

**STATE-OF-THE-ART REVIEW**

# Epidemiological Features of Cardiovascular Disease in Asia



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**ABSTRACT**

Cardiovascular disease (CVD) is the leading cause of death in Asia. To combat the harmful impacts of CVD on public health in Asian countries with more effective strategies and actions, it is crucial to understand the current epidemiologic features of CVD in Asia. Through a systematic study and analysis of various timely data on CVD epidemiology in Asian countries from multiple sources, this state-of-the-art review provides an overview of the important epidemiologic features of CVD in Asia. Current and future challenges in CVD prevention implied by the epidemiologic features in Asian countries are highlighted and discussed in this review. (JACC: Asia 2021;1:1-13) © 2021 The Author. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Despite progress in the availability of effective and safe prevention strategies worldwide, cardiovascular disease (CVD) remains the leading cause of death and premature death globally (1). Among the 18.6 million CVD deaths worldwide in 2019, 58% occurred in Asia (2). As the continent with the largest population and greatest diversity of ethnicities, cultures, socioeconomic status, and health care systems, Asia faces many challenges in CVD prevention and treatment. Timely information on the burdens and epidemiological features of CVD in Asian countries is crucial to understanding the challenges and orienting the development of reasonable policies, strategies, and actions to combat the CVD epidemic. Thus, the aim of this review article was to identify and summarize the key features of the CVD epidemic and highlight the challenges that they create with respect to CVD prevention in Asian countries.

The data presented in this review are mainly drawn from 4 sources. The first data source is the open database of the GBD (Global Burden of Disease) study in the Global Health Data Exchange of The

Institute for Health Metrics and Evaluation (2). This open database provides freely available information on the mortality rate, number, and proportion of deaths from various diseases at global, regional, and country levels by sex and age group. The details of relevant methodology and quality assessment are available on published papers or on the GBD study website (1-3). The second data source used is World Population Prospects 2019, a report by the Department of Economic and Social Affairs, Population Division of the United Nations (UN) (4). The Asian countries and geographic regions referred to in the present review are in accordance with the classifications of this UN official report. This official report provides demographic data for Asian countries by year. The third data source is World Health Statistics 2020, an updated report of the World Health Organization (5). Updated data for life expectancy at birth and comparable estimates of major CVD risk factors in Asian countries were extracted from this report. The final data source was the PubMed database, which was searched for relevant publications

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## ABBREVIATIONS AND ACRONYMS

**ASCVD** = atherosclerotic cardiovascular diseases

**BMI** = body mass index

**CMND** = communicable, maternal, neonatal, and nutritional diseases

**CVD** = cardiovascular disease

**DALYs** = disability-adjusted life-years

**GBD** = global burden of disease

**IHD** = ischemic heart disease

regarding CVD epidemiology in Asian regions or countries. Through the study of the available data and published reports, the following epidemiological features of CVD in Asia were identified.

### CVD IS THE LEADING CAUSE OF DEATH IN ASIA AND IS AN INCREASING EPIDEMIC

CVD was the leading cause of death in Asia in 2019, causing 10.8 million deaths, which were approximately 35% of the total deaths in Asia (2). Nearly 39% of these CVD deaths were premature (defined as the death of a person age <70 years). The proportion of premature deaths was notably higher than that of premature CVD deaths in the United States (23%), Europe (22%), and globally (34%). Most CVD deaths (87%) were due to ischemic heart disease (IHD) (47%) or stroke (40%) (2). From 1990 to 2019, the number of CVD deaths in Asia increased from 5.6 million to 10.8 million, the proportion of CVD deaths in total deaths increased from 23% to 35%, and crude CVD mortality rates increased continuously in both men and women (Figure 1A). Whereas the growing crude CVD mortality rates indicate the increasing burden of CVD in Asian populations, the fall in age-standardized CVD mortality (Figure 1B) implies that the trend in the crude mortality rate was driven mainly by demographic changes (2).

In addition to the impact of demographic changes, increasing CVD epidemics in Asia are likely the consequence of complex effects from changes in socioeconomics, living environments, lifestyles, prevalence of CVD risk factors, and capacities to prevent and treat CVD (6,7).

### DIFFERENCES IN THE CRUDE CVD MORTALITY RATE AMONG ASIAN REGIONS AND COUNTRIES

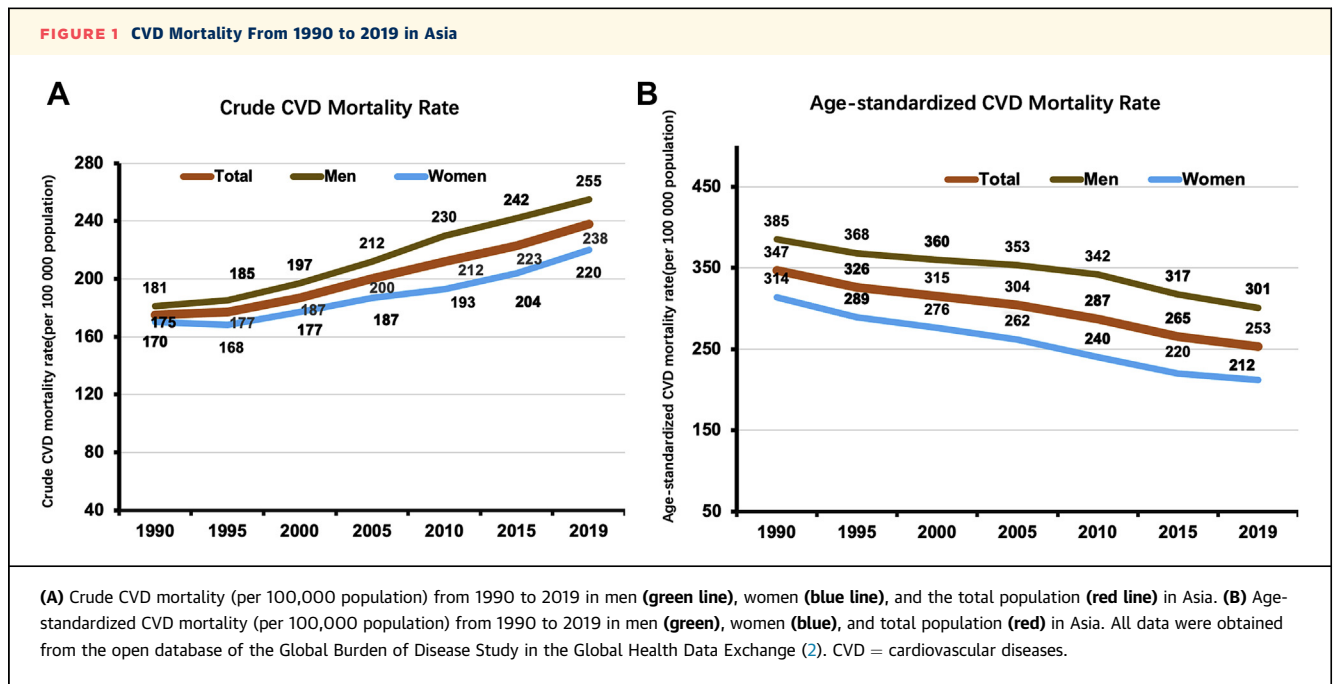
There were remarkable geographic differences in crude CVD mortality rates among Asian countries in 2019 (2). The reason for comparing crude CVD mortality rates instead of age-standardized CVD mortality rates was that comparisons of age-standardized CVD mortality rates among Asian countries would be at the expense of overestimating the CVD burdens and medical resource requirements in low-income or underdeveloped countries with lower proportions of older people than that in the standardized age structure and underestimating the CVD burdens and medical resource requirements in countries with larger proportions of older people than in the standardized age structure.

