

# Hypertension and stroke in Asia: A comprehensive review from HOPE Asia

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**Abstract**

Stroke is the primary cause of disability and vascular death worldwide, including Asia. Asian characteristics that differ from the West lead to higher stroke incidence. Stroke epidemiology studies in Asia have shown varying levels of mortality, incidence, prevalence, and burden of disease. Hypertension is the most prevalent risk factor found in Asia. Besides ethnicity that is associated with stroke incidence, both systolic blood pressure, diastolic blood pressure, and blood pressure variability are positively correlated with stroke incidence. Post-stroke cognitive impairment is one of the sequelae that affect one-third of stroke survivors and has become a significant public health concern that is often neglected despite its increasing prevalence. Therefore, it is very important to prevent recurrence by treating stroke optimally and effectively. Increasing awareness and treatment adherence to hypertension, the leading risk factor for stroke, became the main goal in several countries in Asia.

**1 | INTRODUCTION**

Epidemiology transition has become the leading cause of the substantial increase in the disease burden of non-communicable diseases, such as increased stroke as the primary cause of disability and vascular death worldwide, including Asia.<sup>1</sup> Stroke impacts of decreasing quality of life and its higher average mortality rate compared to Europe, America, and Australia make it a serious problem in Asia.<sup>2,3</sup> More than half of the world population lives in Asia, with the majority in developing countries. 70% stroke incidence and 87% stroke-related deaths happened in low- and lower-middle-income countries.<sup>2,3</sup>

The economic burden of stroke is high and variable in Asia.<sup>4</sup> Average cost per capita for patients with high-risk stroke in 2010 was

estimated to reach \$ 517.8 per year in China.<sup>5</sup> A review in 2019 that compared stroke cost in Indonesia, Malaysia, and Singapore showed variable cost that was \$ 135.55 per day care (3.88% of GDP per capita), \$ 227.53 per day care (2.11% of GDP per capita), and \$ 366.76 per day care (0.65% of GDP per capita), respectively.<sup>6</sup> The considerable amount of economic burden makes it very necessary for stroke to be given more attention and for more effective health care planning, especially in the primary and secondary prevention, and early detection of the disease. The economic impact of stroke and the association between stroke and blood pressure lead to the importance of knowing more about the relationship between stroke and hypertension in Asia.<sup>7</sup>

Asian characteristics that differ from the West lead to higher stroke incidence, which is even higher than coronary artery disease in some

**TABLE 1** Prevalence of stroke, its risk factors, disability-adjusted life year (DALY), and mortality rate of HOPE Asia Network countries

Country	Stroke prevalence	Hypertension prevalence, %	Diabetes mellitus prevalence, %	Smoking, %	Dyslipidemia, %
China	1114.8/100 000 persons (2017)	23.2 (2018)	11.6 (2013)	26.6 (2019)	39.9 (2018)
India	44.29 to 559/100 000 persons (2017)	24 (2015)	8 (2016)	11 (2016)	79 (2014)
Indonesia	10.9% (2018)	34.1 (2018)	10.9 (2018)	29.3 (2018)	35.9 (2013)
Japan	166 per 100 000 person-years (2011)	50.0 (2018)	18.7 (men) 9.3 (women) (2010)	17.8 (2018)	12.2 (men) 21.1 (women) (2018)
Korea	1.71% (2014)	29.1 (2016)	14.4 (2019)	43.1 (men) 5.7 (women) (2019)	40.5 (2019)
Malaysia	11.3% (2017)	30.3 (2015)	17.5 (2015)	22.8 (2015)	47.7 (2016)
Pakistan	4.8% (2006)	46.2 (2017)	26.3 (2017)	14.2 (2017)	39.3 (2017)
Philippines	6.6% (2013)	28 (2013)	5.8 (2016)	20.7 (2018)	46.9 (2013)
Singapore	3.7% (2006)	21.5 (2017)	8.6 (2017)	12 (2017)	33.6 (2017)
Taiwan	6.8% (2016)	25.4 (2016)	15.1 (2016)	14.3 (2016)	36.7 (2016)
Thailand	1.3% (2014)	24.7 (2014)	8.9 (2014)	19.5 (2014)	16.4 (2014)
Vietnam	15.5% (2016)	28.7 (2017)	5.5 (2017)	13.8 (2017)	20.2 (2015)

Asian countries. In this paper, we will discuss the epidemiology of stroke in Asia, specifically countries that are members of the HOPE Asia Network, stroke risk factors, and the role of hypertension in stroke incidence in Asia.

## 2 | STROKE EPIDEMIOLOGY IN ASIA

Stroke epidemiology studies in Asia have shown varying levels of mortality, incidence, prevalence, and burden of disease. Mortality rate and stroke burden range from the lowest in Japan 43.3 per 100 000 person-years (burden 706.6/100 000 people) and Singapore 47.9 per 100 000 person-years (burden 804.2/100 000 people) to the highest in Indonesia 193.3 per 100 000 person-years (burden 3382.2/100 000 people) and Mongolia 222.6 per 100 000 person-years (burden 4409.8/100 000 people), with hypertension, diabetes mellitus, and smoking as the main risk factors.<sup>8</sup>

The overall incidence of stroke in Asia varied between 116 and 483/100 000 per year.<sup>9</sup> Apart from vast differences between countries, stroke incidence also showed high variation within countries, for instance, the northern area of China showed higher incidence than the southern area, being two times higher in stroke belt area, which is suspected to occur due to high rates of hypertension and obesity in the area.<sup>10</sup>

Moreover, stroke incidence in the younger population has increased globally, with higher consequences physically, psychologically, and socially. Furthermore, other varying risk factors, such as air pollution, obesity, physical inactivity, alcohol consumption, and dyslipidemia, have also increased in the younger population.<sup>11–13</sup> In addition to the younger average age of stroke onset and higher incidence rates, the shift had also changed toward hemorrhagic stroke,

which has higher fatality and disability, leading to DALY loss rates up to more than 10-fold higher than the least affected countries.<sup>14</sup> The prevalence of stroke, its risk factors, disability-adjusted life year (DALY), and mortality rate of HOPE Asia Network Countries are shown in Table 1.

