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Risk Factors of Cardiovascular Diseases in Southeast Asia

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ABSTRACT

Cardiovascular diseases, which include coronary heart disease, cerebrovascular disease, peripheral artery disease, and aortic atherosclerosis, constitute the leading cause of death worldwide. In Southeast Asia, the annual mortality rate from cardiovascular diseases is increasing. As there is limited review literature on the risk factors of these diseases in the region, an examination of articles, periodicals, and reports from online databases worldwide can deepen our insights into the risk factors pertaining to Southeast Asian populations. The review finds two main types of factors of cardiovascular diseases that are mainly responsible for the high mortality rates of cardiovascular diseases in Southeast Asia: biological and environmental. Among biological factors, high sodium intake and tobacco consumption account for increased risks of high blood pressure and atherosclerosis, while environmental factors - air pollution and noise pollution - contribute to vasoconstriction, thrombosis, and coronary heart disease. From the findings in this review, an emphasis on regulations and guidelines to address these risk factors can thus reduce the prevalence of cardiovascular disease and solidify the wellbeing of millions in Southeast Asia.

Introduction

Cardiovascular diseases (CVD), or heart disease, have long been a subject of intense interest and investigation. Given the intricacies of the human cardiovascular system, which is made of the heart and its blood vessels, many complications can arise within the system. According to the World Health Organization (WHO), cardiovascular diseases are the leading cause of death worldwide, resulting in approximately 17.9 million deaths annually, representing 30% of all deaths worldwide.[1,2] They also pose heavy economic impacts, with over $216 billion spent on the healthcare system in the United States alone every year and $863 billion globally.[3,4] These statistics thus draw attention to the enormous toll caused by CVDs.

The prevalence of CVDs varies across different geographical regions, socioeconomic backgrounds, and ethnicities. In 2019, approximately 58% of the 18.6 million cardiovascular-related deaths globally happened in Asia. 39% of the deaths occur among people below 70 years old, which is considerably higher than that of premature deaths globally (35%).[4] Given the numerous challenges existing in the healthcare systems and socioeconomic capacities, the annual mortality rate from CVDs in Asia is on the rise. Notably, South East Asia, a region that makes up 8.6% of the world's population, has age-standardized CVD mortality rates ranging from 124.9 to 421.6 per 100,000, the maximum of which almost quadruples the rate of 137.2 deaths in North and South America in 2021.[4,5] Moreover, the death rate from coronary heart disease in some Southeast Asian countries, such as Malaysia, Indonesia, Thailand, and Singapore is notably higher than the rates of East Asian countries, namely South Korea, Japan and China.[6] Therefore, a review of the factors behind CVDs in the population of Southeast Asians can provide a closer insight into improving the outcomes of the diseases and ultimately, the wellbeing of communities across the region.

Overview of CVDs

CVDs encompass four main diseases: coronary heart disease, cerebrovascular disease, peripheral artery disease, and aortic atherosclerosis.[7]

Coronary heart disease - Coronary heart disease is caused by a reduction of myocardial perfusion, which affects the ability of blood to flow through the heart muscle, eventually leading to angina or heart failure. This type of CVD composes of one-third to one-half of all CVD cases.

Cerebrovascular disease - Cerebrovascular disease is severe damage of the vasculature or cerebral perfusion, impacting the effectiveness of blood flow to the brain and frequently causing stroke and transient ischemic attack.[8]

Peripheral artery disease - Peripheral artery disease, which includes atherosclerosis of the iliac, abdominal aorta, and other arteries in the lower region, can give rise to many complications, such as claudication (pain of leg muscles during activity) and limb loss.[9]

Aortic atherosclerosis - Aortic atherosclerosis is due to the excessive accumulation of lesions, namely plaques, in arteries, which poses risks of embolization.[10] General studies define atherosclerosis as having above 4 millimeters of plaque in the arteries. Consequences include thoracic and abdominal aneurysms, which can lead to life-threatening bleeding.

