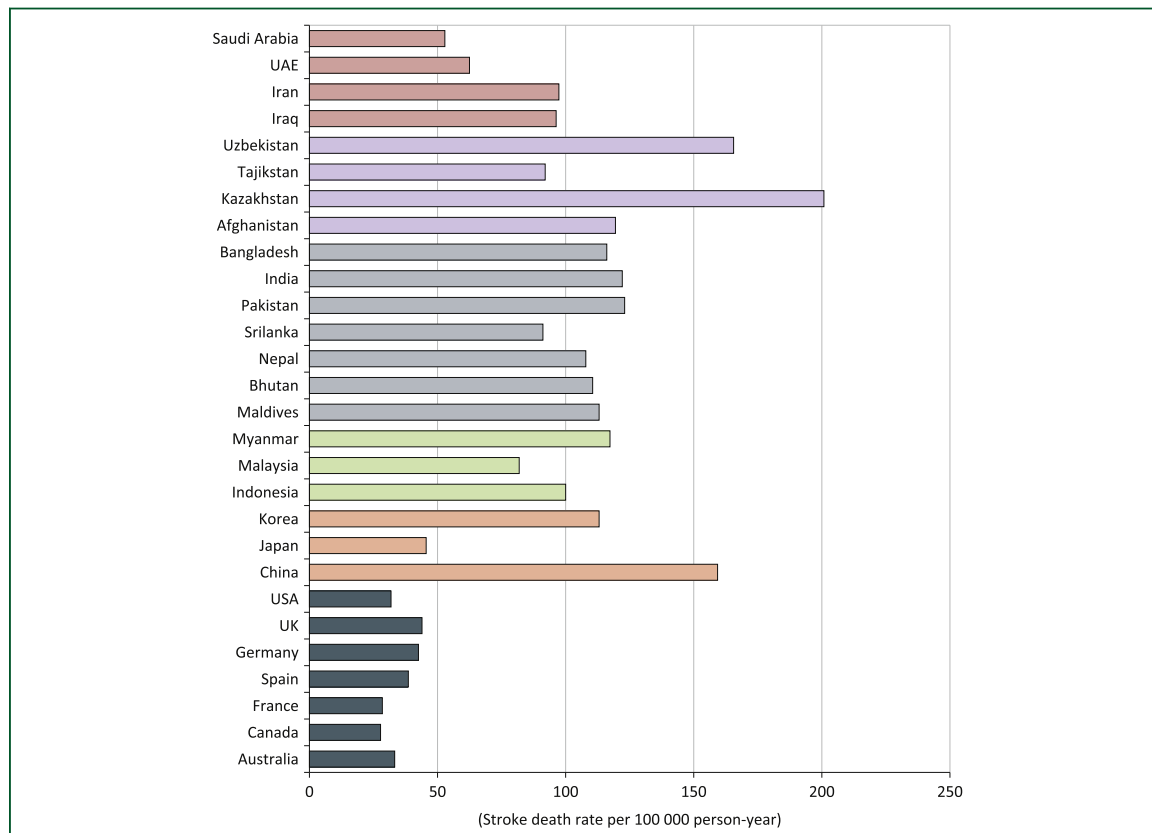
FIGURE 2. Age-standardized death rates per 100,000 for stroke across countries of different regions of Asia in 2002. Bar colors represent different regions: Middle Eastern countries (pink), Central Asian countries (purple), South Asian countries (grey), Southeast Asian countries (green), East Asian countries (peach), and non-Asian countries (blue-grey).

prevalence from stroke in the population-based setup. Unfortunately, population data on stroke burden are almost lacking in Bangladesh, Nepal [17], and Maldives as well.

The prevalence of CHD has doubled in the Indian populations during the past 2 decades, making the billion-people country set to face a major healthcare burden [18–23]. The CHD prevalence ranged from 3.0% to 13.9% across different communities across these studies. Population-based data on CHD burden are almost nonexistent in Bangladesh. In 1974, Malik [24] studied a pooled sample from different tertiary level hospitals and populations and reported a prevalence of 0.33% for heart disease in Bangladesh. Zaman et al. [25] reported a CHD prevalence of 3.4% in a rural Bangladeshi population in 2007. Estimates from a cross-sectional analysis of a thousand men aged 35 years or more in Nepal have suggested that the prevalence of CHD in this population was 5.7% [26,27]. This 2009 study was the first population-based prevalence study of CHD in Nepal.

The prevalence estimates for CHD from the available South Asian population-based studies need to be interpreted with caution due to the poor quality of the underlying data.

In addition, comparisons made across studies also require caution as studies defined CHD differently. A major expansion of research and surveillance is needed with more rigorous and standardized methods to permit comparisons over time, between locations, and between and within populations. Only then can the true extent and impact of the disease in South Asia be known.

THE CVD RISK FACTORS IN SOUTH ASIA

Among worldwide populations, tobacco use [28–30], high blood pressure [31–33], obesity [34,35], metabolic disorders [36,37], and sedentary lifestyles [38,39] are important determinants of CVD. These conventional risk factors are also important contributors to the CVD risk in South Asian populations as well [40–42].