## 3 | STROKE RISK FACTOR IN ASIA

As the second leading cause of death globally, with its significant impacts affecting other areas of life, for example, economically, socially, physically, and psychologically, existing and known risk factors should be thoroughly discussed in the strategy of reducing strokes, especially as 74.2% of the risk is attributable to modifiable risk factors related to lifestyle.<sup>12,78,79</sup>

A previous study that analyzed ethnicity with blood pressure and stroke showed that South Asians had a higher prevalence of dyslipidemia, diabetes mellitus, and central obesity, and twofold higher risk to suffer from stroke than the Europeans.<sup>78</sup> The risk between different ethnicity was also observed in Singapore where Malay people had a lower risk of stroke (OR = 0.4) than the Chinese people.<sup>80</sup>

Hypertension is the most prevalent risk factor found in Asia.<sup>8,9</sup> A study in Sleman District, Indonesia, showed the same pattern where increased age, hypertension, and diabetes mellitus were associated with stroke incidence. It was also observed that stroke risk goes up to almost two times for every additional 10 years lived.<sup>79</sup> A logistic regression analysis comparing stroke risk factors in Sichuan, China, showed low-density lipoprotein cholesterol being the highest risk factor (OR = 2.600), followed by triglycerides (OR = 1.315) and body mass index (OR = 0.217).<sup>81</sup> In Uzbekistan, dominant risk factors after hypertension are smoking and physical inactivity.<sup>2</sup>

Obesity, %	Physical inactivity, %	DALY lost/100 000 people	Stroke mortality/100 000 person-years	Reference
11.9 (2018)	N/A	2,342.3 (2017)	128.2 (2017)	15–21
4 (2016)	33 (2016)	1591.7 (2017)	71.5 (2017)	22–26
21.8 (2018)	33.5 (2018)	3481 (2017)	186.3 (2017)	27–31
32.2 (men) 21.9 (women) (2018)	68.2 (men) 74.5 (women) (2018)	638.9 (2017)	33.6 (2017)	32–35
40.7 (2018)	49.2 (2019)	703 (2013)	34.9 (2017)	36–42
17.7 (2015)	66.5 (2015)	1686.1 (2017)	71.5 (2017)	43–45
43.9 (2017)	58.5 (2016)	2534 (2017)	100.5 (2017)	46–49
31.1 (2013)	40.6 (2018)	2596.8 (2017)	134 0.7 (2017)	50–58
8.7 (2017)	19 (2017)	568.1 (2017)	14.1 (2017)	59–62
52.1 (men) 37.4 (women) (2019)	64.4 (men) 69.3 (women) (2020)	872.3 (2017)	30.8 (2012)	63–67
37.5 (2014)	19.5 (2014)	1128.1 (2017)	62.5 (2017)	69–71
15.6 (2015)	28.1 (2015)	2619.5 (2017)	115.4 (2017)	72–77

Increasing age, no education, and history of smoking were associated with stroke prevalence in Singapore. This logistic regression showed that smoking increased stroke incidence two times higher in 85-year-old group, and no education increased stroke incidence three times.<sup>80</sup>

Other risk factor that also affects the incidence of stroke include air pollution, which, though modifiable, is challenging to avoid.<sup>1,12,82</sup> Main pollutants are particulate matters (PM<sub>2.5</sub>) that could penetrate lung alveoli and brain cells, and gaseous pollutants, for example, ozone (O<sub>3</sub>), sulfur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>), and carbon monoxide (CO).<sup>83</sup> Studies that calculated PM<sub>2.5</sub> in 79 countries found that an increase in global population-weighted PM<sub>2.5</sub> of 20.4% was found in South Asia, South-East Asia, and China, with the highest concentration of 194 µg/m<sup>3</sup> found in Shijiazhuang in China.<sup>84</sup> A meta-analysis, conducted by Pranata et al<sup>85</sup>, showed how PM<sub>2.5</sub> was associated with increased risk of stroke and hypertension. This naturally encourages policymakers and public health practitioners in Asia to be aware of the danger of environmental air pollution and find ways to improve air quality.<sup>86</sup>

#### 4 | HYPERTENSION AS THE MAIN RISK FACTOR FOR STROKE

In the previous part, we have discussed that hypertension is the main risk factor for stroke. Besides ethnicity that is associated with stroke incidence in South Asia, both systolic blood pressure (SBP) and diastolic blood pressure (DBP) are positively correlated with stroke incidence unlike west countries where only SBP was correlated.<sup>78</sup>

In the global May Measurement Month (MMM) 2018 report after age and sex standardization, East Asia had the lowest blood pressure average (117.0/75.4 mm Hg). In contrast, South Asia had the highest average (124.6/78.1 mm Hg).<sup>87</sup> MMM 2017 study in Indonesia alone showed 34.5% of respondents with uncontrolled hypertension, while 20.0% were newly diagnosed.<sup>88</sup> This number is almost similar to the national prevalence (34.1%), with a higher proportion in females (32.9% vs. 28.7%) and urban area (31.7% vs. 30.2%).<sup>27</sup> A study conducted in Sleman and Bogor districts, Indonesia, showed a significant association between hypertension and stroke ( $P < .001$ ).<sup>79,89</sup> 73.91% of stroke patients had hypertension. The CSPPT (China Stroke Primary Prevention Trial) proved that the stroke risk was lowest in patients with the average SBP level of 120-130 mm Hg, and the risk increased in those with SBP <120 mm Hg and those with SBP 130-135 mm Hg (J-shaped curve).<sup>90</sup> Atherosclerotic plaques, smooth muscle cell remodeling, cerebral blood flow reduction, and arterial baroreflex dysfunction, which were caused by hypertension, could lead to cerebrovascular diseases, including stroke.<sup>79</sup> It is also found that South Asians had poorer cerebral autoregulation than Europeans, which increased their vulnerability to stroke by putting the brain at risk of ischemia and developing hemorrhagic transformation.<sup>78,91,92</sup>