Prevalence of CVDs among Southeast Asian populations

Over the past few decades, Southeast Asia saw a considerable increase in premature deaths due to CVDs.[11] For example, in 2019, stroke-attributed deaths constitute 21.5% of deaths in Vietnam, an 2% increase from two decades earlier.[12] Meanwhile, other Southeast Asian populations, such as Myanmar and Singapore, experienced a rising prevalence of high-risk factors for CVDs, with the mean total cholesterol levels increasing in both men and women between 1980 and 2008.[13] Figure 1 below shows the crude CVD mortality rates in Southeast Asia, adapted from the Journal of the American College of Cardiology in 2021.[4]

Methods

To investigate the prevalence and weight of risk factors on CVD rates across Southeast Asia, a review was conducted by researching articles on scientific databases, such as PubMed and the National Institutes of Health. Some common keywords searched were “CVD rates,” “Southeast Asia,” “Asia,” and “risk factors,” along with combinations of the mentioned terms to yield more specific results. A wide range of articles worldwide was considered to compare the CVD-related rates in Southeast Asia with other geographical regions, such as East Asia and Europe. Those include archived articles from the WHO as well as published regulations on governmental websites in Southeast Asia. A thorough search of peer review journals, such as the Journal of the American College of Cardiology, Asia Pacific Journal of Clinical Nutrition, Population Health Metrics, and Journal of Epidemiology and Community Health, was conducted to ensure scientific accuracy. Moreover, reports and articles from major health agencies, including the WHO and Center for Diseases Control and Prevention (CDC), were reviewed along with periodicals, such as Medicine (Baltimore), Nutrients, Atherosclerosis, and BioMed Central Public Health. The years of the 59 articles gathered range from 1992 to 2022.

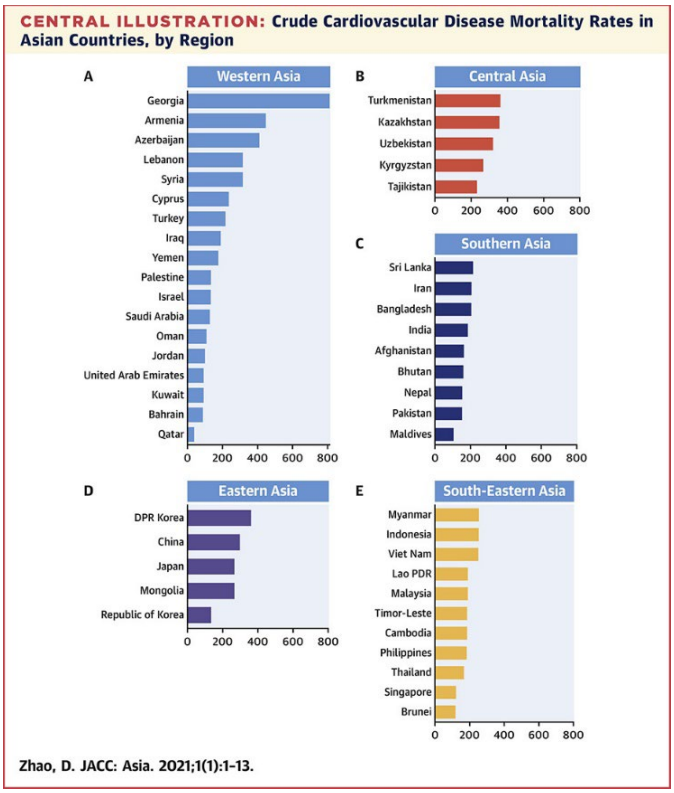

Figure 1. Crude CVD Mortality Rates in Asian countries. Note the yellow figure for Southeast Asia (Courtesy from Dong Zhao, 2021)

Results

After examining the articles, the two main groups of risk factors were identified: biological factors and environmental factors. According to Zhao (2021), the key risk factors for CVDs are smoking, obesity, hypertension, dyslipidemia, and diabetes.[4] In addition, environmental factors, such as noise and air pollution, also contribute to increasing the risks of CVDs.