Shifting dietary preference and lifestyle factors

The South Asian populations, with a diet that was traditionally high in carbohydrates and low in fat, have shown major shifts in their dietary behavior. The global availability of cheap vegetable oils and fats has resulted
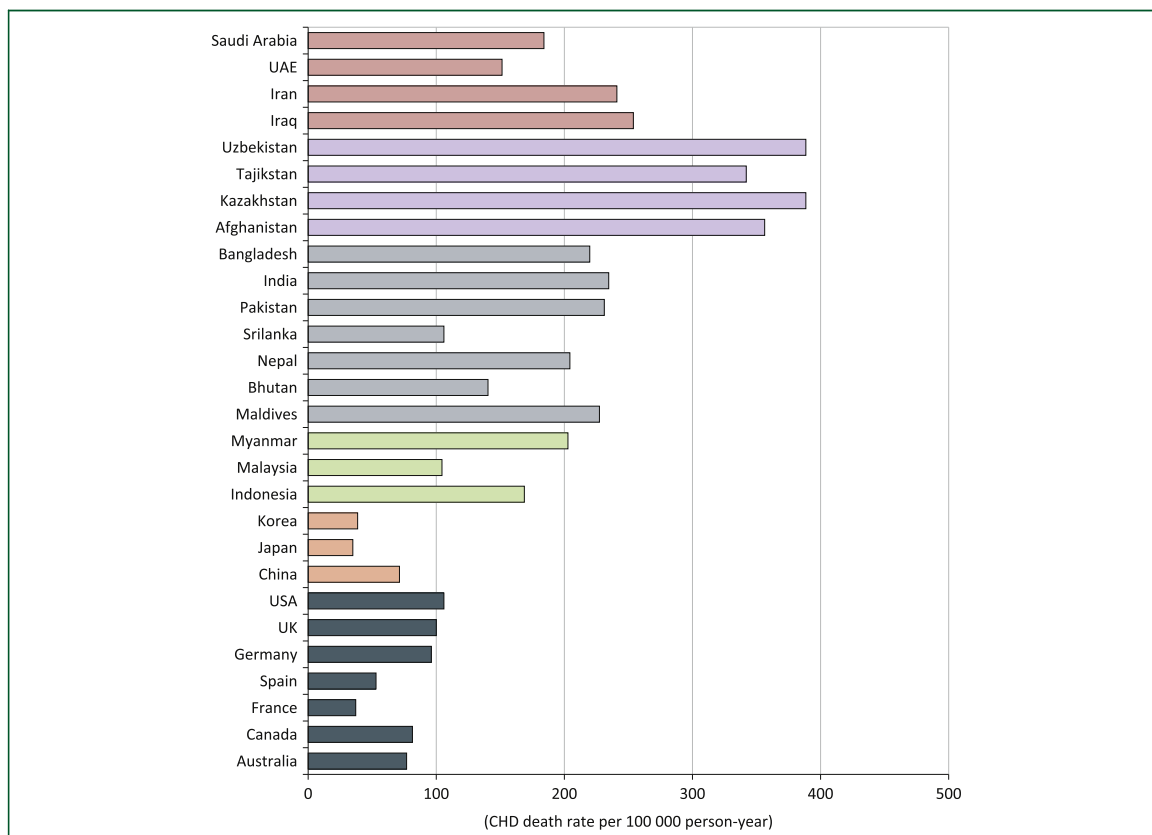
FIGURE 3. Age-standardized death rates per 100,000 for coronary heart disease (CHD) across countries of different regions of Asia in 2002. Bar colors represent different regions: Middle Eastern countries (pink), Central Asian countries (purple), South Asian countries (grey), Southeast Asian countries (green), East Asian countries (peach), and non-Asian countries (blue-grey). Abbreviations as in Figure 1.

in greatly increased fat consumption among low-income countries, which also includes the South Asian countries. Major dietary change includes a large increase in the consumption of fat and added sugar in the diet, often a marked increase in animal food products contrasted with a fall in total cereal intake and fiber [43]. In many ways, this seems to be an inexorable shift to the higher-fat Western diet, reflected in a large proportion of the population consuming over 30% of energy from fat [44,45]. The globalization of food production and marketing is also contributing to the increasing consumption of energy-dense foods, which are poor in dietary fiber and several micronutrients [46]. The fast food or junk food culture, instant preparations, pre-cooked foods, and the easy availability of high salt—containing snacks are contributing to the already worsening cardiovascular risk factors in the South Asian populations. In Bhutan, it has been reported that two-thirds of the population are not eating enough fruits and vegetables (less than 5 combined servings per day), with the consumption of fruit being particularly low and infrequent [47]. A similar inadequate vegetable and fruit intake was also reported for the Maldivian population. Fruits and vegetables were consumed on a median of 3

days per week each with a median of 1 serving per day [48]. The transitions to less healthy eating was initially observed more prominently in the expanding middle class, but they are now also being observed at lower levels of socioeconomic status and are further accelerated by the rapid rate of urbanization [49]. This reversal of social gradient (higher occurrence of risk factors in the low socioeconomic group) was reported in the Maldivian [48] as well as the Indian populations [50]. A major change in the economic structure associated with the nutrition transition is very much influenced by the shift from a pre-industrial agricultural economy to industrialization. Along with the shift toward occupations that require less energy to be expended, new technologies allow those at each occupation to engage in increasingly sedentary work [44]. With urbanization, which has also been referred to as migration to Western environments, there is a marked increase in consumption of energy-rich foods, and a decrease in energy expenditure through less physical activity [49]. The increasing sedentary behavior comprising less physical activities, also has contributed to the current cardiovascular adverse scenario. Given the fact that CVD is already a major problem in South Asian populations and

cardiovascular risk factors are on the rise, CVD is likely to be substantially more common in the future. The South Asian populations are found to disadvantaged in a wide range of CVD risk factors in comparison to developed country populations due to the worsening of the conventional cardiovascular risk factors.