Crude CVD mortality rates in Asian countries by region are shown in the **Central Illustration**. The highest CVD mortality rate in Asia was in Georgia (810.7 per 100,000 population) and the lowest in Qatar (39.1 per 100,000 population), with a 20-fold difference between the highest and lowest rates. Whereas the CVD mortality rate varied among different countries within the same region, especially in Western Asia, CVD rates were generally higher in countries of Central and Eastern Asia than in Southern and Southeast Asia. The lowest CVD mortality rate in Central Asian countries was even higher than the highest mortality rate among countries of Southern Asia. The proportion of premature CVD deaths among total CVD deaths was substantially lower in high-income Asian countries, especially in Japan (11%) and Israel (15%), but was significantly higher in many low- and middle-income Asian countries. Differences in age-standardized CVD mortality among Asian regions have also been reported in several published studies (7-9).

### DOMINANT SUBTYPES OF CVD AMONG ASIAN REGIONS AND COUNTRIES

Whereas IHD and stroke are the most common causes of CVD in Asia in general, epidemics of these 2 types of CVD varied substantially among Asia regions and countries. IHD was the most dominant cause of CVD deaths in Central, Western, and Southern Asia, accounting for 62%, 60%, and 57% of CVD deaths, respectively, whereas stroke deaths were more common than IHD deaths in Eastern and Southeastern Asia (Figure 2) (2). There were marked differences between IHD mortality and stroke mortality in some Asian countries (Figure 3). For example, IHD mortality was approximately 7 times higher than stroke mortality in Lebanon and more than 3 times higher than stroke mortality in Armenia and Uzbekistan. However, stroke mortality was more than 1.5 times higher than IHD mortality in Myanmar, Vietnam, and North Korea. Data from a published report of the GBD Study showed a similar dominant subtype of CVD as the cause of premature CVD deaths in Asian countries (10). In China, the dominant subtype of CVD deaths has transitioned from stroke to IHD owing to a considerable decline in hemorrhagic stroke deaths and an increase in IHD deaths (11,12). However, the underlying cause of the differences in the dominant CVD subtypes among Asian regions or countries is not yet well understood.

Peripheral artery disease and heart failure are also considered important CVD subtypes owing to their increasing morbidities worldwide with harmful



outcomes (13,14). However, updated epidemiological data for these 2 subtypes of CVD in Asian countries are limited.

### CHARACTERISTICS OF THE TRANSITIONS IN CVD EPIDEMIOLOGY

The fundamentals of the theoretical framework of epidemiological transition are that the health status and characteristics of disease spectrums in different countries are linked to their socioeconomic environments (15-17). Therefore, the characteristics of disease spectrums in countries at different stages of economic development may feature different transition stages of the CVD epidemic. It is critical to recognize the characteristics of different transition stages of the CVD epidemic in different Asian countries to guide the identification of priority issues in public health, resource allocation, and research in these countries.

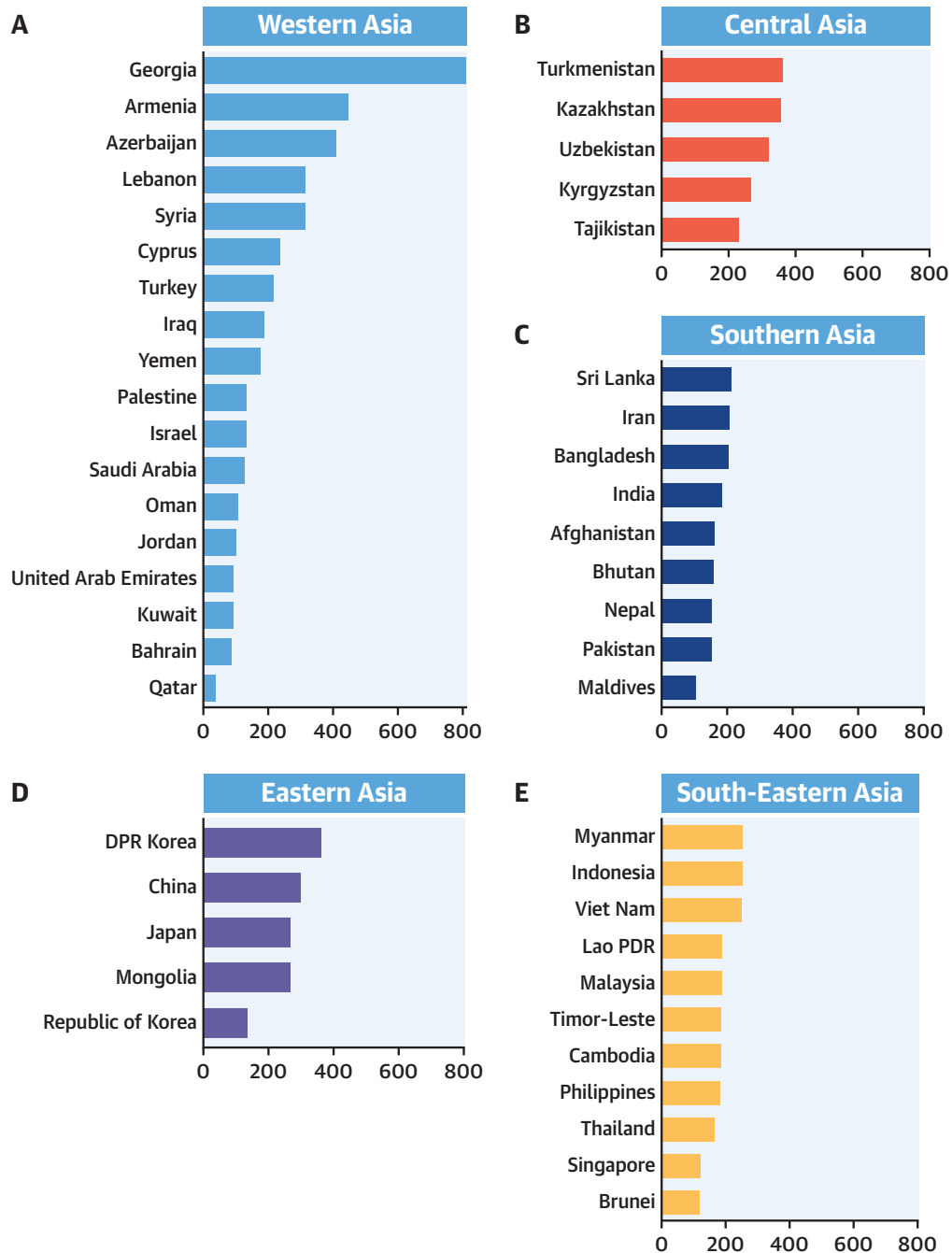
This review not only compares the characteristics of disease spectrums (ie, distributions of relevant disease categories in total deaths) but also CVD mortality rates, the proportions of premature CVD deaths in total CVD deaths, and life expectancies in Asian countries (2,5). The characteristics of different transition stages of the CVD epidemic are summarized in Table 1.

Characteristics of the first or early stage of the CVD epidemic were identified in lower-income countries such as India, Nepal, and Pakistan; these included

relatively lower CVD mortality rates and proportions of CVD among total deaths; a high proportion of premature CVD deaths among CVD deaths; deaths due to communicable, maternal, neonatal, and nutritional diseases (CMNND) close to or greater than CVD deaths; a much lower proportion of cancer deaths than CVD deaths; and very few deaths due to dementia (a degenerative disease) (2,5). Asian countries at this stage face the challenge of a double burden of CVD and CMNND (Table 1).