Biological factors

Obesity

Southeast Asia has long been established as one of the regions with the lowest rates of obesity globally. The region also sees a lower obesity prevalence compared to those of West and South Asia, as demonstrated by the 18-fold difference between the age-standardized prevalence of obesity between Kuwait (37.9%) and Vietnam (2.1%). Moreover, the prevalence of obesity in Southeast Asia in 2019 ranged from 2.1% to 15.6%, showing considerably lower rates compared to an average of 40.9% of adults being overweight across Asia.[14,15]

Dyslipidemia

Dyslipidemia, which is causally related to atherosclerosis CVD, is defined by the WHO as blood levels of total cholesterol above 5 mmol/L. Despite the rise of dyslipidemia in several Asia-Pacific countries, it should be noticed that several countries have different thresholds to define lipid-related disorders.[16] The WHO reported that in 2008, the

prevalence of dyslipidemia in Southeast Asia was 30.3%, remarkably less than that in Europe (53.7%) and the Americas (47.7%).[17]

Diabetes

According to the International Diabetes Federation, 90 million adults (aged 20 to 79) are living with diabetes in Southeast Asia.[18] There exists limited literature regarding diabetes in the region, as only 60% of the countries have recently examined the frequency of diabetes.[19] The mean comparative prevalence of diabetes among Southeast Asian adults in 2019 is 7.8%, much lower than the global diabetes prevalence of 9.3%.[20,21] Given the lower rates of obesity, dyslipidemia, and diabetes in Southeast Asia compared to those in other regions of Asia and worldwide, sodium intake and tobacco consumption play significant roles in highlighting the risks of CVDs in the region.

Sodium intake

The presence of salt has been a staple in traditional Southeast Asian cuisines through the incorporation of processed seafood products, such as fish sauce, fish paste, and shrimp paste, along with various sauces and condiments, such as soya sauce.[22] As a result of rapid urbanization, demand for convenient fast food is also on the rise, giving rise to the addition of sodium-containing preservatives, such as anti-caking agents, neutralizers, and thickeners into processed foods. These factors encourage the consumption of salt, inadvertently heightening the risks for CVDs among Southeast Asians by increasing blood pressure levels, with a third of the region's population experiencing high blood pressure.[23] As around 54% of strokes and 47% of coronary heart diseases worldwide are caused by high blood pressure, the risks for hypertension, one of the leading causes of CVDs, are especially emphasized.[24] A meta-analysis by Wang et al. suggested a significant linear relationship between sodium intake and risks of CVDs. Specifically, for every 1-gram increase in sodium intake, the risk for CVDs rises to 6%, thus underscoring the role of sodium intake in contributing to CVDs.[25]

The amount of sodium intake is recommended by the WHO to be 2 grams a day for adults.[26] However, many Southeast Asian countries saw amounts higher than the recommended portion, as five countries (Indonesia, Malaysia, the Philippines, Singapore, and Thailand) are reported to have estimated sodium intakes above 2 grams among most sampled adults aged 18 to 70.[27] For example, studies conducted by the Singaporean Ministry of Health along with Lee et al and Whittow reveal the mean sodium consumed for both males and females to fall in the mid to high range of 3 grams per day.[27] Meanwhile, the consumption of salt in the Thai military reaches 7.12 grams daily, showing the excessively high sodium consumption present across different social groups in Southeast Asia.[27] This information thus shows the alarming sodium intake leading to increasing CVD rates in the region while highlighting the need to reduce salt consumption among Southeast Asian populations.

Tobacco use

Smoking has been long regarded as one of the top risk factors for CVDs, causing around 1.58 million deaths in Southeast Asia every year.[28] The region is ranked top in the world for tobacco consumption, as 22% of worldwide tobacco users aged 15 and above are from Southeast Asia. Through several forms, such as hand-rolled, chewed, inhaled, or smoked, tobacco use has a widespread prevalence regardless of nationality or socioeconomic status, yet is especially prevalent in groups with lower socioeconomic statuses and education levels.[29,30] In a cross-sectional survey by Peltzer and Pengpid, 6.9% and 2.5% of 8806 male and female university students in 9 ASEAN countries respectively identified themselves as current tobacco users.[11] In Indonesia, Timor Leste, and Cambodia, the rates of smoking among men surpass 33%, with rates in the first two countries reaching approximately 70%.[30] Meanwhile, the age-standardized smoking rate in Myanmar was ranked the highest among most Asian countries.[31] These statistics emphasize the prevalence of tobacco consumption while raising alarming concerns for cardiovascular wellbeing in the region.