Overweight and obesity in women and higher waist circumference (a measure of central obesity) in men were significantly associated with uncontrolled hypertension. Other lifestyle factors, such

as high salt intake and physical inactivity, were also correlated with higher blood pressure.<sup>93</sup> Excess of sodium intake, associated with fluid retention and increased blood pressure, is also considered as a specific characteristic of hypertension disease in Asia.<sup>94,95</sup> A meta-analysis showed that 5 g per day higher salt intake could increase 23% risk of stroke which became our biggest concern as average daily salt intake in Asia is higher than 12 g.<sup>95,96</sup>

Sub-analysis of the countries that took part in the HBPM Asia BP@Home study showed that Japan and Philippines had the most participants with well-controlled hypertension (64% and 62%), while Indonesia has the least well-controlled participants (23%).<sup>50,97,98</sup> However, HOPE Asia Network has stated in many prior papers on how important it is to detect hypertension and its phenotypes early, including masked uncontrolled hypertension and sustained uncontrolled hypertension, by releasing a guide to home blood pressure monitoring (HBPM) and/or ambulatory blood pressure monitoring (ABPM).<sup>99,100</sup>

#### 5 | BLOOD PRESSURE VARIABILITY AND STROKE

Prior studies showed that hypertension management goal has shifted to prevent end-organ damage by controlling 24-hr blood pressure. Blood pressure variability (BPV), including early morning blood pressure surge (EMBS), could result in the increment of the left ventricular mass index and carotid intima-media thickness, leading to a higher risk of cerebrovascular events.<sup>101</sup> 24-hour blood pressure and BPV were also associated with worse functional outcome after stroke and silent cerebral diseases, including silent cerebral infarction.<sup>102,103</sup> Moreover, high BPV in ischemic stroke was associated with increased 90-day mortality risk.<sup>104</sup>

As ABPM database is widely available nowadays, studies have shown that nocturnal hypertension and nondipper/riser patterns of blood pressure at night are associated with vascular damage, increasing left ventricular preload and afterload, which could trigger stroke.<sup>105,106</sup>

As discussed before, Asians had a higher incidence of stroke and its risk factors, which also include higher morning and nocturnal blood pressure than the Western population. High morning surge could lead to arterial stiffness and a higher risk of cerebrovascular events, including stroke.<sup>101,107</sup> Furthermore, morning hypertension is also known to be the most influential independent risk factor for stroke.<sup>108</sup> It was shown that people who had morning blood pressure surge 55 mm Hg or more had a 2.7 times higher risk of stroke than those who had lower than 55 mm Hg.<sup>101</sup> Therefore, ABPM is also strongly recommended, to measure 24-hour blood pressure, including nocturnal blood pressure, diurnal variations, and morning surge.<sup>109</sup>

#### 6 | POST-STROKE DEMENTIA

Post-stroke cognitive impairment (PSCI) or post-stroke dementia (PSD) is one of the sequelae that affect one-third of stroke survivors

and has become a significant public health concern that is often neglected despite its increasing prevalence.<sup>110,111</sup> Its consequences are often worse than the physical impairment, which tends to improve over time.<sup>111</sup> The prevalence varies between 20% and 80% depending on both the ethnicity and diagnostic criteria.<sup>112</sup> The prevalence of PSD in Asia ranges from 20% in India to 69.8% in South Korea.<sup>112</sup> In China, two studies showed prevalence of 37.1% in Chongqing and 41.8% in Changsha.<sup>112</sup> While Singapore and Hong Kong had a prevalence of 44% (6-month follow-up) and 21.8% (3-months follow-up), respectively, as assessed by MMSE.<sup>112</sup> Important risk factors for PSD related to stroke including index stroke factors (hemorrhagic, recurrent, and location), post-stroke factors (infection, delirium, and early seizures), and neuroimaging factors (presence of atrophy and small-vessel disease).<sup>111</sup> Biomarkers have also been used to predict and detect PSD. These include cerebrospinal fluid and serum biomarkers, genetic markers, peripheral microRNA, inflammatory mediators, and neuroimaging measures.<sup>111</sup> PSCI with no dementia is also known to interfere with the quality of life in stroke patients.<sup>113</sup> This great impact reminds us that it is very important to prevent recurrence and increasing severity by treating stroke optimally and effectively.<sup>111</sup>

## 7 | STROKE AWARENESS AND SPECIFIC CONCERNS IN ASIA

Although healthy lifestyle campaigns, inclusive of reduction in salt intake and increase in physical activity, and infographics regarding stroke and its risk factors have been increased, awareness of hypertension in Indonesia is still poor.<sup>98</sup> Poor awareness that leads to poor blood pressure control could explain why few adults are effectively treated.<sup>93</sup> Also, despite the knowledge of having hypertension, only 23% had well-controlled blood pressure in Indonesia.<sup>98</sup>

Using the 2017 AHA/ACC classification threshold, home blood pressure monitoring (HBPM) study in Asia found that only 26% of patients were well-controlled, compared with 40% of sustained hypertension, 6% of masked morning hypertension, and 28% of white-coat hypertension.<sup>114</sup> Availability of ABPM and HBPM could improve control and help early detection of uncontrolled hypertension.<sup>109</sup> Previous studies summarized how awareness, treatment, and control rates of traditional risk factors for stroke improved in China, Japan, Mongolia, Korea, and Taiwan compared with decades ago. However, these numbers are still considered low compared with Western countries.<sup>12</sup>

Increasing awareness and treatment adherence to hypertension, the leading risk factor for stroke, became the main goal in several countries in Asia.<sup>50,98,115,116</sup> Generally, Yap *et al* described that treatment adherence in elderly depends on patient factors, medication factors, health care provider factors, and health care system factors.<sup>117</sup> Expensive and unaffordable medicine price, multiple number of doses, and medicines also complicate and reduce treatment adherence in multi-ethnic Asian population.<sup>118</sup> In Pakistan, it was found that, other than lack of literacy and education, there was also a shortage of health care workers.<sup>119</sup> Study in Malaysia showed that more than 60% of

participants' overall knowledge of stroke symptoms and actions to be taken was good, higher than India and Oman.<sup>120</sup> Educational program for stroke that is readily available and global campaigns such as MMM, which was very useful in screening hypertension, should continue, to increase not only knowledge but also awareness on how it is vital to keep the blood pressure controlled to prevent stroke incidence.<sup>87,88</sup> A trial to prevent stroke occurrence from the CSPPT in Chinese hypertensive population by consuming folic acid may be considered as an additional primary prevention.<sup>121,122</sup> Furthermore, it is also essential to obtain information from patients or their family about their perceptions on stroke management and find out factors that might be associated with medication compliance.<sup>123,124</sup> However, the role of ethnicity and culture in stroke management is still limited, and we suggest to account these factors for future research.