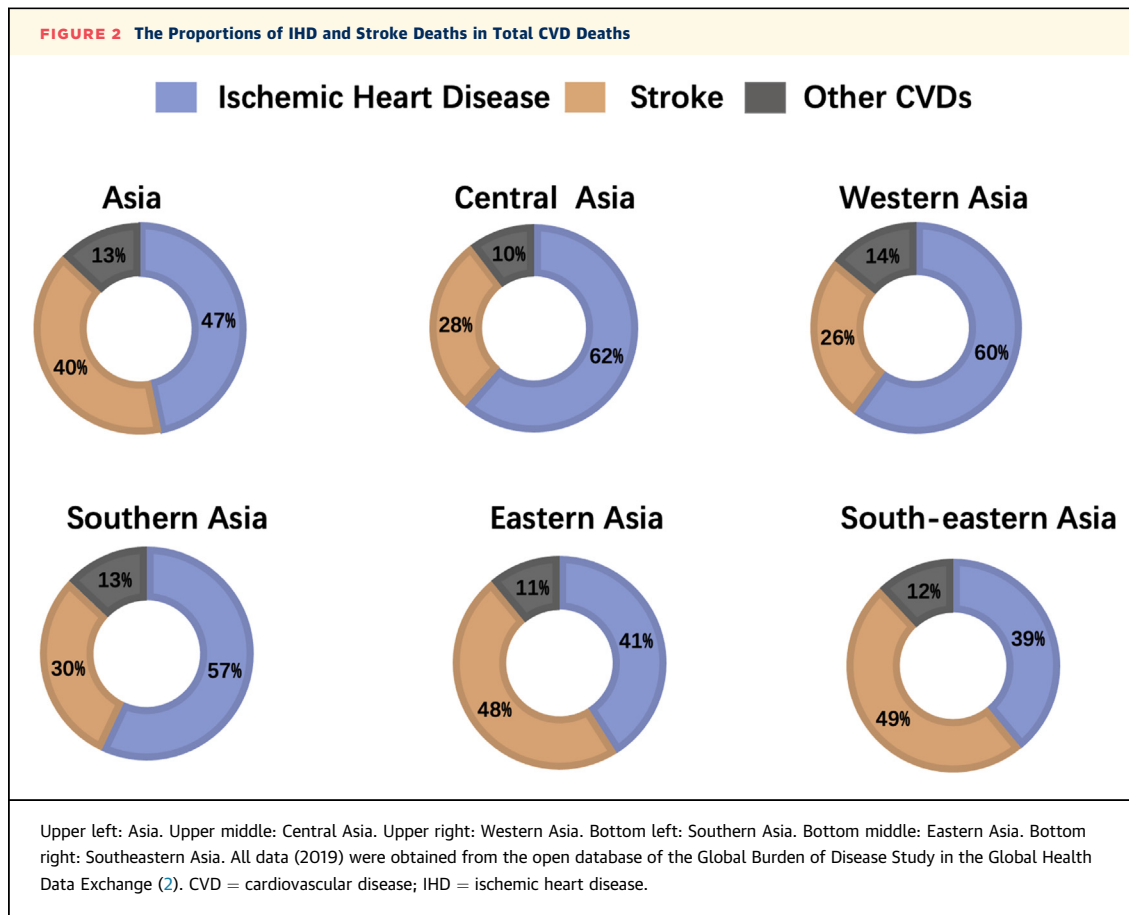
More Asian countries are in the second stage of the rapidly increasing CVD epidemic. In these countries (for example, Georgia, Azerbaijan, Uzbekistan, Turkmenistan, China, Mongolia), CVD mortality rates are quite high, with the proportion of CVD deaths among total deaths generally higher than 40%, fewer than 10% CMNND deaths, CVD deaths exceeding cancer deaths, and the proportions of total deaths due to dementias low or slightly higher than those of countries in the early stage (Table 1).

Characteristics of CVD epidemics in high-income or developed countries feature the third and most advanced stage of epidemiological transition, the stage of degenerative diseases. The disease pattern at this stage may imply the future pattern for countries currently in the early stage of CVD epidemic or in the stage of an increasing CVD epidemic. The third stage is characterized by further extension of life expectancy, lower proportions of CVD deaths, and low premature CVD deaths; cancer deaths become more dominant, and there is a marked increase in deaths

**CENTRAL ILLUSTRATION** Crude Cardiovascular Disease Mortality Rates in Asian Countries, by Region

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Crude CVD mortality rates (per 100,000 population) in (A) Western Asian countries, (B) Central Asian countries, (C) Southern Asian countries, (D) Eastern Asian countries, and (E) Southeastern Asian countries. All data (2019) were obtained from the open database of the Global Burden of Disease Study in the Global Health Data Exchange (2). CVD = cardiovascular diseases; DPR Korea = Democratic People's Republic of Korea (North Korea); Lao PDR = Lao People's Democratic Republic (Laos).



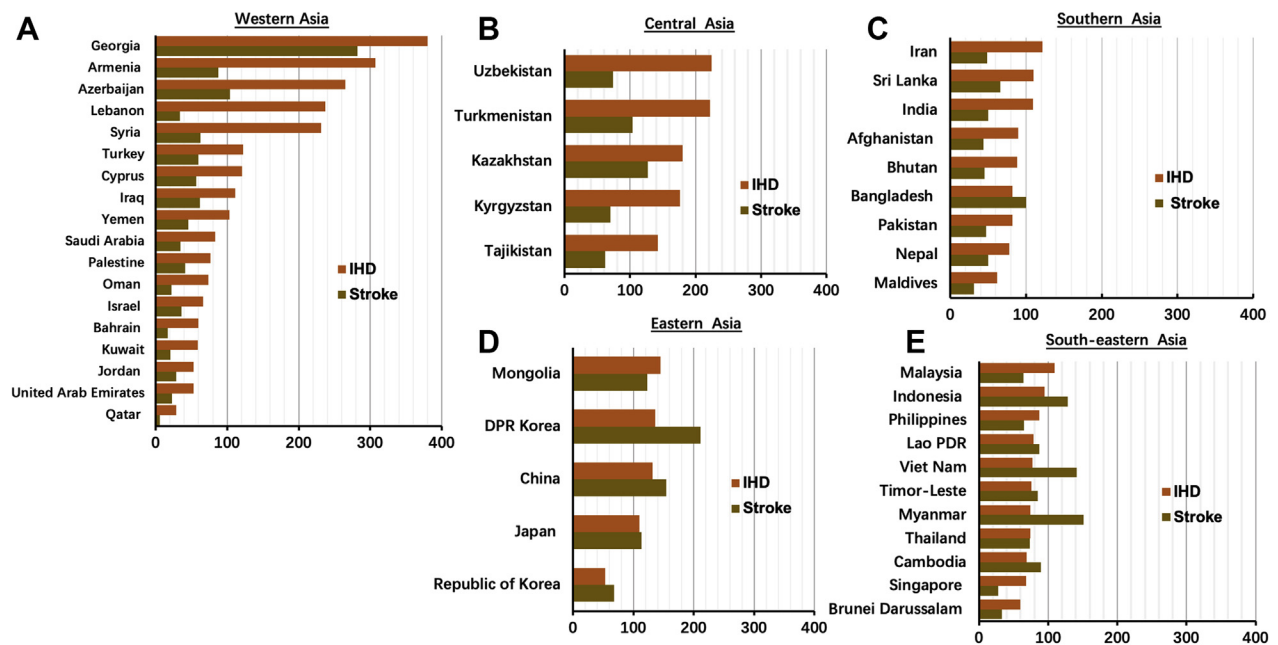
from dementias. Trajectories of the CVD epidemiologic transition from the characteristics of the rapidly increasing stage to the third stage could be observed in developed countries, such as Japan and South Korea, over a period of approximately 30 years. The respective proportions of CVD deaths among total deaths in Japan and South Korea were reduced from 34.9% and 36.2%, respectively, in 1990 to 26.6% and 24.3% in 2019, deaths from cancer increased from 29.9% and 20.4% in 1990 to 31.6% and 32.7% in 2019, and deaths due to dementia increased from 3.6% and 4.5% in 1990 to 11.8% and 5.8% in 2019 (2). Other traits of the epidemiologic transition of CVD in the third stage may include growing degenerative CVDs, increasing morbidity of heart failure, and rising prevalence of IHD and stroke owing to increasing survival rate and length in patients with these diseases. The observed characteristics of the CVD epidemics in different Asian countries are of long-term importance, not only in guiding current national policies and strategies in CVD prevention, but also in predicting future challenges.