The high rates of smoking in Southeast Asia indicate a higher likelihood of CVDs among its population. According to the CDC, several studies revealed the heightened risks of coronary heart disease associated with smoking, even for smoking fewer than five cigarettes daily.[32] The physiological mechanisms behind the detrimental effects of smoking derive from the harm inflicted on the vascular wall, causing damaged prostacyclin function and increased interactions between platelets and vessels.[33] These alterations can lead to the reduction of the elasticity of the aorta, thus resulting in impaired vasodilation of the coronary arteries. Furthermore, exposure to nicotine in tobacco accelerates atherosclerosis by stimulating the emission of catecholamines and platelet aggregability through the accumulation of thrombus.[34] The direct impact of tobacco use on cardiovascular wellbeing thus demonstrates an association between smoking and CVDs across Southeast Asian populations. A meta-analysis conducted by Irawati et al. reported that the CVD-attributed fatality rate among smokers in Asia was 1.68 higher than the rate for non-smokers.[35] Another report by Biswas et al. regarding the biological risk factors of CVDs among adults in South and Southeast Asia reported the percentage of smoking as a risk factor to be 31.48% in Timor-Leste, a rate ranked one of the tops in Southeast Asia.[36] The country's CVD mortality rate is around 200 per 100,000, almost doubling the lowest rate of 124.9 per 100,000, thus showing the association between smoking and CVDs.[37]

Environmental factors

Air pollution

The WHO estimates that approximately 7 million premature deaths due to air pollution occur globally every year, with several studies indicating a close association between air pollution and CVDs.[38] In Southeast Asia, common sources of pollution include vehicle and industrial exhaust along with biomass burnings, which account for up to 40-60% of the total haze region-wide.[39] The vast impact of fire aerosols is largely due to the seasonal vegetation fires created by the common "slash-and-burn" method, which involves the burning of trees and plants to form a sustaining and weed-free ash layer for future crops.[40] The issue of transboundary haze has been emerging as a public health concern, for many studies have demonstrated the consequences of long-term exposure to haze, which include chronic health diseases, such as CVDs. The ubiquity of biomass burning has negatively impacted the air pollution rates in Southeast Asia, as 99.9% percent of the region's population live in areas with particulate pollution exceeding the WHO guideline of 5 $\mu g/m^3$.[41] In particular, the minimum $PM_{2.5}$ concentration for the 25 most polluted regions in Southeast Asia is 37.4 $\mu g/m^3$, highlighting the severity of air pollution in the area.

As a result of the excessive concentration of air pollution, approximately 28% of all CVD-related deaths in Southeast Asia are due to air pollution.[42] Despite the limited existing literature concerning the association of the two variables in the region, a relationship between air pollution exposure and CVDs has been corroborated by various studies using animals, which demonstrated increased risks of atherogenesis and thrombosis leading to coronary heart disease.[43] A study by Zhao et al. of the relationship between air pollutant concentration and cardiovascular mortality revealed that for every additional 10 $\mu g/m^3$ in NO_2, SO_2, and O_3 concentration, the excess risks percentages increase by 1.12%, 0.75% and 0.62% respectively, thus demonstrating the association between CVDs and air pollution.[44] Another report by Suwa et al. evidenced the potent effects of air pollution by comparing the characteristics of the cardiovascular system between hyperlipidemic rabbits exposed to PM_{10} and those in the control group.[45] Confirming the hypothesis, the former group experienced more severe coronary lesions, enlarged plaque size, increased risks of plaque rupture, and more advanced atherosclerosis.[45]

Noise pollution

With rising rates of urbanization and modernization in Southeast Asia, it is not unexpected that noise pollution is becoming one of the most prevalent types of pollution in the region in addition to air pollution. With 9 cities in the region included in the list of the top 20 cities with the worst air pollution worldwide, air pollution is rampant in Southeast Asia.[46] A study by Schwela indicated the main sources of noise pollution in Southeast Asia, which are motor vehicles, aircraft fleets, industries, and domestic noises.[47] Furthermore, in many cities, the lack of separation between

residential and commercial or industrial areas aggravates the impact of noise pollution on residents' wellbeing.[48] Despite the WHO guidelines for noise exposure levels suggesting not exceeding 70 dB over a 24-hour period, the noise intensity in several Southeast Asian cities hovers above the specified range.[49] For example, a study concerning the noise exposure of cyclists circling Ho Chi Minh City, Vietnam, recorded a mean noise level of 78.8 dB(A), with the levels nearing central neighborhoods and airports quadrupling the levels in rural areas.[48] This illustrates the pressing issue of air pollution as it contributes to increasing the risks of CVDs in Southeast Asia.