Hypertension

Hypertension is directly responsible for 57% of all stroke deaths and 24% of all CHD deaths in India [51]. Summarizing 5 decades of prevalence rates and blood pressure trends in the Indian population, studies reported a hypertension prevalence of 1.2%−4.0% during the mid-1950s [52,53]. Subsequent studies report the prevalence increased steadily to 12%−15% in the 1990s [52,53]. Recent studies have reported the current prevalence to be as high as 41.2% [20,54−58]. A similar trend in the prevalence of hypertension was also observed in studies from the Bangladeshi population [59−62]. The current prevalence in Bangladesh has not been reported to be as high as the Indian prevalence, but across studies, the prevalence of hypertension has been reported to be 6.7% during the 1980s and the prevalence was reported to be 14.4% in a study published in 2002 [59−62]. The National Health Survey of Pakistan (NHSP) conducted during 1990−1994 highlighted the magnitude of the burden of hypertension in Pakistan. Hypertension was shown to affect about 33% of adults [63,64]. Also, a study based on the urban population has also reported that the overall prevalence of hypertension was 26% [65]. One study looking at the prevalence of hypertension in different ethnic groups in Pakistan using the NHSP data, reported a high prevalence ranging from 9.0% to 41.4% [64]. In Maldives, a survey conducted by the Health Ministry reported that the overall prevalence of high blood pressure was 31.5% [48]. A study conducted on 6,047 Sri Lankan adults between the age of 30 and 65 years reported the prevalence of hypertension to be 18.8% [66]. The earliest study of prevalence and risk factors of hypertension in Nepal was conducted in 1980 using the then WHO criteria of 160/95 [67]. The highest rate was found to be 9.9% in Urban Kathmandu followed by 8.11% in Rural Kathmandu, 5.98% in Plain of Terai, and 5.31% in the mountain region of Jumla [68]. A statistically significant correlation was found between salt intake and hypertension [69]. A repeat study was done in the same area of Rural Kathmandu recently and the prevalence rate was found to be 33.8%. Even if we take the old criteria of 160/95, the prevalence rate is 18.1%. So, there has been a 3-fold increase of prevalence of hypertension in the last 25 years. Using a house-to-house survey in a suburban area of Kathmandu valley in 2005 [70], researchers reported an overall prevalence of hypertension to be 19.7% for their study population. Another study of 1,000 men aged 35 years and older reported 22.7% prevalence of hypertension [71]. The prevalence of hypertension has been

reported to be 17.1% in Bhutan [47]. The Annual Health Bulletins of the Bhutan government reported an increasing trend of hypertension incidence among the population [72]. Hypertension has been increasing geometrically. It increased by 11% in 2004, 16% in 2005, and 23% in 2006 [72]. Table 1 summarizes some selected studies for the prevalence of hypertension over time in South Asian populations. Despite these studies being widely distributed in time and having methodological differences, an increasing trend in the prevalence of hypertension over time among the South Asian populations was observed. While interpreting the trend based on reports from different periods, it should be kept in mind that high-quality method for standardization of blood pressure measurements is needed for the comparison of blood pressure levels, as well as the estimate of the prevalence of hypertension across time or among populations. Also, the changes in the standard definitions of hypertension at different periods also might influence temporal trends in the prevalence of hypertension.

Smoking

Smoking is a common and growing problem in South Asian countries. Tobacco usage is high among the Bangladeshi population. Forty to 55% of the population are reported to be habitual tobacco users—through smoking, oral intake, or both [73,74]. Through smoking, 31% of Bangladeshi population consumes tobacco [73]. According to the SuRF Report 2 (2005) [75], the prevalence of smoking in Bangladesh was 36.3% for men aged 18−29 years, 64.2% for men aged 30−39 years, and 70.8% for men aged 40−49 years. Among Bangladeshi women, the prevalence of smoking was 7.1%, 23.3%, and 42.5%, respectively [75]. The smoking rate in the Indian population was also reported to be quite high. In the National Family Health Survey-2 (1998−1999) [76], among 315,598 individuals from 91,196 households, 47% of men and 14% of women either smoked or chewed tobacco. Based on the NHSP data from Pakistan, it has been reported that the prevalence of smoking was 28.6% among men and 3.4% among women [63,77]. The highest prevalence of 40.9% was reported in men aged 40−49 years [77]. In early studies in Nepal, during the early 1980s, very high percentages of tobacco smoking was reported: 79.3% in men and 57.9% in women in a rural community [78]. In another study from Nepal, examining a rural population, remarkably high prevalence of daily smokers (73.7%) was reported [79]. It was interesting to note that in the mountain region, the female smoking rate was 71.6%, which is among the highest reported in the world. Apart from this study, the prevalence of tobacco smoking was found to be 68.8%, 77.4% in men, and 60.6% in women [80]. An interesting feature is that Nepal, and to some extent Bangladesh, still have very high prevalence rates of female smokers compared with other South Asian countries. In Nepal, the relatively recent smoking rate has been reported to be 48% for adult men and 29% for the adult

TABLE 1. Prevalence of hypertension in South Asian population from selected studies

Country	Author	Year	Age range	Urban/rural	Sample size	Prevalence of hypertension
Bangladesh	Islam et al. [59]	1983	>18	Rural	5026	6.7%
	Abu Sayeed et al. [60]	1995	>15	Rural	1005	9.5%
	Zaman et al. [61]	2001	≥18	Rural	Men: 238	Men: 9.8%
					Women: 271	Women: 15.6%
	Sayeed et al. [62]	2002	>20	Urban/rural	2361	12.5%
Bhutan	Royal Government of Bhutan—STEPS survey report [47]	2007	25—74	Urban	Men: 1105	Men: 16.1%
					Women: 1318	Women: 18.1%
	Royal Government of Bhutan—Annual Health Bulletins [72]	2005 2008 2009	—	—	—	160/10,000 population 303/10,000 population 310/10,000 population
India	Gupta et al. [57]	1994	20—75	Rural	Men: 1982	Men: 23.7%
					Women: 1166	Women: 16.9%
	Gupta et al. [54]	1995	20—75	Urban	Men: 1415	Men: 29.5%
					Women: 797	Women: 33.5%
	Anand [56]	2000	30—60	Urban	Men: 1521	34.1%
					Women: 141	
	Mohan et al. [58]	2001	20—70	Urban	Men: 518	14.0%
					Women: 657	
	Gupta et al. [20]	2002	20—75	Urban	Men: 550	Men: 36.4%
					Women: 573	Women: 37.5%
Maldives	Aboobakur et al. [48]	2003—2004	25—64	Urban	Men: 934	Men: 29.7%
					Women: 1094	Women: 32.9%
Nepal	Pandey et al. [67]	1981	—	Urban/rural	—	Urban: 9.9% Rural: 8.1%
	Sharma et al. [70]	2005	≥18	Suburban	Men: 541	Men: 22.2%
					Women: 573	Women: 17.3%
	Vaidya et al. [71]	2004—2005	≥35	Urban	Men: 1000	Men: 22.7%
Pakistan	National Health Survey of Pakistan [63]	1990—1994	>15	Urban/rural	9442	33%
	Safdar et al. [65]	2002	>18	Urban	Men: 172	Men: 34%
					Women: 658	Women: 24%
Sri Lanka	Wijewardene et al. [66]	2004	30—65	Urban/rural	Men: 2692	Men: 18.8%
					Women: 3335	Women: 19.3%