### MAJOR DETERMINANTS OF CVD EPIDEMICS IN ASIA

As mentioned previously, the increasing CVD epidemics in Asia are the consequence of complex effects from interrelated changes in socioeconomics and living environments, demography, lifestyles, the prevalence of CVD risk factors, and the capacity to achieve CVD prevention and treatment goals.

The following risk factors are important determinants of CVD epidemics in Asia, both currently and in the future.

**DIETARY FACTORS.** An unhealthy diet is an important upstream risk factor for CVD in Asian countries. The transition in nutrition from traditional Asian diets to westernized diets has been observed in some Asian countries. A review article highlighted the characteristics of this nutrition transition in China and other low- to middle-income countries, which included increasing consumption of oil, animal-source foods, snacks, sugar and sugar-sweetened beverages, and declining consumption

**FIGURE 3** IHD Mortality Rates and Stroke Mortality in Asian Countries

Crude IHD and stroke mortality rates (per 100,000 population) in (A) Western Asian countries, (B) Central Asian countries, (C) Southern Asian countries, (D) Eastern Asian countries, and (E) Southeastern Asian countries. All data (2019) were obtained from the open database of the Global Burden of Disease Study in the Global Health Data Exchange (2). DPR Korea = Democratic People's Republic of Korea (North Korea); IHD = ischemic heart disease; Lao PDR = Lao People's Democratic Republic (Laos).

of coarse grains and legumes (18). A recent publication from the GBD Study provided comprehensive information on the consumption of major foods and nutrients in 195 countries across different continents and the potential impact of their suboptimal intake on CVD mortality and morbidity and on other non-communicable diseases (19). There were large gaps between current and optimal intake levels for 10 healthy foods and 5 unhealthy foods and nutrients in Asian regions. With respect to the 10 healthy foods or nutrients (fruit, vegetables, legumes, whole grains, nuts and seeds, milk, calcium, fiber, omega-3 fatty acids, and polyunsaturated fatty acids), Asian countries did not reach the optimal intake levels for all except vegetables in Central Asia and omega-3 fatty acid intake in Japan, South Korea, and Singapore. For the 5 unhealthy foods (red meat, processed meat, sugar-sweetened beverages, trans fats, and sodium), all Asian regions exceeded the optimal intakes of sugar-sweetened beverages and sodium, and countries in Eastern and Central Asia exceeded the optimal intake of red meat (19). Among the 21 GBD regions, countries in Central Asia had the highest rates of diet-related CVD deaths (613 per

100,000 population), and those in Eastern Asia had the highest age-standardized proportions of diet-related disability-adjusted life-years (DALYs) from CVD (64%). Among the 20 most populous countries worldwide, China had the highest age-standardized rate of diet-related CVD deaths (299 per 100,000 population) and Pakistan had the highest proportion of diet-related CVD deaths (60%) (19). Unlike Europe, it may be difficult to recommend a standard healthy dietary pattern in Asia because of the variety of dietary cultures and traditions in Asian countries and the lack of systematic and comparative evaluation and evidence. Some Asian countries have issued localized food-based dietary guidelines for their populations (20,21).

**SMOKING.** Although smoking has been recognized as a risk factor for CVD since the 1950s, smoking remains a highly prevalent risk factor that threatens cardiovascular health globally (22). World Health Statistics 2020 provides age-standardized smoking rates as combined estimates for men and women in most Asian countries (Figure 4) (5). According to the available data, the highest age-standardized smoking rate in Asian countries was in Myanmar (45.5%), and

**TABLE 1** Characteristics of Different Transition Stages of the CVD Epidemic in Selected Countries

Countries	CVD Mortality (per 100,000 Population)	Proportion of Total Deaths (%)				Proportion of Premature CVD Deaths (%)	Life Expectancy (y)
		CVD	CMNND	Cancer	Dementia		
Early stage of CVD epidemic							
India	185	27.4	25.0	9.9	1.4	50.6	68.8
Nepal	153	24.0	21.1	11.2	1.3	46.2	70.2
Pakistan	152	22.7	39.0	12.0	0.7	59.3	66.5
Stage of rapidly increasing CVD							
Georgia	811	60.1	2.8	16.8	3.5	23.8	72.6
Armenia	447	48.3	3.1	20.8	3.1	27.1	74.8
Azerbaijan	410	56.1	7.3	15.8	1.3	42.7	73.1
Turkmenistan	360	54.5	9.8	10.8	1.7	50.7	68.2
Kazakhstan	356	46.9	5.3	15.1	1.7	40.2	71.1
China	322	43.0	3.3	25.5	3.0	28.0	75.7
Lebanon	315	48.2	6.2	22.1	3.1	29.1	74.8
Mongolia	289	39.5	7.2	24.1	0.9	57.8	69.8
Stage of degenerative disease							
Japan	291	26.6	9.4	31.6	11.8	10.8	84.2
South Korea	145	24.3	6.7	32.7	5.8	18.4	82.7
Israel	133	25.9	5.4	30.5	5.8	15.1	82.3