## 8 | SUMMARY

Stroke epidemiology studies in Asia have shown varying levels of mortality, incidence, prevalence, and burden of disease. Besides ethnicity that is associated with stroke incidence, both systolic blood pressure, diastolic blood pressure, and blood pressure variability are positively correlated with stroke incidence. Post-stroke cognitive impairment is one of the sequelae that affect one-third of stroke survivors and has become a significant public health concern that is often neglected despite its increasing prevalence. The application in clinical practice includes primary prevention by emphasizing patients' HBPM practice—if applicable—and secondary prevention through recurrence prevention by treating stroke optimally and effectively. Solving stroke and its greatest risk factor, hypertension, increasing awareness, and treatment adherence to hypertension should be on top of public health priority considering its high burden of disease in several countries in Asia.

## CONFLICT OF INTEREST

S Park has received research grants and honoraria from Pfizer. S Siddique has received honoraria from Bayer, Pfizer, ICI, and Servier; and travel, accommodation, and conference registration support from Hilton Pharma, Atco Pharmaceutical, Highnoon Laboratories, Horizon Pharma, ICI, and Pfizer. YC Chia has received honoraria and sponsorship to attend conferences and CME seminars from Abbott, Bayer, Boehringer Ingelheim, GlaxoSmithKline, Menarini, Merck Sharp & Dohme, Novartis, Orient Europharma, Pfizer, and Sanofi; and a research grant from Pfizer. Jinho J Shin has received lecture honoraria from Pfizer Inc, Hanmi Pharm. Co. Ltd., Yuhan Co. Ltd., Boryung Pharmaceutical Co. Ltd, and Menarini; consulting fees from Hanmi Pharm. Co. Ltd.; and research grants from Sanofi Pharm. and Hanmi Pharm. Co. Ltd. CH Chen has received honoraria as a member of a speaker's bureau for Pfizer. J Sison has received honoraria from Pfizer, AstraZeneca, Boehringer Ingelheim, and Novartis. GP Sogunuru has received a research grant related to hypertension monitoring and treatment from Pfizer. JC Tay has received advisory board and consultant honoraria from Pfizer. JG Wang has received research grants

from Bayer, Pfizer, and Phillips; and lecture and consulting fees from Bayer, Daiichi Sankyo, Merck Sharp & Dohme, Pfizer, Sanofi, and Servier. Y Zhang has received research grants from Bayer, Novartis, and Shuanghe; and lecture fees from Bayer, Daiichi Sankyo, Novartis, Pfizer, Sanofi, Servier, and Takeda. All other authors report no potential conflicts of interest in relation to this article.

## AUTHOR CONTRIBUTIONS

Yuda Turana and Kazuomi Kario conceived and designed the study. Yuda Turana, Jeslyn Teng kawan, Yook Chin Chia, and Kazuomi Kario approved the final version of the manuscript. Yuda Turana, Jeslyn Teng kawan, Yook Chin Chia, Michael Nathaniel, Ji-Guang Wang, Apichard Sukonthasarn, Chen-Huan Chen, Huynh Van Minh, Peera Buranakitjaroen, Jinho Shin, Saulat Siddique, Jennifer M. Naites, Sungha Park, Boon Wee Teo, Jorge Sison, Jam Chin Tay, Guru Prasad Sogunuru, Yuqing Zhang, Narsingh Verma, Tzung-Dau Wang, and Kazuomi Kario analyzed the data and/or interpreted the data, and drafted the article and/or critically revised the manuscript.

## DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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## REFERENCES