women [81]. Studies in Sri Lanka have reported the smoking rate to be around 21% to ∼38% among the male population and a quite low prevalence (0.1% to ∼1.7%) among the female population [81–83]. For the women, this was the lowest for all the South Asian countries. The Health Ministry survey in Maldives revealed that 39.9% of the male and 9.9% of the female populations are current smokers [48]. A survey conducted by the Bhutanese authority in 2007 reported that 8.4% of men and 4.7% of women were current smokers [47].

Smokeless tobacco use

Nonsmoking tobacco uses, primarily chewing tobacco use, are quite common across the South Asian population. The

Inter Heart Study has reported that chewing tobacco alone was associated with increased heart disease risk, and smokers who also chewed tobacco had the highest risk [30]. Traditionally, men smoke cigarettes and bidi and chew tobacco leaf. However, women usually do not smoke but chew tobacco leaf. The recent GATS (Global Adult Tobacco Survey) study Bangladesh chapter has reported that use of any current smokeless tobacco was 27.2% in Bangladesh [74]. The estimated number of current users of smokeless tobacco in Bangladesh was reported to be 25.9 million, of which 13.4 million women and 12.5 million men used smokeless tobacco products [74]. Unlike the use of smoked tobacco products, the use of smokeless tobacco among men and women were reported at quite similar levels; though in most cases, the use was slightly higher in women. Overall, 26.4% of men and 27.9% of women used any smokeless tobacco product. In Bhutan, a study reported that 19.4% of the population currently used smokeless tobacco [47]. The use of smokeless tobacco was more prevalent than the smoking-type tobacco in Bhutan. This was a distinct characteristic for the Bhutanese population's tobacco usage.

Glucose intolerance and diabetes

Reports from various parts of India suggest a rising trend in the prevalence of diabetes [84−86]. A national-level prevalence study, the National Urban Diabetes Survey, reported the age-standardized prevalence to be 12.1% for diabetes and 14.0% for impaired glucose tolerance [87]. The WHO has made an alarming projection that by 2025, the highest global increase in diabetes will occur in India [88]. The results from the Pakistan National Diabetes Survey, conducted during the 1990s, indicated that the prevalence of diabetes and impaired glucose levels were in the high ranges of the South Asian population [89−92]. All the major ethnic populations have been shown to have a consistently high prevalence [92,93] of diabetes. In a 2007 population-based survey in Bhutan, 4.0% of respondents had impaired glucose tolerance and 21.6% were found to have impaired fasting glycemia [47]. Additionally, 2.5% of participants had been diagnosed with diabetes during preceding year [47]. Diabetes incidence more than doubled in the Bhutanese population from 2005 to 2009 [72]. A similar trend has been observed for the Bangladesh population. During the 1990s and earlier, the prevalence of diabetes in Bangladesh was reported to be around 2% [94−96], whereas the studies conducted during the last decade have been reporting the prevalence around 4% to ∼6% [95,97−99].

Higher prevalence rates for diabetes and impaired glucose tolerance was observed among the Nepalese [100−102] and Maldivian populations [48] as well. However, South Asian populations have a lower body mass index (kg/m^2) than Western populations do; the body mass index is around 20−24 in Asian populations but 26−29 in Western populations [103,104]. Because body mass index in the South Asian populations is increasing and obesity is on the rise, the prevalence of glucose intolerance and diabetes is expected to increase further as well. In addition, as the life expectancy increases in the South Asian populations, the projected increase in the prevalence of diabetes is expected to contribute to the CVD burden more significantly in years to come.

Dyslipidemia

Studies suggest that dyslipidemia, a component of metabolic syndrome, is quite common in urban Indians [20,105]. This distinctive dyslipidemic pattern of reduced concentrations of high-density lipoprotein cholesterol and high concentrations of low-density lipoprotein cholesterol and higher triglycerides is also likely to be the same in the other South Asian countries [106]. The prevalence of hypercholesterolemia varies across the South Asian countries [107]. The highest reported was 37.4% for Indian men [20], whereas the lowest prevalence reported was 2.8% for Bangladeshi men [61]. Sri Lankan [108] and Pakistani [63] men showed the prevalence of 12.6% for hypercholesterolemia. In Bhutan, the percentage with raised total cholesterol (⩾5.0 mmol/l or ⩾190 mg/dl) was 44.3% and the percentage with raised total cholesterol (⩾6.2 mmol/l or ⩾240 mg/dl) was 9.2% [47]. Among the Maldivian population, 54.4% had hypercholesterolemia (⩾5.2 mmol/dl), and 22.1% had hypertriglyceridemia (⩾1.73 mmol/dl) [48]. Among men, 41.1% had low-density lipoprotein cholesterol levels of <1.04 mmol/dl. Among women, 56.3% had low-density lipoprotein cholesterol levels of <1.30 mmol/dl [48].

CVD AND RISK FACTORS AMONG IMMIGRANTS FROM SOUTH ASIA

The trends observed for CVD and its risk factors within the South Asian countries have been observed in migrant populations of South Asians origins as well [109−116]. Multiple studies indicate that the South Asian immigrants experience a disproportionately larger burden of CVD and are at higher risk of mortality compared with native populations [116,117]. In the United Kingdom, men and women from many parts of South Asia have markedly higher mortality from CHD than what is seen in the general population [118]. South Asians in the United Kingdom have more elevated risk-factor levels compared with their siblings living in India [119]. In Canada, higher rates of CVD are observed among South Asian immigrants compared with people with European ethnic backgrounds [113]. The encouraging news, however, is that in the United Kingdom and Canada, although the CHD mortality rate of South Asians compared with other populations remains high, a decline in CHD rates has been observed over the past 10 years [120,121]. These data suggest that the high rates of CHD with economic changes are reversible and perhaps even avoidable [122]. Lessons learned

from migrant South Asians may be helpful in developing prevention strategies for South Asian countries.