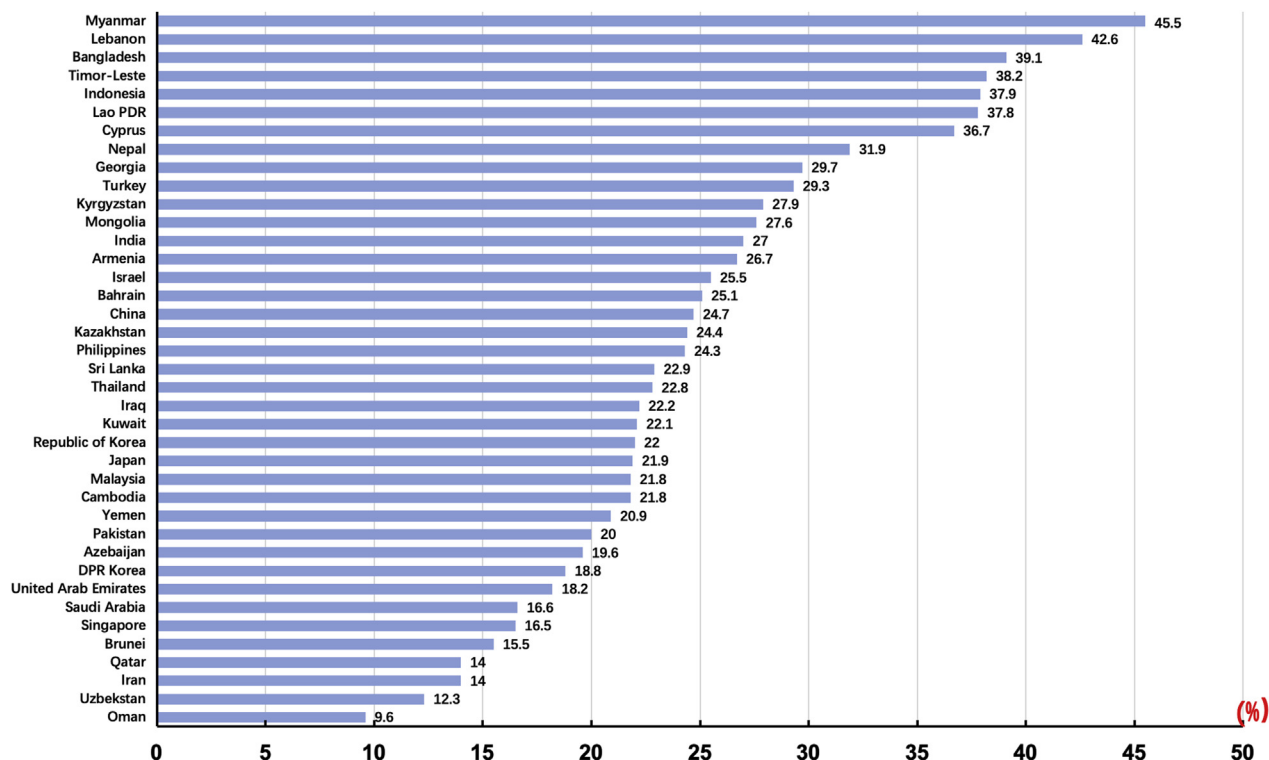
Data (2019) were obtained from the open database of the Global Burden of Disease Study in the Global Health Data Exchange and the World Health Statistics 2020 (2,5).  
 CVD = cardiovascular disease; CMNND = communicable diseases and maternal, neonatal, and nutritional diseases.

the lowest smoking rate was in Oman (9.6%). Among the 39 Asian countries with available data in this report, the smoking prevalence was more than 30% in 8 countries and more than 20% in 29 countries. However, because the male population has a much higher smoking prevalence than the female population in Asian countries, the combined estimates of smoking prevalence may underestimate the problem of smoking in men. Another global statistics report published in 2018 provides smoking prevalence for men and women separately by regions of the world (22). Based on data from this report, the global age-standardized prevalence of daily tobacco smoking was 25% in men and 5.4% in women. Eastern Europe had the highest age-standardized smoking prevalence in men (38.7%), followed by Southeastern Asia (37.7%) and Eastern Asia (37.1%). For women, Central Europe had the highest age-standardized smoking prevalence (19.2%); the prevalence of smoking was lower in Eastern and Central Asia (2.2% and 2.8%, respectively).

According to the GBD 2015 Risk Factors Collaborators report, smoking was the leading cause of DALYs in North Korea, Thailand, and Vietnam in 2015 and was 1 of the 5 leading causes of DALYs in many other Asian countries (23). A more recent meta-analysis regarding risk factors for CVD events in Asian populations reported that the risk of fatal CVD events in

smokers was 1.68 times higher than in nonsmokers (24). Furthermore, smokeless tobacco is popular in Southern and Southeastern Asian countries. The reported rate of smokeless tobacco use for men was 33% in India and 31% in Nepal; for women, this rate was 24% in Bangladesh and 18% in India (25). The association between smokeless tobacco use and CVD risk in Asian countries with high rates of smokeless tobacco use warrants further study.

**OBESITY.** Obesity is mainly a consequence of an unhealthy lifestyle and is an established risk factor for CVD and diabetes. World Health Statistics 2020 provides the age-standardized prevalence of obesity in most Asian countries (Figure 5) (5). Among the 47 Asian countries with available data, the age-standardized prevalence of obesity ranged from 37.9% in Kuwait to 2.1% in Vietnam, an 18-fold difference. The prevalence of obesity was higher mostly in Western Asian countries and was more than 30% in all Western Asian countries. The prevalence of obesity in Eastern, Southern, or Southeastern Asian countries was relatively lower. However, in India and China, this still accounts for large numbers of obese people because of the extremely large total populations of these countries. The NCD-RisC (Non-Communicable Disease Risk Factor Collaboration) study reported changes in body mass index (BMI) in 200 countries from 1975 to 2014 (26). In 1975, there

**FIGURE 4** Age-Standardized Prevalence of Smoking in Asian Countries (%)

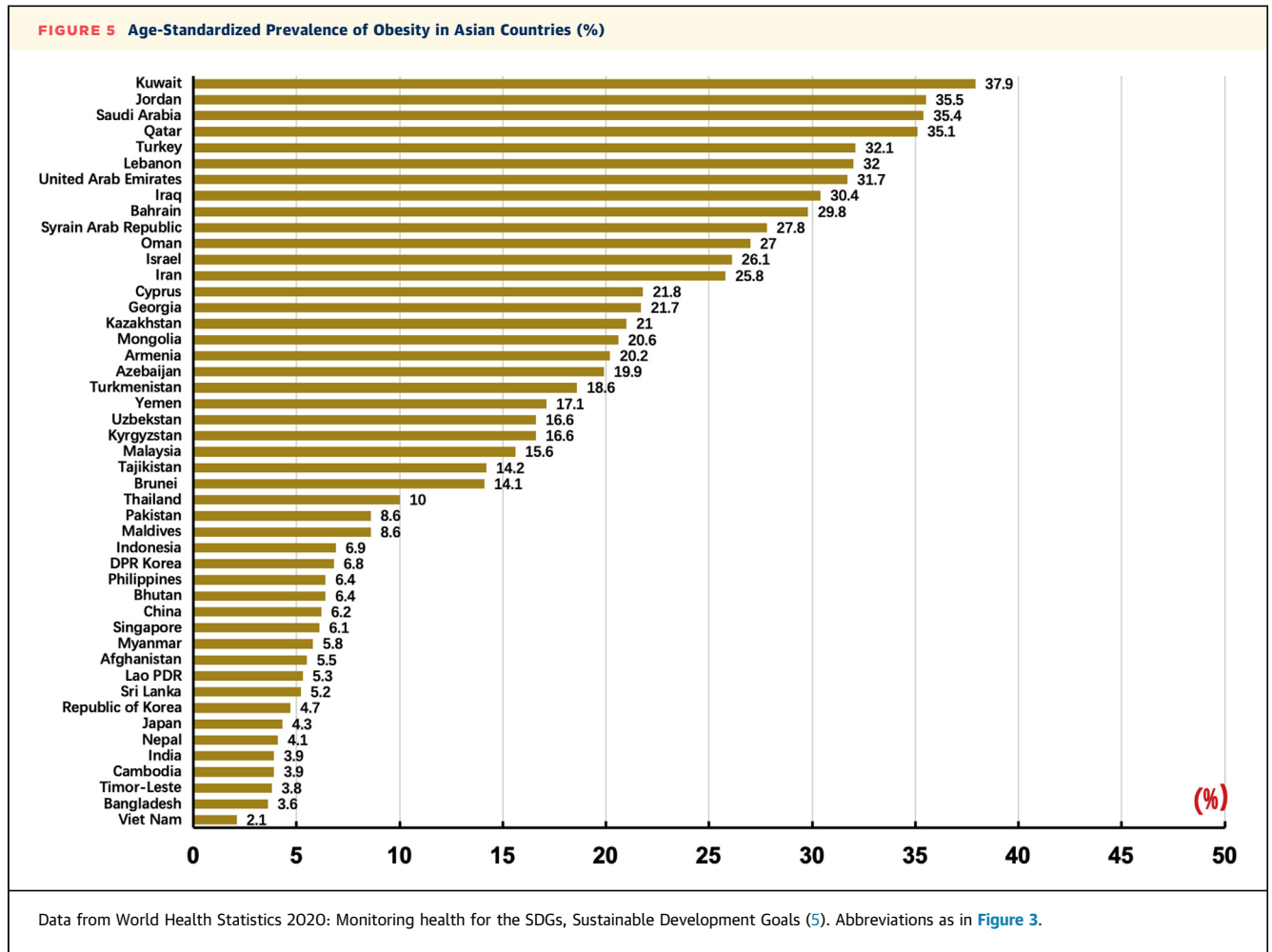
Data from World Health Statistics 2020: Monitoring health for the SDGs, Sustainable Development Goals (5). Abbreviations as in Figure 3.