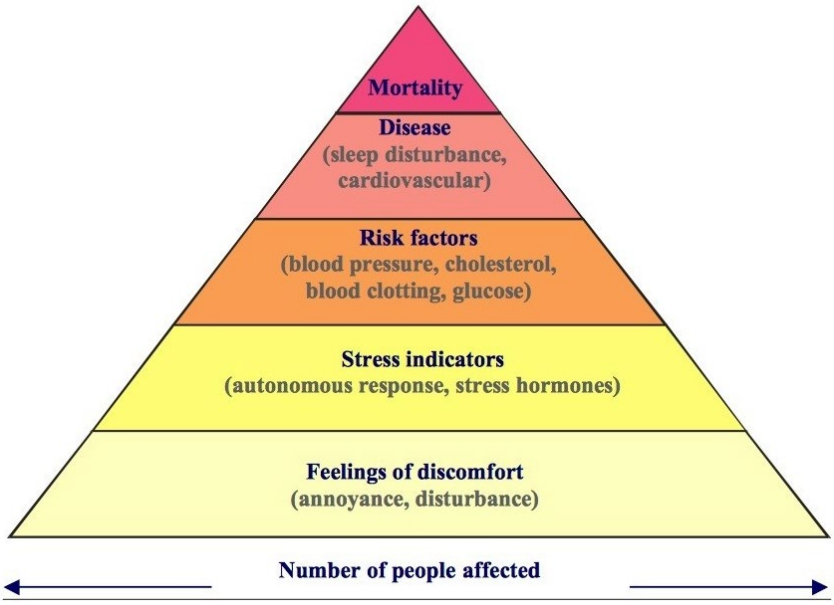

Figure 2. Severity of health effects of noise and number of people affected (Courtesy from WHO) [46]

Many studies have illustrated the relationship between CVDs and noise pollution, emphasizing the increasing likelihood to experience CVDs by being exposed to prolonged noise. According to a meta-analysis by WHO, for every 10 dB(A) increase in road-traffic noises starting at 50 dB(A), the likelihood of coronary heart disease goes up by 8%.[50] The physiological implications of noise pollution can be traced back to the stress induced on blood pressure and vascular function. The underlying mechanisms reveal the noise-induced activation of the hypothalamic-pituitary-adrenal axis and the sympathetic nervous system, which leads to the emission of cortisol and catecholamines.[51] The heightened stress levels lead to vessel hypersensitivity, causing vasoconstriction and hypertension that eventually poses risks to several CVDs, such as coronary heart disease and ischemic heart disease.[51, 52] As illustrated by Figure 2, the top three tiers of the health impacts of noise, namely blood pressure, cardiovascular effects, and mortality, are related to CVDs. Despite limited literature on the relationship between CVDs and noise levels among the Southeast Asian population, several studies worldwide have demonstrated the detrimental effects of noise on cardiovascular wellbeing. A study by Moreyra, which aligned with many similar studies done in Europe, examined heart attack rates among 16,000 New Jersey residents hospitalized due to heart attacks in 2018.[49] In areas with high transportation noise exposure, the heart attack rate was 72% higher than that of people living in quieter areas, showing the high prevalence of the association between noise pollution and CVDs.

Discussion

Various attempts to reduce sodium intake among Southeast Asians have been taken in order to reduce the risks of developing CVDs due to high sodium intake. A report on sodium intake among Southeast Asian countries by the

WHO has suggested initiatives to encourage salt reduction by regulating the salt content of processed and convenience food products; monitoring of health awareness programs; and supporting small local businesses with product reformulation technology.[23] A prime example of a successful salt-reducing initiative in Southeast Asia is the National Salt Initiative in Thailand, which was established and managed by the Ministry of Public Health and several healthwise institutions. During the implementation of the initiative from 2006 to 2009, the death rates for stroke and ischemic heart disease remained roughly stable at 20 percent, a considerable decrease from 25 percent in 2005.[53] Thus, employing a holistic approach, which involves extensive contributions from governments, businesses, and consumers, can help decrease sodium consumption and alleviate the risks of CVDs.