SUMMARY

In South Asian populations, similar to other developing countries, CVD is already an important cause of morbidity and a leading contributor to mortality. Projections indicate that the scenario may become more alarming. Prevention and control activities for hypertension, obesity, and dyslipidemia in South Asian countries are important for the reduction of CVD. Prevention of smoking is also an important strategy for reducing CVD in the South Asian countries, especially for men. Recent Westernization in South Asian countries has led to an increase in fat consumption followed by an increase in serum total cholesterol and the promotion of a sedentary lifestyle with less physical work required in general. The prevalence of obesity is also increasing, especially among the affluent section of the society, which is also rapidly increasing. This might also cause an increase in the prevalence of diabetes, glucose intolerance, and metabolic disorders. Similar to the rest of the world, management of these conventional risk factors is very important for the prevention of CVD in South Asia.

REFERENCES

1. Omran A. Epidemiologic transition. In: Ross JA, editor. International encyclopedia of population. London: The Free Press; 1982. p. 172–83.
2. Omran AR. The epidemiologic transition: a theory of the epidemiology of population change. Milbank Mem Fund Q 1971;49:509–38.
3. WHO Statistical Information System. Causes of death. Mortality and health status. WHO Data and Statistics. Available at: http://www.who.int/research/en/. Accessed February 21, 2011.
4. Ueshima H. Explanation for the Japanese paradox: prevention of increase in coronary heart disease and reduction in stroke. J Atheroscler Thromb 2007;14:278–86.
5. Ueshima H. Trend in Asia. In: Marmot M, Elliott P, editors. Coronary heart disease epidemiology: from aetiology to public health. New York, NY: Oxford University Press; 2005. p. 102–12.
6. Ueshima H, Sekikawa A, Miura K, et al. Cardiovascular disease and risk factors in Asia: a selected review. Circulation 2008;118:2702–9.
7. Murray JL, Lopez AD. The global burden of disease: a comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020. Boston, MA: The Harvard School of Public Health; 1996.
8. Pakistan Stroke Society. How many stroke patients are there in Pakistan? Available at: http://www.pakstroke.com. Accessed April 14, 2011.
9. Jafar T. Blood pressure, diabetes, and increased dietary salt associated with stroke—results from a community-based study in Pakistan. J Hum Hypertens 2005;20:83–5.
10. Vohra EA, Ahmed WU, Ali M. Aetiology and prognostic factors of patients admitted for stroke. J Pak Med Assoc 2000;50:234–6.
11. Aho K, Harmsen P, Hatano S, et al. Cerebrovascular disease in the community: results of a WHO collaborative study. Bull World Health Organ 1980;58:113–30.
12. Saha SP, Bhattacharya S, Das SK, et al. Epidemiological study of neurological disorders in a rural population of Eastern India. J Indian Med Assoc 2003;101:299–304.
13. Banerjee T, Mukherjee C, Sarkhel A. Stroke in the urban population of Calcutta: an epidemiological study. Neuroepidemiology 2000;20:201–7.
14. Gourie-Devi M, Gururaj G, Satishchandra P, Subbakrishna D. Prevalence of neurological disorders in Bangalore, India: a community-based study with a comparison between urban and rural areas. Neuroepidemiology 2004;23:261–8.
15. Das SK, Banerjee TK, Biswas A, et al. A prospective community-based study of stroke in Kolkata, India. Stroke 2007;38:906–10.
16. Dalal P, Malik S, Bhattacharjee M, et al. Population-based stroke survey in Mumbai, India: incidence and 28-day case fatality. Neuroepidemiology 2008;31:254–61.
17. Bhalla D, Marin B, Preux PM. Stroke profile in Afghanistan and Nepal. Neurol Asia 2009;14:87–94.
18. Janus ED, Postiglione A, Singh RB, Lewis B. The modernization of Asia: implications for coronary heart disease. Circulation 1996;94: 2671–3.
19. Singh RB, Sharma JP, Rastogi V, et al. Prevalence of coronary artery disease and coronary risk factors in rural and urban populations of north India. Eur Heart J 1997;18:1728–35.
20. Gupta R, Gupta V, Sarna M, et al. Prevalence of coronary heart disease and risk factors in an urban Indian population: Jaipur Heart Watch-2. Indian Heart J 2002;54:59–66.
21. Raman Kutty V, Balakrishnan K, Jayasree A, Thomas J. Prevalence of coronary heart disease in the rural population of Thiruvananthapuram district, Kerala, India. Int J Cardiol 1993;39:59–70.
22. Chadha S, Radhakrishnan S, Ramachandran K, et al. Epidemiological study of coronary heart disease in urban population of Delhi. Indian J Med Res 1990;92:424–30.
23. Gupta R, Prakash H, Gupta V, Gupta K. Prevalence and determinants of coronary heart disease in a rural population of India. J Clin Epidemiol 1997;50:203–9.
24. Malik A. Congenital and acquired heart diseases (a survey of 7062 persons). Bangladesh Med Res Counc Bull 1974;2:115–8.
25. Zaman MM, Ahmed J, Choudhury SR, Numan SM, Parvin K, Islam MS. Prevalence of ischemic heart disease in a rural population of Bangladesh. Indian Heart J 2007;59:239–41.
26. Vaidya A, Pokharel P, Nagesh S, et al. Prevalence of coronary heart disease in the urban adult males of eastern Nepal: a population-based analytical cross-sectional study. Indian Heart J 2009;61:341–7.
27. Vaidya A. Need for community-based primary prevention of coronary heart disease in Nepal. Kathmandu Univ Med J 2009;6:435–6.
28. Shinton R, Beevers G. Meta-analysis of relation between cigarette smoking and stroke. BMJ 1989;298:789.
29. Ueshima H, Choudhury SR, Okayama A, et al. Cigarette smoking as a risk factor for stroke death in Japan: NIPPON DATA80. Stroke 2004;35:1836–41.
30. Teo KK, Ounpuu S, Hawken S, et al. Tobacco use and risk of myocardial infarction in 52 countries in the INTERHEART study: a case—control study. Lancet 2006;368:647–58.
31. Chobanian AV, Bakris GL, Black HR, et al. Seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure. Hypertension 2003;42:1206–52.
32. Lida M, Ueda K, Okayama A, et al. Impact of elevated blood pressure on mortality from all causes, cardiovascular diseases, heart disease and stroke among Japanese: 14 year follow-up of randomly selected population from Japanese—NIPPON DATA80. J Hum Hypertens 2003; 17:851–7.
33. Whelton PK, Jiang H, Appel LJ, et al. Primary prevention of hypertension: clinical and public health advisory from the National High Blood Pressure Education Program. JAMA 2002;288:1882–8.
34. Hubert HB, Feinleib M, McNamara PM, Castelli WP. Obesity as an independent risk factor for cardiovascular disease: a 26-year follow-up of participants in the Framingham Heart Study. Circulation 1983; 67:968–77.
35. Larsson B, Svärdsudd K, Welin L, et al. Abdominal adipose tissue distribution, obesity, and risk of cardiovascular disease and death: 13 year follow up of participants in the study of men born in 1913. Br Med J 1984;288:1401–4.
36. Lakka HM, Laaksonen DE, Lakka TA, et al. The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men. JAMA 2002;288:2709–16.