- GBD 2016 Stroke Collaborators. Global, regional, and national burden of stroke, 1990–2016: a systematic analysis for the global burden of disease study 2016. *Lancet Neurol*. 2019;18(5):439–458.
- Abduboriyevna RK, Yusufjonovich NS. Stroke burden in Asia: to the epidemiology in Uzbekistan. *Eur Sci Rev [Internet]*. 2018;7–8. [Cited 2020 Apr 12] <https://cyberleninka.ru/article/n/strok-e-burden-in-asia-to-the-epidemiology-in-uzbekistan>.
- WHO. Stroke: a global response is needed [Internet]. WHO. [cited 2020 Apr 12]. <http://www.who.int/bulletin/volumes/94/9/16-18163/6/en/>.
- Evers SMAA, Struijs JN, Ament AJHA, van Genugten MLL, Jager JHC, van den Bos GAM. International comparison of stroke cost studies. *Stroke*. 2004;35(5):1209–1215.
- Statement on Stroke Care in China [Internet]. World Stroke Organization. [cited 2020 Apr 12]. <https://www.world-stroke.org/news-and-blog/news/statement-on-stroke-care-in-china-june>.
- Wijaya HR, Supriyanto E, Salim MIM, Siregar KN, Eryando T. Stroke management cost: review in Indonesia, Malaysia and Singapore. *AIP Conf Proc*. 2019;2092(1):030022.
- Kario K. Key points of the 2019 Japanese society of hypertension guidelines for the management of hypertension. *Korean Circ J*. 2019;49(12):1123–1135.
- Venkatasubramanian N, Yoon BW, Pandian J, Navarro JC. Stroke epidemiology in South, East, and South-East Asia: a review. *J Stroke*. 2017;19(3):286–294.
- Suwanwela NC, Pongvaran N. Asian stroke advisory panel. Stroke burden and stroke care system in Asia. *Neurol India*. 2016;64(Suppl):S46–S51.
- Xu G, Ma M, Liu X, Hankey G. Is there a stroke belt in China and why? *Stroke*. 2013;44(7):1775–1783.
- Boot E, Ekker MS, Putaala J, Kittner S, Leeuw F-ED, Tuladhar AM. Ischaemic stroke in young adults: a global perspective. *J Neurol Neurosurg Psychiatry*. 2020;91(4):411–417.
- Kim YD, Jung YH, Saposnik G. Traditional risk factors for stroke in East Asia. *J Stroke*. 2016;18(3):273–285.
- Ojha R, Huang D, An H, Zuo L, Zhu W. Young ischemic stroke in South Asia: a review. *J Adv Int Med*. 2013;15:2.
- Kim AS, Cahill E, Cheng NT. Global stroke belt. *Stroke*. 2015;46(12):3564–3570.
- Wang Z, Chen Z, Zhang L, et al. Status of hypertension in China: results from the China hypertension survey, 2012–2015. *Circulation*. 2018;137(22):2344–2356.
- Wang W, Jiang B, Sun H, et al. Prevalence, incidence, and mortality of stroke in China: results from a nationwide population-based survey of 480 687 adults. *Circulation*. 2017;135(8):759–771.
- Xu Y. Prevalence and control of diabetes in Chinese adults. *JAMA*. 2013;310(9):948.
- Survey: tobacco use declines on mainland-Chinese association on tobacco control [Internet]. [Cited 2020 Apr 12] <http://www.catcprc.org.cn/index.aspx?menuid=25&type=articleinfo&lanmu id=186&infolid=11491&language=en>.
- National Center for Cardiovascular Diseases. *Report on Cardiovascular Diseases in China 2017*. Beijing: Encyclopedia of China Publishing House; 2017.
- China [Internet]. Institute for health metrics and evaluation. 2015 [cited 2020 Apr 29]. <http://www.healthdata.org/china>.
- Stroke in China [Internet]. World life expectancy. [cited 2020 Apr 29]. <https://www.worldlifeexpectancy.com/china-stroke>.
- Kamalakaran S, Gudlavalleti ASV, Gudlavalleti VSM, Goenka S, Kuper H. Incidence & prevalence of stroke in India: a systematic review. *Indian J Med Res*. 2017;146(2):175–185.
- Non-communicable Disease Country Profile: India [Internet]. [Cited 2020 Apr 20] World Health Organization; 2016. [http://www.who.int/nmh/countries/ind\\_en.pdf](http://www.who.int/nmh/countries/ind_en.pdf).
- Joshi SR, Anjana RM, Deepa M, et al. Prevalence of dyslipidemia in urban and rural India: the ICMR-INDIAB study. *PLoS One*. 2014;9(5):e96808. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4016101/>.
- India [Internet]. Institute for health metrics and evaluation. 2015 [cited 2020 May 7]. <http://www.healthdata.org/india>.
- Stroke in India [Internet]. World Life Expectancy. [cited 2020 May 7]. <https://www.worldlifeexpectancy.com/india-stroke>.
- Ministry of Health and National Institute of Health Research and Development. National report on basic health research, Riskesdas, 2018. Jakarta, Indonesia, 2018.
- Ministry of Health and National Institute of Health Research and Development. National report on basic health research, Riskesdas, 2013. Jakarta, Indonesia, 2014 (and additional analysis).