To address the negative effects of smoking on cardiovascular wellbeing, several strategies, such as smoking prevention policies among adolescents and smoking prohibition in public places, have been proposed to reduce smoking in Southeast Asia.[54] The WHO Global Report on Trends in Prevalence of Tobacco Use 2000-2025 (4th edition, 2021) has reported that the region achieved the fastest rate of decline in tobacco use, with the average smoking rate for men reducing from 50% in 2000 to 25% in 2020 and the prevalence for women plummeting from 8.6% in 2000 to 1.6% in 2020.[55] A strategy proposed in Indonesia, where 62% of adult males frequently smoke, was banning smoking in public areas to discourage people from smoking.[54] Furthermore, as Indonesia is categorized as a developing country, the reduction in smokers is projected to be 6-10% as a result of a 10% increase in cigarette prices, thus establishing this strategy as effective for a majority of countries in Southeast Asia.[54,56] Meanwhile, Singapore introduced a national policy of tobacco control in 1986, which incorporated various sectors, such as public education, taxation, and legislation.[57] To uphold the regulations, the advertisement of cigarette brands in Singapore is prohibited as well as cigarette vending machines and smokeless tobacco. This contributed to establishing Singapore as having the second lowest CVD mortality rate in the region, with only around 170 per 100,000.[4] Therefore, a strong reinforcement of smoking policies can bar CVD-related from exacerbating in Southeast Asia.

Given the association between air pollution and CVDs, a reduction in air pollution can be crucial in lowering the rates of CVDs in Southeast Asia. Despite multiple factors that could influence the decrease in CVD treatment demands, such as the burden on hospitalization facilities due to COVID-19, considering improving the air quality could be one of the key strategies to curb the rise of CVD cases in Southeast Asia. Regarding noise pollution, several strategies have been proposed to lessen the detriments of CVDs in Southeast Asia. Schwela (2007) suggested further improvements in integrated environmental planning, noise emission standards, and low noise implementation plans.[47] One such method is the 1992 Enhancement and Conservation of National Environmental Quality Act in Thailand, which aimed to manage environmental noise by imposing standards on noise levels with fines for exceeding the limits.[58] The changes implemented can yield some fruits in alleviating the CVD rates in Southeast Asia. In Singapore, the Municipal Services Office set standards for noise volume for certain times and locations, thus catering to the wellbeing of various groups of people. While the noise limit in residential buildings is 75 dB(A) for a maximum of 12 hours from 7 am to 7 pm, the limit for the same time span reduces to 60 dB(A) to hospitals, schools, and nursing homes.[59] These regulations implemented in Thailand and Singapore have brought definite successes in alleviating the CVD rates, as both countries are ranked respectively the third and second lowest in CVD mortality rates in Southeast Asia.[4] By reinforcing measures to keep noise levels in check, Southeast Asian countries could see a better future for cardiovascular wellbeing among their populations.

Conclusion

CVDs, encompassing coronary heart disease, cerebrovascular disease, peripheral artery disease, and aortic atherosclerosis, are the top cause of death in Southeast Asia. Due to the complex nature of the cardiovascular system, several risk factors, both biological and environmental, should be examined upon investigating CVD rates in the region. A holistic approach that integrates cooperation among governments, health agencies, and the public, along with an emphasis on learning from other countries and accommodating across socioeconomic groups, can contribute to improving the lives of millions.

Limitations

This review has some potential limitations. As some of the examined articles were published more than two decades ago, with the oldest one dating to 1992, the statistics of CVD-related rates in Southeast Asia may not reflect the current nature of the cardiovascular wellbeing of the region. Furthermore, many existing articles regarding the risk factors, regulations, and resolutions in Southeast Asia solely focus on certain countries, especially Singapore, Thailand, and Indonesia, thus reducing the representation of other countries in the review. These potential limitations thus should be considered when considering this review article.

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