37. Kadota A, Hozawa A, Okamura T, et al. Relationship between metabolic risk factor clustering and cardiovascular mortality stratified by high blood glucose and obesity: NIPPON DATA90, 1990—99. Diabetes Care 2007;30:1533–8.

38. Franco OH, De Laet C, Peeters A, Jonker J, Mackenbach J, Nusselder W. Effects of physical activity on life expectancy with cardiovascular disease. Arch Intern Med 2005;165:2355–60.

39. Thompson PD, Buchner D, Pina IL, et al. Exercise and physical activity in the prevention and treatment of atherosclerotic cardiovascular disease: a statement from the Council on Clinical Cardiology (Subcommittee on Exercise, Rehabilitation, and Prevention) and the Council on Nutrition, Physical Activity, and Metabolism (Subcommittee on Physical Activity). Circulation 2003;107:3109–16.

40. Yusuf S, Hawken S, Ôunpuu S, et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case—control study. Lancet 2004;364:937–52.

41. Joshi P, Islam S, Pais P, et al. Risk factors for early myocardial infarction in South Asians compared with individuals in other countries. JAMA 2007;297:286–94.

42. Uddin MJ, Mondol BA, Ahmed S, Ullah A, Jabbar M, Mohammad QD. Smoking and ischemic stroke. Bangladesh J Neurosci 2009;24:50–4.

43. Reddy K. The emerging epidemic of cardiovascular disease in India. In: Shetty PS, Gopalan C, editors. Diet, nutrition and chronic disease: an Asian perspective. Bedford, UK: Smith-Gordon; 1998. p. 50–4.

44. Popkin BM. The nutrition transition and obesity in the developing world. J Nutr 2001;131:871S–3S.

45. Drewnowski A, Popkin BM. The nutrition transition: new trends in the global diet. Nutr Rev 1997;55:31–43.

46. Lang T. The public health impact of globalisation of food trade. In: Shetty P, McPherson K, editors. Diet, nutrition and chronic disease: lessons from contrasting worlds. London: John Wiley; 1997. p. 73–87.

47. Royal Government of Bhutan. Report on 2007 STEPS survey for risk factors and prevalence of noncommunicable diseases. Ministry of Health, Thimphu, 2004. Available at: http://www.health.gov.bt/reports/.

48. Aboobakur M, Latheef A, Mohamed AJ, et al. Surveillance for noncommunicable disease risk factors in Maldives: results from the first STEPS survey in Male. Int J Public Health 2010;55:489–96.

49. Yusuf S, Reddy S, Ounpuu S, Anand S. Global burden of cardiovascular diseases: part I: general considerations, the epidemiologic transition, risk factors, and impact of urbanization. Circulation 2001; 104:2746–53.

50. Reddy KS, Prabhakaran D, Jeemon P, et al. Educational status and cardiovascular risk profile in Indians. Proc Natl Acad Sci U S A 2007; 104:16263–8.

51. Rodgers A, Lawes C, MacMahon S. Reducing the global burden of blood pressure-related cardiovascular disease. J Hypertens 2000;18:S3–6.

52. Gupta R, Al-Odat N, Gupta V. Hypertension epidemiology in India: meta-analysis of fifty-year prevalence rates and blood pressure trends. J Hum Hypertens 1996;10:465–72.

53. Gupta R. Trends in hypertension epidemiology in India. J Hum Hypertens 2004;18:73–8.

54. Gupta R, Guptha S, Gupta VP, Prakash H. Prevalence and determinants of hypertension in the urban population of Jaipur in western India. J Hypertens 1995;13:1193–200.

55. Joseph A, Kutty V, Soman C. High risk for coronary heart disease in Thiruvananthapuram city: a study of serum lipids and other risk factors. Indian Heart J 2000;52:29–35.

56. Anand MP. Prevalence of hypertension amongst Mumbai executives. J Assoc Physicians India 2000;48:1200–1.

57. Gupta R, Sharma A. Prevalence of hypertension and subtypes in an Indian rural population: clinical and electrocardiographic correlates. J Hum Hypertens 1994;8:823–9.

58. Mohan V, Deepa R, Shanthi Rani S, Premalatha G. Prevalence of coronary artery disease and its relationship to lipids in a selected population in South India. J Am Coll Cardiol 2001;38:682–7.