were no or few Asian countries among the top 10 countries with the largest numbers of obese men and women. In 2014, China became the country with the largest number of people with obesity for both men (43.2 million) and women (46.4 million) (26). Comprehensive and pronounced lifestyle changes that have come about with economic development in China, India, and other developing countries are likely the main cause of the marked increases in obesity rates. However, it must be noted that the largest number of underweight people globally were also in Asian countries in 2014. A pooled analysis of prospective data from the Asian Cohort Consortium found that BMI had a U-shaped association with the risks of CVD death, IHD death, and stroke death among Asians. Increased CVD risks were associated with both lower and higher BMIs (27).

**HYPERTENSION.** Hypertension is highly prevalent and is responsible for the largest portion of CVD deaths in many Asian countries, especially those in which stroke is the dominant type of CVD (6,28,29). World Health Statistics 2020 provides the age-standardized

prevalence of hypertension for most Asian countries (5). This report showed that the age-standardized prevalence of hypertension in adults was more than 20% in 39 of 47 (83%) and was more than 25% in 23 of 47 (49%) Asian countries with available data. The highest age-standardized prevalence of hypertension was in Yemen in Western Asia (30.7%), and the lowest was in South Korea in Eastern Asia (11%) (Figure 6). Countries in Southern and Central Asia generally had a higher prevalence of hypertension than those in Eastern, Southeastern, and Western Asia (5). Although the age-standardized prevalence of hypertension provides comparable estimations, the prevalence underestimates the real burden of hypertension in some countries, especially those with aging populations. Some publications of country-based surveys, as well as a paper from the HOPE Asia (Hypertension, brain, cardiovascular and renal Outcomes Prevention and Evidence in Asia) Network have reported the real burdens of hypertension in some Asian countries. These reports show that the crude prevalence of hypertension was 28% in China, 29% in South Korea, and

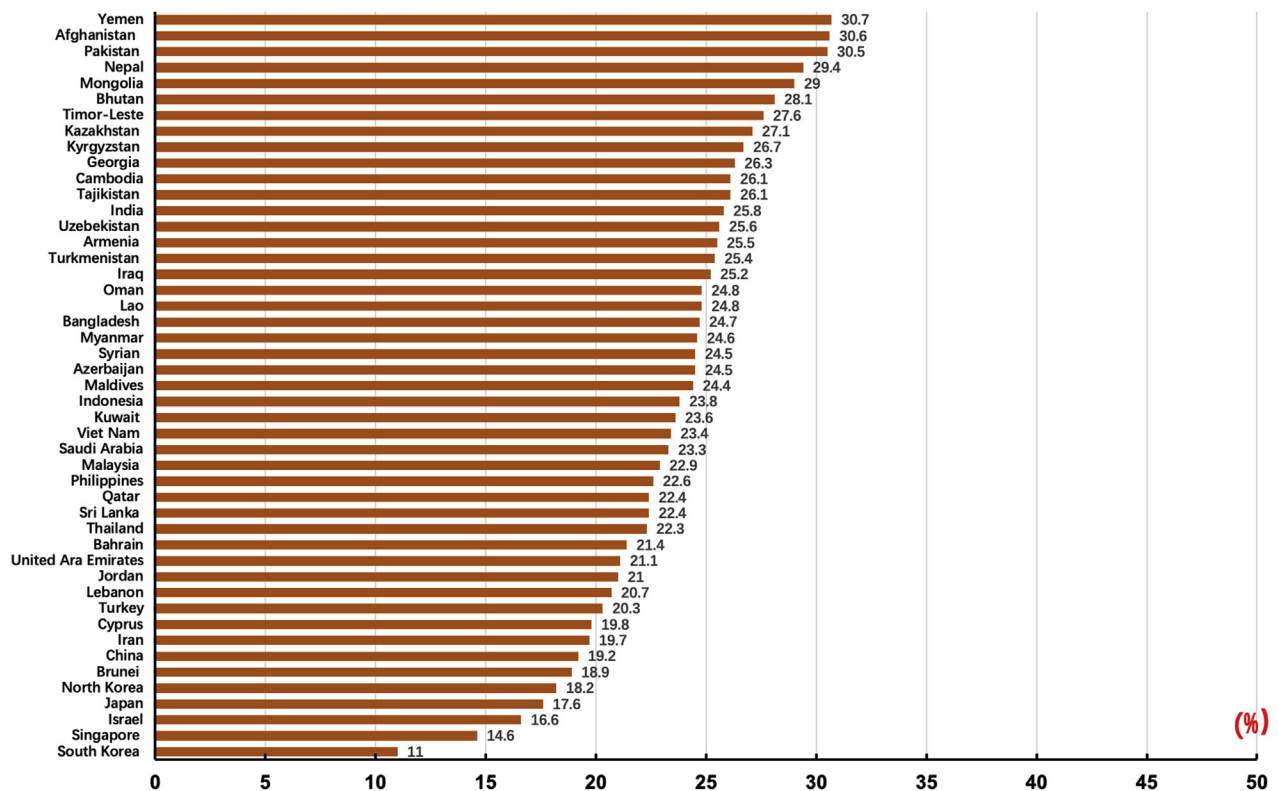




42% in Japan; these values are higher than the age-standardized prevalence rates in a World Health Organization report of 19.2% in China, 11% in South Korea, and 17.6% in Japan (5,30). Although the availability and accessibility of blood pressure measurement and low-cost antihypertensive medication are improving, the main challenge in hypertension management in most low- and middle-income Asian countries remains the low awareness, treatment, and control rates of hypertension (31-33).