29. Indonesia [Internet]. Institute for health metrics and evaluation. 2015 [cited 2020 Apr 13]. <http://www.healthdata.org/indonesia>.
30. Lin C-F, Chang Y-H, Chien S-C, Lin Y-H, Yeh H-Y. Epidemiology of dyslipidemia in the asia pacific region. *Int J Gerontol*. 2018;12(1):2-6.
31. Stroke in Indonesia [Internet]. World Life Expectancy. [cited 2020 Apr 29]. <https://www.worldlifeexpectancy.com/indonesia-stroke>.
32. Takashima N, Arima H, Kita Y, et al. Incidence, management and short-term outcome of stroke in a general population of 1.4 million Japanese - Shiga stroke registry. *Circ J*. 2017;81(11):1636-1646.
33. Ministry of Health, Labour and Welfare. National Health and Nutrition Survey 2018 [Internet]. [cited 2020 May 7]. [https://www.mhlw.go.jp/bunya/kenkou/kenkou\\_eiyuu\\_chousa.html](https://www.mhlw.go.jp/bunya/kenkou/kenkou_eiyuu_chousa.html).
34. Japan [Internet]. Institute for health metrics and evaluation. 2015 [cited 2020 May 7]. <http://www.healthdata.org/japan>.
35. Stroke in Japan [Internet]. World life expectancy. [cited 2020 May 7]. <https://www.worldlifeexpectancy.com/japan-stroke>.
36. Kim JY, Kang K, Kang J, et al. Executive summary of stroke statistics in Korea 2018: a report from the epidemiology research council of the Korean stroke society. *J Stroke*. 2019;21(1):42-59.
37. Hong K-S, Bang OY, Kang D-W, et al. Stroke statistics in Korea: part i. epidemiology and risk factors: a report from the Korean stroke society and clinical research center for stroke. *J Stroke*. 2013;15(1):2-20.
38. The Korean Society Hypertension (KSH), Hypertension Epidemiology Research Working Group, Kim HC, Cho M-C. Korea hypertension fact sheet 2018. *Clin Hypertens*. 2018;24(1):13.
39. Kim B-Y, Won JC, Lee JH, et al. Diabetes fact sheets in Korea, 2018: an appraisal of current status. *Diab& Metab J*. 2019;43(4):487-494.
40. Seo MH, Kim Y-H, Han K, et al. Prevalence of obesity and incidence of obesity-related comorbidities in Koreans based on national health insurance service health checkup data 2006&ndash;2015. *JOMES*. 2018;27(1):46-52.
41. Rhee E-J, Kim HC, Kim JH, et al. 2018 Guidelines for the management of dyslipidemia. *Korean J Intern Med*. 2019;34(4):723-771.
42. Stroke in South Korea [Internet]. World Life Expectancy. [cited 2020 May 2]. <https://www.worldlifeexpectancy.com/south-korea-stroke>.
43. Stroke in Malaysia [Internet]. World life expectancy. [cited 2020 May 4]. <https://www.worldlifeexpectancy.com/malaysia-stroke>.
44. National health and morbidity survey 2015 [Internet]. [cited 2020 Apr 29]. <http://iku.moh.gov.my/index.php/research-eng/list-of-research-eng/iku-eng/nhms-eng/nhms-2015>.
45. Malaysia [Internet]. Institute for health metrics and evaluation. 2015 [cited 2020 Apr 29]. <http://www.healthdata.org/malaysia>.
46. Pakistan Health Research Council. *Non-communicable diseases survey - Pakistan*. Islamabad, Pakistan: World Health Organization; 2016.
47. Pakistan Health Research Council, Diabetic Association of Pakistan. 2nd National Diabetes Survey of Pakistan National Health survey, 2016-2017. Islamabad, Pakistan; 2018.
48. Stroke in Pakistan [Internet]. World life expectancy. [cited 2020 May 4]. <https://www.worldlifeexpectancy.com/pakistan-stroke>.
49. Pakistan [Internet]. Institute for health metrics and evaluation. 2015 [cited 2020 May 4]. <http://www.healthdata.org/pakistan>.
50. Sison J, Divinagracia R, Nailes J. Asian management of hypertension: current status, home blood pressure, and specific concerns in Philippines (a country report). *J Clin Hypert*. 2020;22(3):504-507. <https://onlinelibrary.wiley.com/doi/abs/10.1111/jch.13802>
51. Loo KW, Gan SH. Burden of stroke in the Philippines. *Int J Stroke*. 2013;8(2):131-134.
52. International Diabetes Federation. Global diabetes scorecard: Philippines, 2014 [Internet]. International Diabetes Federation; 2014. <http://www.idf.org/global-diabetes-scorecard/assets/downloads/Scorecard-29-07-14.pdf>.
53. Patalen CF. Health and Nutritional Status of Filipino Adults, 20-59 years old. 2018;32.
54. Guerrero AE. 2015 clinical practice guidelines for the management of dyslipidemia in the Philippines - executive summary: dyslipidemia guidelines 2015. *ASEAN Heart J*. 2016;24:7.
55. FNRI-DOST 2018 Annual Report [Internet]. Philippines: Food and Nutrition Research Institute, Department of Science and Technology; 2018:81. [cited 2020 Apr 29] <https://www.fnri.dost.gov.ph/images/sources/AnnualReports/AR-2018.pdf>.
56. FNRI-DOST 2015 Annual Report [Internet]. Philippines: Food and Nutrition Research Institute, Department of Science and Technology; 2015:58-60. [cited 2020 Apr 29] <https://www.fnri.dost.gov.ph/images/sources/AnnualReports/AR-2015.pdf>.
57. Philippines [Internet]. Institute for Health Metrics and Evaluation. 2015 [cited 2020 Apr 29]. <http://www.healthdata.org/philippines>.
58. Stroke in Philippines [Internet]. World life expectancy. [cited 2020 Apr 29]. <https://www.worldlifeexpectancy.com/philippine-s-stroke>.
59. Venketasubramanian N, Chen CLH. Burden of stroke in Singapore. *Int J Stroke*. 2008;3(1):51-54.
60. Singapore Ministry of Health. *Executive summary on singapore national population health survey 2016/17* [Internet]. Singapore: Singapore Ministry of Health; 2017. [https://www.moh.gov.sg/docs/librariesprovider5/resources-statistics/reports/executive-summary-nphs-2016\\_17.pdf](https://www.moh.gov.sg/docs/librariesprovider5/resources-statistics/reports/executive-summary-nphs-2016_17.pdf).
61. Singapore [Internet]. Institute for health metrics and evaluation. 2015 [cited 2020 May 7]. <http://www.healthdata.org/singapore>.
62. Stroke in Singapore [Internet]. World life expectancy. [cited 2020 May 7]. <https://www.worldlifeexpectancy.com/singapore-stroke>.
63. Chuang S-Y, Cheng H-M, Bai C-H, Yeh W-T, Chen J-R, Pan W-H. Blood pressure, carotid flow pulsatility, and the risk of stroke: a community-based study. *Stroke*. 2016;47(9):2262-2268.
64. Chuang S-Y, Chang H-Y, Cheng H-M, Pan W-H, Chen C-H. Prevalence of hypertension defined by central blood pressure measured using a type ii device in a nationally representative cohort. *Am J Hypertens*. 2018;31(3):346-354.
65. Prevalence of overweight and obesity in Taiwan [Internet]. [cited 2020 Apr 29]. [https://www.gender ey.gov.tw/gecdb/Stat\\_Statistics\\_DetailData.aspx?sn=%2FmQvqHYEayTt8pmhMjRvA%3D%3D](https://www.gender ey.gov.tw/gecdb/Stat_Statistics_DetailData.aspx?sn=%2FmQvqHYEayTt8pmhMjRvA%3D%3D).
66. The proportion of population in the regular movement of Chinese people [Internet]. [cited 2020 Apr 29]. [https://www.gender ey.gov.tw/gecdb/Stat\\_Statistics\\_DetailData.aspx?sn=IE9%2bVKlq9nql0ld4b%2b5R4w%3d%3d&d=m9ww9odNZAz2Rc5Ooj%2fwlQ%3d%3d](https://www.gender ey.gov.tw/gecdb/Stat_Statistics_DetailData.aspx?sn=IE9%2bVKlq9nql0ld4b%2b5R4w%3d%3d&d=m9ww9odNZAz2Rc5Ooj%2fwlQ%3d%3d).
67. Taiwan (Province of China) [Internet]. Institute for Health Metrics and Evaluation. 2015 [cited 2020 Apr 29]. <http://www.healthdata.org/taiwan-province-china>.
68. Hsieh F-I, Chiou H-Y. Stroke: morbidity, risk factors, and care in Taiwan. *J Stroke*. 2014;16(2):59-64.
69. Aekplakorn W. The 5th Report of National Health Exam Survey in Thai population by physical examination (NHES V) [Internet]. Health System Research Institute. 2014;. [cited 2020 May 2]. [http://www.thaiheart.org/images/column\\_1387023976/NHES5\\_EGATMeeting13Dec13.pdf](http://www.thaiheart.org/images/column_1387023976/NHES5_EGATMeeting13Dec13.pdf).
70. Thailand [Internet]. Institute for health metrics and evaluation. 2015 [cited 2020 May 2]. <http://www.healthdata.org/thailand>.
71. Stroke in Thailand [Internet]. World life expectancy. [cited 2020 May 2]. <https://www.worldlifeexpectancy.com/thailand-stroke>.
72. Van Minh H, Viet NL, Sinh CT, et al. Blood pressure screening during the may measurement month 2017 programme in Vietnam-South-East Asia and Australasia. *Eur Heart J Suppl*. 2019;21(Supplement\_D):D127-D129.
73. Nhung NTT, Long TK, Linh BN, Vos T, Huong NT, Anh ND. Estimation of Vietnam national burden of disease 2008. *Asia Pac J Public Health*. 2014;26(5):527-535.
74. NCDs. TEPwise approach to chronic disease risk factor surveillance [Internet]. WHO. World Health Organization; [cited 2020