59. Islam N, Khan M, Latif Z. Hypertension in the rural population of Bangladesh: a preliminary survey. Bangladesh Med Res Counc Bull 1983;9:11–4.

60. Abu Sayeed M, Banu A, Khan AR, Hussain M. Prevalence of diabetes and hypertension in a rural population of Bangladesh. Diabetes Care 1995;18:555–8.

61. Zaman MM, Choudhury SR, Ahmed J, et al. Plasma lipids in a rural population of Bangladesh. Eur J Cardiovasc Prev Rehabil 2006;13:444–8.

62. Sayeed M, Banu A, Haq J, et al. Prevalence of hypertension in Bangladesh: effect of socioeconomic risk factor on difference between rural and urban community. Bangladesh Med Res Counc Bull 2002;28:7–18.

63. Pakistan Medical Research Council. National Health Survey of Pakistan in health profile of the people of Pakistan—1990—94. Islamabad, Pakistan: Pakistan Medical Research Council, Network Publication Service; 1998.

64. Jafar TH, Levey AS, Jafary FH, et al. Ethnic subgroup differences in hypertension in Pakistan. J Hypertens 2003;21:905–12.

65. Safdar S, Omair A, Faisal U, Hasan H. Prevalence of hypertension in a low income settlement of Karachi, Pakistan. J Pak Med Assoc 2004;54:506–8.

66. Wijewardene K, Mohideen M, Mendis S, et al. Prevalence of hypertension, diabetes and obesity: baseline findings of a population based survey in four provinces in Sri Lanka. Ceylon Med J 2010;50:62–70.

67. Pandey MR, Upadhyaya LR, Dhungel S, et al. Prevalence of hypertension in a rural community in Nepal. Indian Heart J 1981;33:284–9.

68. Pandey M. Hypertension in Nepal. Bibl Cardiol 1987;42:68–76.

69. Pandey MR, Dhungel S. Relation of prevalence of systemic hypertension with salt intake. J Nepal Med Assoc 1982;3:19–32.

70. Sharma D, Man B, Rajbhandari S, et al. Study of prevalence, awareness, and control of hypertension in a suburban area of Kathmandu, Nepal. Indian Heart J 2006;58:34–7.

71. Vaidya A, Pokharel P, Karki P, Nagesh S. Exploring the iceberg of hypertension: a community based study in an eastern Nepal town. Kathmandu Univ Med J 2007;5:349–59.

72. Royal Government of Bhutan. Annual Health Bulletin 2010. Ministry of Health, Thimphu, 2010. Available at: http://www.health.gov.bt/bulletin.php/. Accessed March 11, 2011.

73. WHO. Impact of tobacco related illnesses in Bangladesh. Bangladesh: WHO Bangladesh. Available at: http://www.who.int/tobacco/research/economics/publications/FinalReport5Jan05.pdf; 2005. Accessed March 12, 2011.

74. WHO. Global adult tobacco survey: Bangladesh report 2009. Bangladesh: WHO Country Office for Bangladesh; 2009.

75. WHO. Surveillance of chronic disease: risk factors: country-level data and comparable estimates (SuRF reports 2). Bangladesh: WHO; 2005.

76. Rani M, Bonu S, Jha P, Nguyen S, Jamjoum L. Tobacco use in India: prevalence and predictors of smoking and chewing in a national cross sectional household survey. Tob Control 2003; 12:e4.

77. Ahmad K, Jafary F, Jehan I, et al. Prevalence and predictors of smoking in Pakistan: results of the National Health Survey of Pakistan. J Cardiovasc Risk 2005;12:203–8.

78. Pandey MR, Shrestha NK, Upadhyaya AB, Neupane RP. Prevalence of smoking in a rural community of Nepal. World Smoking Health 1981;6:14–8.

79. Pandey M, Venkatramaiah S, Neupane R, Gautam A. Epidemiological study of tobacco smoking behaviour among young people in a rural community of the hill region of Nepal with special reference to attitude and beliefs. J Public Health 1987; 9:110–20.

80. Pandey M, Neupane R, Gautam A. Epidemiological study of tobacco smoking behaviour among adults in a rural community of the hill region of Nepal with special reference to attitude and beliefs. Int J Epidemiol 1988;17:535–41.

81. The Tobacco Atlas. Prevalence and health. Geneva, Switzerland: WHO; 2002. Available at: http://www.who.int/tobacco/statistics/tobacco_atlas/en/. Accessed March 11, 2011.

82. Katulanda P, Wickramasinghe K, Mahesh JG, et al. Prevalence and correlates of tobacco smoking in Sri Lanka. Asia Pac J Public Health 2011;23:861–9.

83. Perera B, Fonseka P, Ekanayake R, Lelwala E. Smoking in adults in Sri Lanka: prevalence and attitudes. Asia Pac J Public Health 2005;17:40–5.

84. Ramachandran A, Jali MV, Mohan V, et al. High prevalence of diabetes in an urban population in south India. BMJ 1988;297:587–90.

85. Ramachandran A, Snehalatha C, Latha E, et al. Rising prevalence of NIDDM in an urban population in India. Diabetologia 1997;40:232–7.

86. Ramaiya KL, Kodali V, Alberti K. Epidemiology of diabetes in Asians of the Indian subcontinent. Diabetes Metab Rev 1990;6:125–46.

87. Ramachandran A, Snehalatha C, Kapur A, et al. High prevalence of diabetes and impaired glucose tolerance in India: National Urban Diabetes Survey. Diabetologia 2001;44:1094–101.

88. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995—2025: prevalence, numerical estimates, and projections. Diabetes Care 1998;21:1414–31.

89. Shera A, Rafique G, Khwaja I, et al. Pakistan national diabetes survey: prevalence of glucose intolerance and associated factors in Shikarpur, Sindh Province. Diabet Med 1995;12:1116–21.