**DYSLIPIDEMIA.** Lipid disorders have a well-established causal relationship with atherosclerotic cardiovascular disease (ASCVD). ASCVD is the most common type of CVD in Asia, with an increasing disease burden in many Asian countries (11). The NCD-RisC study pooled 1,127 population-based studies and data from 102.6 million individuals from 200 countries worldwide. This study recently reported

the current global repositioning of lipid-related risk during the period from 1980 to 2018. The prevalence of nonoptimal cholesterol levels shifted from being a distinct feature of high-income countries in Northwestern Europe, North America, and Australasia to becoming a problem in countries of Eastern and Southeastern Asia and Oceania (34). According to the NCD-RisC report, the countries ranked as having the top 10 highest levels of non-high-density lipoprotein cholesterol (HDL-C) in 1980 (for example, Belgium, Finland, and Greenland) experienced the largest declines in non-HDL-C from 1980 to 2018. The largest increases in cholesterol levels were found in Eastern Asian countries (e.g., China) and Southeastern Asian countries (for example, Indonesia, Thailand, Malaysia, and Cambodia). China was among the countries with the lowest mean cholesterol levels in 1980 but reached or surpassed the non-HDL-C levels of many Western countries in 2018. The NCD-RisC

**FIGURE 6** Age-Standardized Prevalence of Hypertension in Asian Countries (%)

Data source: World Health Statistics 2020: Monitoring health for the SDGs, Sustainable Development Goals (5). Abbreviations as in Figure 3.

report showed that whereas the number of ASCVD deaths attributable to high non-HDL-C levels in high-income Western countries decreased from 950,000 in 1990 to 480,000 in 2017, the number of ASCVD deaths greatly increased across Asia during this period, more than tripling in East Asia (from 250,000 to 860,000) and more than doubling in Southeast Asia from 110,000 to 310,000. Among the 3.9 million deaths worldwide from IHD and ischemic stroke that were attributed to high non-HDL-C levels in 2017, one-half of these occurred in Eastern, Southeastern, and Southern Asia (34).

Challenges with respect to dyslipidemia in many Asian countries include the extreme gaps in capacity for implementation of effective and comprehensive national strategies to contain the rise of serum cholesterol in the population and to lower LDL-C to target levels using statins in patients with high CVD risk for both primary and secondary prevention. There have been few collaborative studies in Asia for dyslipidemia. Some country-based studies have shown that compared with the rates for hypertension,

the rates of awareness, treatment, and control of dyslipidemia were much lower (32,35).

**DIABETES.** China, India, Japan, Indonesia, and Pakistan were among the 10 countries with a large number of adults with diabetes in 2014. The total number of patients with diabetes in these 5 Asian countries accounted for 48% of global patients with this disease, with trends of increasing diabetes prevalence in all Asian regions (36). China and India had the largest numbers of patients with diabetes. The estimated total number of adult patients with diabetes was 103 million in China and 65 million in India in 2014, accounting for 24.4% and 15.3% of global patients with this disease, respectively. The results of a comparative study showed that India, China, Indonesia, and Pakistan were among the top 10 countries with the largest contributions to global deaths attributable to high blood glucose (37).

Based on a pooled analysis of more than 1 million participants from 22 prospective cohort studies of the Asia Cohort Consortium, a recent study on the association of diabetes with risks of all-cause and cause-

specific mortality in Asian people reported that compared with patients without diabetes, those with diabetes had significantly higher risks of coronary heart disease (HR: 2.57; 95% CI: 2.19 to 3.02) and ischemic stroke (HR: 2.15; 95% CI: 1.85 to 2.51) (38).

An Indian study reported that diabetic hyperglycemia accounted for 27.5 million DALYs in 2016 and that 40.9% of the loss of DALYs was due to IHD or stroke, 37.8% was related to living with uncomplicated diabetes or diabetic microvascular complications, and 15.8% was due to chronic kidney disease. The study also reported that high BMI, dietary factors (diet low in fruits, nuts and seeds, and whole grains), and tobacco use were the most important risk factors for diabetes in India (39).

**POPULATION AGING.** Population aging is the most important determinant of an increasing CVD epidemic. The generally longer life span and lower birth rate in many Asian countries has led to changes in the age structure and increasing absolute numbers of older adults. Based on data available in the World Population Prospects 2019, the proportion of the population age  $\geq 65$  years in Asia was 4.8% in 2019 and was predicted to rise to 8.8% in 2020 and 17.8% in 2050, with an increase in absolute numbers from 0.4 billion to 0.9 billion in the next 30 years (4). The data from India and China, 2 low- to middle-income countries with extremely large population sizes, may demonstrate how soon the era of aging populations will arrive. According to the World Population Prospects 2019, the proportion of the population aged  $\geq 65$  years in India was 3.8% in 1990 and was predicted to rise to 6.5% in 2020 and 13.7% in 2050 (4). In China, the proportion of the population aged  $\geq 65$  years was 5.6% in 1990 and was predicted to rise to 11.9% in 2020 and 26% in 2050 (4). As a high-income country with the longest life expectancy in the world, the data from Japan may represent the possible future age structure in many Asian countries. In 1990, the proportion of the Japanese population aged  $\geq 65$  years was already 11.8% and was predicted to rise to 28.4% in 2020 and 37.7% in 2050 (4). An aging population presents many challenges in CVD prevention and treatment beyond the mere increase in the number of older adults (11). First, there is less evidence for primary and secondary prevention of CVD as well as emergency care strategies for CVD from randomized controlled trials that included a large number of patients aged  $>75$  years. The second challenge is that most aging patients with CVD have multiple morbidities, and few guidelines provide clear evidence-based recommendations to guide their treatment, even though most

#### HIGHLIGHTS

- Comprehensive data for the current features of CVD epidemics in Asia are lacking.
- This review provides an overview of the epidemiologic features of CVD in Asia.
- Current and future challenges and requirements for CVD prevention in Asian countries are addressed.

clinicians encounter these patients frequently in their daily practice. The third challenge is that aging individuals with CVD might change the disease spectrum by rapidly increasing the prevalence of degenerative CVD and dementia. Furthermore, older adult patients need a more suitable medical care delivery system, such as wearable medical devices, telemedicine, or Internet-based care, a safe hospitalization environment, and suitable facilities for cardiac rehabilitation (40,41).

#### SUMMARY

This review presented a comprehensive overview of the CVD epidemic and identified 5 epidemiological features in Asia. The first feature is the continuously increasing CVD mortality rate, with a high proportion of premature CVD deaths in Asia. The second feature is the marked geographic differences in CVD mortality in Asia due to the combined effects of age and other determinants. Central and Eastern Asian countries generally have higher CVD mortality rates than Southern and Southeastern Asian countries. Western Asian countries have the largest variation in CVD mortality rates. The third feature is the regional differences in the dominant CVD subtype. Whereas IHD is obviously the main dominant type for CVD deaths in Central, Western, and Southern Asia, stroke is much more common than IHD in Eastern and Southeastern Asia. The fourth feature is that different Asian countries are in different transition stages of the CVD epidemic. The characteristics of the different transition stages imply not only the current challenges in CVD prevention and treatment facing countries in different stages of CVD epidemics, but also indicate potential future challenges for these countries. The fifth feature is the increasing epidemics and massive burdens of key modifiable CVD risk factors in most Asian countries with inadequate capacities for management, including unhealthy diet, smoking, obesity, hypertension, dyslipidemia, and diabetes, along with

the rapid progression of population aging in many Asian countries. The information summarized in this review provides a complete picture of CVD epidemiology in Asia, highlighting specific requirements for the development of localized CVD prevention strategies and research, and may illuminate not only the current, but also future challenges faced by different Asian countries.