- Apr 29]. [http://www.who.int/ncds/surveillance/steps/viet\\_nam/en/](http://www.who.int/ncds/surveillance/steps/viet_nam/en/).
75. Carr C, Kahn L, Mathkour M, Biro E, Bui CJ, Dumont AS. The shifting burden of neurosurgical disease: Vietnam and the middle-income nations. *Neurosurg Focus*. 2018;45(4):E12.
  76. Vietnam [Internet]. Institute for health metrics and evaluation. 2015 [cited 2020 Apr 29]. <http://www.healthdata.org/vietnam>.
  77. Stroke in Viet Nam [Internet]. World life expectancy. [cited 2020 Apr 29]. <https://www.worldlifeexpectancy.com/viet-nam-stroke>.
  78. Eastwood SV, Therese T, Nish C, Hughes AD. Ethnic differences in associations between blood pressure and stroke in South Asian and European men. *Hypertension*. 2015;66(3):481-488.
  79. Setyopranoto I, Bayuangga HF, Panggabean AS, et al. Prevalence of stroke and associated risk factors in Sleman District of Yogyakarta Special Region, Indonesia [Internet]. *Stroke Res Treat*. 2019;2019:1-8. [cited 2020 Apr 12]. <https://www.hindawi.com/journals/srt/2019/2642458/>
  80. Teh WL, Abdin E, Vaingankar JA, et al. Prevalence of stroke, risk factors, disability and care needs in older adults in Singapore: results from the WISE study. *BMJ Open*. 2018;8(3):e020285.
  81. Li R-C, Xu W-D, Lei Y-L, et al. The risk of stroke and associated risk factors in a health examination population. *Medicine*. 2019;98(40):e17218. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6783153/>.
  82. Neurology TL. Air pollution and brain health: an emerging issue. *Lancet Neurol*. 2018;17(2):103.
  83. Lee KK, Miller MR, Shah ASV. Air pollution and stroke. *J Stroke*. 2018;20(1):2-11.
  84. Brauer M, Freedman G, Frostad J, et al. Ambient air pollution exposure estimation for the global burden of disease 2013. *Environ Sci Technol*. 2016;50(1):79-88.
  85. Pranata R, Vania R, Tondas AE, Setianto B, Santoso A. A time-to-event analysis on air pollutants with the risk of cardiovascular disease and mortality: a systematic review and meta-analysis of 84 cohort studies. *J Evid Based Med*. 2020;13(2):102-115.
  86. Graber M, Mohr S, Baptiste L, et al. Air pollution and stroke. A new modifiable risk factor is in the air. *Rev Neurol (Paris)*. 2019;175(10):619-624.
  87. Beaney T, Burrell L, Castillo R, et al. May Measurement Month 2018: a pragmatic global screening campaign to raise awareness of blood pressure by the International Society of Hypertension. *Eur Heart J*. 2019;40(25):2006-2017.
  88. Widiantoro B, Situmorang TD, Turana Y, et al. May measurement month 2017: an analysis of the blood pressure screening campaign results in Indonesia—South-East Asia and Australasia. *Eur Heart J Suppl*. 2019;21(Suppl D):D63-D65.
  89. Turana WRJPKY. Stroke in Indonesia: risk factors and predispositions in young adults. *J Cardio Dis Res*. 2020;11(2):178-183.
  90. Fangfang F, Ziwen Y, Xianhui Q, et al. Optimal systolic blood pressure levels for primary prevention of stroke in general hypertensive adults. *Hypertension*. 2017;69(4):697-704.
  91. Xiong L, Liu X, Shang T, et al. Impaired cerebral autoregulation: measurement and application to stroke. *J Neurol Neurosurg Psychiatry*. 2017;88(6):520-531.
  92. Castro P, Azevedo E, Sorond F. Cerebral autoregulation in stroke. *Curr Atheroscler Rep*. 2018;20(8):37.
  93. Hussain MA, Mamun AA, Reid C, Huxley RR. Prevalence, awareness, treatment and control of hypertension in Indonesian adults aged  $\geq 40$  years: findings from the Indonesia family life survey (IFLS). *PLoS One*. 2016;11(8):e0160922.
  94. Turlova E, Feng Z. Dietary salt intake and stroke. *Acta Pharmacol Sin*. 2013;34(1):8-9.
  95. Kario K, The HOPE Asia (hypertension cardiovascular outcome prevention and evidence in Asia) network. The HOPE Asia Network for “zero” cardiovascular events in Asia. *J Clin Hypertens*. 2018;20(2):212-214.
  96. Strazzullo P, D'Elia L, Kandala N-B, Cappuccio FP. Salt intake, stroke, and cardiovascular disease: meta-analysis of prospective studies. *BMJ*. 2009;339(nov24 1):b4567-b4567. <https://www.bmj.com/content/339/bmj.b4567>
  97. Kabutoya T, Hoshida S, Kario K. Asian management of hypertension: current status, home blood pressure, and specific concerns in Japan. *J Clin Hypert*. 2020;22(3):486-492. <https://www.onlinelibrary.wiley.com/doi/abs/10.1111/jch.13713>.
  98. Turana Y, Tengawan J, Soenarta AA. Asian management of hypertension: current status, home blood pressure, and specific concerns in Indonesia. *J Clin Hypertens*. 2020;22(3):483-485. <https://www.onlinelibrary.wiley.com/doi/abs/10.1111/jch.13681>.
  99. Kario K, Park S, Buranakitjaroen P, et al. Guidance on home blood pressure monitoring: a statement of the HOPE Asia network. *J Clin Hypertens*. 2018;20(3):456-461.
  100. Kario K, Park S, Chia Y-C, et al. 2020 Consensus summary on the management of hypertension in Asia from the HOPE Asia Network. *J Clin Hypertens*. 2020;22(3):351-362. <https://onlinelibrary.wiley.com/doi/abs/10.1111/jch.13751>.
  101. Sogunuru GP, Kario K, Shin J, et al. Morning surge in blood pressure and blood pressure variability in Asia: evidence and statement from the HOPE Asia network. *J Clin Hypertens*. 2019;21(2):324-334.
  102. Turana Y, Tengawan J, Chia YC, et al. Hypertension and dementia: a comprehensive review from the HOPE Asia Network. *J Clin Hypertens*. 2019;21(8):1091-1098.
  103. Mistry EA, Mehta T, Mistry A, et al. Blood pressure variability and neurologic outcome after endovascular thrombectomy. *Stroke*. 2020;51(2):511-518. <https://doi.org/10.1161/STROKEAHA.119.027549>
  104. Stead LG, Gilmore RM, Vedula KC, Weaver AL, Decker WW, Brown RD. Impact of acute blood pressure variability on ischemic stroke outcome. *Neurology*. 2006;66(12):1878-1881.
  105. Kario K, Matsuo T, Kobayashi H, Imiya M, Matsuo M, Shimada K. Nocturnal fall of blood pressure and silent cerebrovascular damage in elderly hypertensive patients. Advanced silent cerebrovascular damage in extreme dippers. *Hypertension*. 1996;27(1):130-135.
  106. Kazuomi K. Nocturnal hypertension. *Hypertension*. 2018;71(6):997-1009.
  107. Pierdomenico SD, Pierdomenico AM, Cuccurullo F. Morning blood pressure surge, dipping, and risk of ischemic stroke in elderly patients treated for hypertension. *Am J Hypertens*. 2014;27(4):564-570.
  108. Kario K, Ishikawa J, Pickering TG, et al. Morning hypertension: the strongest independent risk factor for stroke in elderly hypertensive patients. *Hypertens Res*. 2006;29(8):581-587.
  109. Shin J, Kario K, Chia Y-C, et al. Current status of ambulatory blood pressure monitoring in Asian countries: a report from the HOPE Asia Network. *J Clin Hypertens*. 2020;22(3):384-390. <https://www.onlinelibrary.wiley.com/doi/abs/10.1111/jch.13724>
  110. Hu G-C, Chen Y-M. Post-stroke dementia: epidemiology, mechanisms and management. *Int J Gerontol*. 2017;11(4):210-214.
  111. Mijajlović MD, Pavlović A, Brainin M, et al. Post-stroke dementia – a comprehensive review. *BMC Med*. 2017;15(1):11. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5241961/>.
  112. Sun J-H, Tan L, Yu J-T. Post-stroke cognitive impairment: epidemiology, mechanisms and management. *Ann Transl Med*. 2014;2(8):80. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4200648/>.
  113. Park JH, Kim BJ, Bae H-J, et al. Impact of post-stroke cognitive impairment with no dementia on health-related quality of life. *J Stroke*. 2013;15(1):49-56.