90. Shera AS, Rafique G, Khwaja IA, et al. Pakistan National Diabetes Survey prevalence of glucose intolerance and associated factors in North West at Frontier Province (NWFP) of Pakistan. J Pak Med Assoc 1999;49:206–11.

91. Shera AS, Rafique G, Khawaja IA, et al. Pakistan National Diabetes Survey: prevalence of glucose intolerance and associated factors in Baluchistan province. Diabetes Res Clin Pract 1999;44:49–58.

92. Shera AS, Basit A, Fawwad A, et al. Pakistan National Diabetes Survey: prevalence of glucose intolerance and associated factors in the Punjab Province of Pakistan. Prim Care Diabetes 2010;4:79–83.

93. Akhter J. The burden of diabetes in Pakistan: the national diabetes survey. Medicine (Baltimore) 1997;14:S7–84.

94. Abu Sayeed M, Banu A, Khan AR, Hussain MZ. Prevalence of diabetes and hypertension in a rural population of Bangladesh. Diabetes Care 1995;18:555–8.

95. Rahim M, Hussain A, Azad Khan A, et al. Rising prevalence of type 2 diabetes in rural Bangladesh: a population based study. Diabetes Res Clin Pract 2007;77:300–5.

96. Mahtab H, Ibrahim M, Banik N. Diabetes detection survey in a rural and a semiurban community in Bangladesh. Tohoku J Exp Med 1983;141:211–7.

97. Sayeed MA, Mahtab H, Khanam PA, et al. Diabetes and impaired fasting glycemia in a rural population of Bangladesh. Diabetes Care 2003;26:1034–9.

98. Hussain A, Rahim M, Azad Khan A, et al. Type 2 diabetes in rural and urban population: diverse prevalence and associated risk factors in Bangladesh. Diabet Med 2005;22:931–6.

99. Sayeed MA, Mahtab H, Khanam PA, et al. Diabetes and impaired fasting glycemia in the tribes of Khagrachari hill tracts of Bangladesh. Diabetes Care 2004;27:1054–9.

100. Shrestha U, Singh D, Bhattarai M. The prevalence of hypertension and diabetes defined by fasting and 2 h plasma glucose criteria in urban Nepal. Diabet Med 2006;23:1130–5.

101. Singh D, Bhattarai M. High prevalence of diabetes and impaired fasting glycaemia in urban Nepal. Diabet Med 2003;20:170–1.

102. Ono K, Limbu YR, Rai SK, et al. The prevalence of type 2 diabetes mellitus and impaired fasting glucose in semi-urban population of Nepal. Nepal Med Coll J 2007;9:154–6.

103. Stamler J, Elliott P, Appel L, et al, for the INTERMAP Research Group. Higher blood pressure in the middle-aged American adults with less education—role of multiple dietary factors: the INTERMAP study. J Hum Hypertens 2003;17:665–775.

104. Pierce BL, Kalra T, Argos M, et al. A prospective study of body mass index and mortality in Bangladesh. Int J Epidemiol 2010;39:1037–45.

105. Ramachandran A, Snehalatha C, Satyavani K, et al. Metabolic syndrome in urban Asian Indian adults: a population study using modified ATP III criteria. Diabetes Res Clin Pract 2003;60:199–204.

106. Ghaffar A, Reddy KS, Singhi M. Burden of non-communicable diseases in South Asia. BMJ 2004;328:807–10.

107. Nishtar S. Prevention of coronary heart disease in south Asia. Lancet 2002;360:1015–8.

108. Mendis S, Ekanayake E. Prevalence of coronary heart disease and cardiovascular risk factors in middle aged males in a defined population in central Sri Lanka. Int J Cardiol 1994;46:135–42.

109. McKeigue P, Miller G, Marmot M. Coronary heart disease in south Asians overseas: a review. J Clin Epidemiol 1989;42:597–609.

110. Shaukat N, de Bono DP. Are Indo-origin people especially susceptible to coronary artery disease? Postgrad Med J 1994;70:315–8.

111. Enas EA, Yusuf S, Mehta JL. Prevalence of coronary artery disease in Asian Indians. Am J Cardiol 1992;70:945–9.

112. Bhopal R, Unwin N, White M, et al. Heterogeneity of coronary heart disease risk factors in Indian, Pakistani, Bangladeshi, and European origin populations: cross sectional study. BMJ 1999;319:215–20.

113. Anand SS, Yusuf S, Vuksan V, 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.

114. Balarajan R. Ethnic differences in mortality from ischaemic heart disease and cerebrovascular disease in England and Wales. BMJ 1991;302:560–4.

115. Kamath SK, Hussain EA, Amin D, et al. Cardiovascular disease risk factors in 2 distinct ethnic groups: Indian and Pakistani compared with American premenopausal women. Am J Clin Nutr 1999;69:621–31.

116. Bhopal R, Rahemtulla T, Sheikh A. Persistent high stroke mortality in Bangladeshi populations. BMJ 2005;331:1096–7.

117. Klatsky A, Tekawa I, Armstrong M, Sidney S. The risk of hospitalization for ischemic heart disease among Asian Americans in northern California. Am J Public Health 1994;84:1672–5.

118. Wild S, McKeigue P. Cross sectional analysis of mortality by country of birth in England and Wales, 1970—92. BMJ 1997;314:705–10.

119. Patel D, Winterbotham M, Britt R, et al. Coronary risk factors in people from the Indian subcontinent living in West London and their siblings in India. Lancet 1995;345:405–9.

120. Balarajan R. Ethnicity and variations in mortality from coronary heart disease. Health Trends 1996;28:45–51.

121. Sheth T, Nair C, Nargundkar M, et al. Cardiovascular and cancer mortality among Canadians of European, south Asian and Chinese origin from 1979 to 1993: an analysis of 1.2 million deaths. Can Med Assoc J 1999;161:132–8.

122. Yusuf S, Reddy S, Ounpuu S, Anand S. Global burden of cardiovascular diseases: part II: variations in cardiovascular disease by specific ethnic groups and geographic regions and prevention strategies. Circulation 2001;104:2855–64.