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## REFERENCES

1. GBD 2017 Causes of Death Collaborators. Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* 2018;392:1736–88.
2. Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2019 (GBD 2019) Results. Seattle, WA: Institute for Health Metrics and Evaluation (IHME); 2020. Available at: <http://ghdx.healthdata.org/gbd-results-tool>. Accessed May 1, 2021.
3. GBD 2019 Demographics Collaborators. Global age-sex-specific fertility, mortality, healthy life expectancy (HALE), and population estimates in 204 countries and territories, 1950–2019: a comprehensive demographic analysis for the Global Burden of Disease Study 2019. *Lancet* 2020;396:1160–203.
4. Department of Economic and Social Affairs, Population Division, United Nations. World Population Prospects 2019. Available at: <https://population.un.org/wpp/>. Accessed May 1, 2021.
5. World Health Statistics 2020: monitoring health for the SDGs, sustainable development goals. Geneva: World Health Organization; 2020. Available at: <https://www.who.int/publications/item/9789240005105>. Accessed May 1, 2021.
6. Pullar TJ, Allen J, Townsend N, et al. The impact of poverty reduction and development interventions on non-communicable diseases and their behavioural risk factors in low and lower-middle income countries: a systematic review. *PLoS One* 2018;13:e0193378.
7. Huxley RR, Hirakawa P, Hussain MA, et al. Age- and sex-specific burden of cardiovascular disease attributable to 5 major and modifiable risk factors in 10 Asian countries of the Western Pacific region. *Circ J* 2015;79:1662–74.
8. Ohira T, Iso H. Cardiovascular disease epidemiology in Asia. *Circ J* 2013;77:1646–52.
9. Roth GA, Johnson C, Abajobir A, et al. Global, regional, and national burden of cardiovascular diseases for 10 causes, 1990 to 2015. *J Am Coll Cardiol* 2017;70:1–25.
10. GBD 2016 Causes of Death Collaborators. Global, regional, and national age-sex specific mortality for 264 causes of death, 1980–2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet* 2017;390:1151–210.
11. Zhao D, Liu J, Wang M, Zhang XG, Zhou MG. Epidemiology of cardiovascular disease in China: current features and implications. *Nat Rev Cardiol* 2019;16:203–12.
12. Zhao D, Liu J, Wang W, et al. Epidemiological transition of stroke in China: twenty-one-year observational study from the Sino-MONICA-Beijing Project. *Stroke* 2008;39:1668–74.
13. MacDonald MR, Tay WT, Teng TK, et al. ASIAN-F Investigators. Regional variation of mortality in heart failure with reduced and preserved ejection fraction across Asia: outcomes in the ASIAN-HF Registry. *J Am Heart Assoc* 2020;9:e012199.
14. Song P, Rudan D, Zhu Y, et al. Global, regional, and national prevalence and risk factors for peripheral artery disease in 2015: an updated systematic review and analysis. *Lancet Glob Health* 2019;7:e1020–30.
15. Omran AR. The epidemiologic transition: a theory of the epidemiology of population change. *Milbank Mem Fund Q* 1971;49:509–38.
16. Yusuf S, Reddy KS, Ounpuu S, Anand S. Global burden of cardiovascular diseases: part I: general consideration, the epidemiology transition, risk factors and impact of urbanization. *Circulation* 2001;104:2746–53.
17. Mckeown RE. The epidemiologic transition: changing patterns of mortality and population dynamics. *Am J Lifestyle Med* 2009;3 Suppl: 19S–26S.
18. Popkin BM. Synthesis and implications: China nutrition transition in the context of changes across other low- and middle-income countries. *Obes Rev* 2014;15 Suppl 1:60–7.
19. GBD 2017 Diet Collaborators. Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* 2019;393:1958–72.
20. Piepoli MF, Hoes AW, Agewall S, et al., ESC Scientific Document Group. 2016 European Guidelines on cardiovascular disease prevention in clinical practice: The Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts) developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). *Eur Heart J* 2016;37:2315–81.
21. Herforth A, Arimond M, Álvarez-Sánchez C, Coates J, Christianson K, Muehlhoff E. A global review of food-based dietary guidelines. *Adv Nutr* 2019;10:590–605.
22. Peacock A, Leung J, Larney S, et al. Global statistics on alcohol, tobacco and illicit drug use: 2017 status report. *Addiction* 2018;113: 1905–26.
23. GBD 2015 Risk Factors Collaborators. Global, regional, and national comparative risk assessment of 79 behavioral, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet* 2016;388: 1659–724.
24. Irawati S, Wasir R, Schmidt AF, et al. Long-term incidence and risk factors of cardiovascular events in Asian populations: systematic review and meta-analysis of population-based cohort studies. *Curr Med Res Opin* 2019;35:291–9.
25. Gupta R, Gupta N, Khedar RS. Smokeless tobacco and cardiovascular disease in low and middle income countries. *Indian Heart J* 2013;65: 369–77.
26. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128.9 million children, adolescents, and adults. *Lancet* 2017;390: 2627–42.
27. Chen Y, Copeland WK, Vedanthan R, et al. Association between body mass index and cardiovascular disease mortality in east Asians and south Asians: pooled analysis of prospective data from the Asia Cohort Consortium. *BMJ* 2013;347: f5446.

- 28.** Hyun KK, Huxley RR, Arima H, et al. A comparative analysis of risk factors and stroke risk for Asian and non-Asian men: The Asia Pacific Cohort Studies Collaboration. *Int J Stroke* 2013;8:606-11.
- 29.** Zhou M, Wang LH, Zeng XW, et al. Mortality, morbidity, and risk factors in China and its provinces, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* 2019;394:1145-58.
- 30.** Shin J, Chia YC, Heo R, et al. Current status of adherence interventions in hypertension management in Asian countries: a report from the HOPE Asia Network. *J Clin Hypertens (Greenwich)* 2020 Dec 17 [E-pub ahead of print].
- 31.** Siddique S. Asian management of hypertension: current status, home blood pressure, and specific concerns in Pakistan. *J Clin Hypertens (Greenwich)* 2020;22:501-3.
- 32.** Wang ZW, Chen Z, Zhang LF, et al. China Hypertension Survey Investigators. Status of hypertension in China: results from the China Hypertension Survey, 2012-2015. *Circulation* 2018;137:2344-56.
- 33.** Chia YC, Kario K. Asian management of hypertension: current status, home blood pressure, and specific concerns in Malaysia. *J Clin Hypertens (Greenwich)* 2020;22:497-500.
- 34.** NCD Risk Factor Collaboration (NCD-RisC). Repositioning of the global epicentre of non-optimal cholesterol. *Nature* 2020;582:73-7.
- 35.** Zhang M, Deng Q, Wang LH, et al. Prevalence of dyslipidemia and achievement of low-density lipoprotein cholesterol targets in Chinese adults: a nationally representative survey of 163,641 adults. *Int J Cardiol* 2018;260:196-203.
- 36.** NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in diabetes since 1980: a pooled analysis of 751 population-based studies with 4.4 million participants. *Lancet* 2016;387:1513-30.
- 37.** Ramachandran A, Ma RCW, Snehalatha C. Diabetes in Asia. *Lancet* 2010;375:408-18.
- 38.** Yang JJ, Yu D, Wen WQ, et al. Association of diabetes with all-cause and cause-specific mortality in Asia: a pooled analysis of more than 1 million participants. *JAMA Netw Open* 2019;2:e192696.
- 39.** Tripathy JP. Burden and risk factors of diabetes and hyperglycemia in India: findings from the Global Burden of Disease Study 2016. *Diabetes Metab Syndr Obes* 2018;11:381-7.
- 40.** Marengoni A, Tazzeo C, Calderón-Larrañaga A, et al. Multimorbidity patterns and 6-year risk of institutionalization in older persons: the role of social formal and informal care. *J Am Med Dir Assoc* 2021 Feb 5 [E-pub ahead of print].
- 41.** Dou LX, Liu XY, Zhang TH, Wu YF. Health care utilization in older people with cardiovascular disease in China. *Int J Equity Health* 2015;14:59.

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**KEY WORDS** aging, diabetes, diet, dyslipidemia, hypertension, smoking