114. Kario K, Tomitani N, Buranakitjaroen P, et al. Home blood pressure control status in 2017–2018 for hypertension specialist centers in Asia: Results of the Asia BP@Home study. *J Clin Hypertens*. 2018;20(12):1686–1695.
115. Chia Y-C, Kario K. Asian management of hypertension: current status, home blood pressure, and specific concerns in Malaysia. *J Clin Hypertens*. 2020;22(3):497–500. <https://www.onlinelibrary.wiley.com/doi/abs/10.1111/jch.13721>.
116. Tay JC, Teo BW. Asian management of hypertension: current status, home blood pressure, and specific concerns in Singapore. *J Clin Hypertens*. 2020;22(3):508–551. <https://onlinelibrary.wiley.com/doi/abs/10.1111/jch.13782>.
117. Yap AF, Thirumoorthy T, Kwan YH. Medication adherence in the elderly. *J Clin Gerontol Geriatrics*. 2016;7(2):64–67.
118. Toh MR, Teo V, Kwan YH, Raaj S, Tan S-YD, Tan JZY. Association between number of doses per day, number of medications and patient's non-compliance, and frequency of readmissions in a multi-ethnic Asian population. *Prev Med Rep*. 2014;1(1):43–47.
119. Siddique S. Asian management of hypertension: current status, home blood pressure, and specific concerns in Pakistan. *J Clin Hypertens*. 2020;22(3):501–503. <https://www.onlinelibrary.wiley.com/doi/abs/10.1111/jch.13778>.
120. Ching S, Chia YC, Chew BN, et al. Knowledge on the action to be taken and recognition of symptoms of stroke in a community: findings from the may measurement month 2017 blood pressure screening programme in Malaysia. *BMC Public Health*. 2019;19(1):1602.
121. Huo Y, Li J, Qin X, et al. Efficacy of folic acid therapy in primary prevention of stroke among adults with hypertension in China: the CSPPT randomized clinical trial. *JAMA*. 2015;313(13):1325–1335.
122. Zhang T, Lin T, Wang Y, et al. Estimated stroke-free survival of folic acid therapy for hypertensive adults: projection based on the CSPPT. *Hypertension*. 2020;75(2):339–346.
123. Cheiloudaki E, Alexopoulos EC. Adherence to treatment in stroke patients. *Int J Environ Res Public Health [Internet]*. 2019;16(2):196. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6351941/>.
124. Turana Y, Sani T, Suryani E, Kaptein A. Cognitive and functional impairment, and perception of illness in acute stroke patients. *Arc Psychiatr Psychother*. 2019;18(21):37–44.

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