Title: The burden of neurological diseases in Asia: an analysis for the Global Burden of Disease Study 2019

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# Abstract

**Objectives**

The burden of diseases of neurological disorders is increasing worldwide, including Asia. The purpose of this study was to determine the burden of neurological disorders between 1990 and 2019 in Asia using the GBD Sociodemographic index.

**Design, setting, outcome and participants:** The GBD study is updated every year and the most recent version provides the burden of diseases according to age, gender and region from 1990 to 2019. The burden of neurological disorders was evaluated as incidence, prevalence, mortality, disability-adjusted life-years (DALYs), years of life lost (YLLs) and years lived with disability (YLDs).

**Results**

In 2019, DALYs of neurological diseases were 64.4 million in South-East Asia (95% UI 45.2-94.2) and 85.0 million in Western pacific regions (95% UI 63.0-118.5). Stroke, migraine, Alzheimer's disease and other dementias had the highest DALYs in the WHO South-East Asia and WHO Western pacific regions in 2019. DALYs of stroke, Alzheimer's disease and other dementia, Parkinson’s disease, brain and central nervous system cancer, multiple sclerosis, migraine and tension-type headache increased in both regions in 2019 compared to 1990. Infectious diseases such as tetanus, meningitis and encephalitis decreased in both regions. DALYs of idiopathic epilepsy and motor neuron disease increased in the WHO South-East Asia region and decreased in the WHO Western Pacific region.

**Conclusions**

This study demonstrated the burden of neurological diseases in Asia. To reduce the burden of neurological disease, strategies suitable for each country’s real health care needs and challenges are needed; this study can serve as the cornerstone of the strategy.

**Keywords:** Global burden of diseases, neurological disease, stroke, dementia

**Strengths and limitations of this study**

Our study showed the DALYs of 13 key neurological diseases in the Asian region in 2019 and compared the difference in disease patterns with those reported in 1990.

The GBD methodology offers standardized statistical approaches, that are comparable across countries and time, which can reduce the challenges of trying to estimate disease burdens in terms of incidence, prevalence, mortality, YLLs or YLDs, diminishing potential biases.

The quality of the information varies in the countries and there may be incomplete data.

# Introduction

Neurological disorders are among the major causes of death and permanent or transient disabilities in human beings.1 Globally, the burden of diseases of neurological disorders is increasing.2 According to the 2016 global burden of disease, it was the second most common cause of death and the leading cause of disability-adjusted life-years (DALY).2 In addition, the incidence, prevalence and DALYs of neurological disorders are expected to increase with the increasing aged population across the world. The aged population is increasing in many countries, including the Asian countries.3,4 In Asia the gap between the rich and the poor is also large and varies across countries.5 Notably, the prevalence and mortality of neurological diseases vary according to age and socioeconomic status,6,7 and in Asia, these characteristics are likely to directly or indirectly affect the burden of neurological disorders. Moreover, different characteristics of the Asia population including genetic, climatic, cultural and economic conditions, may present differences in the burden of diseases of neurological disorders between the Asian countries. Therefore, evaluating the burden of neurological diseases in the individual Asian countries is essential for health policymaking.

The global burden of disease (GBD) study is a collaborative study of diseases worldwide, providing systematic information on 369 diseases in 204 countries each year.8 According to the recent GBD study,9,10 neurological diseases are increasing worldwide including in Asia, but studies analyzing each neurological disease in detail in Asia are lacking.

The purpose of this study was to determine the burden of neurological disorders, including incidence, prevalence, death, DALY, years lived with disability (YLDs) and years of life lost (YLLs) between 1990 and 2019 in the Asian region and each Asian country using estimates from the GBD study website.

# Methods

*Overview*

Our data was extracted from GBD's publicly provided website; all GBD’s research results can be freely accessed and downloaded from the GBD compare and the Global Health Data Exchange websites (GBD Compare; Available at https://vizhub.healthdata.org/gbd-compare/, Global Health Data Exchange; Available at http://ghdx.healthdata.org/).8 The GBD 2019 methods are described in detail on the GBD website and in a previous study.9 The GBD 2019 is a worldwide multinational collaborative study. The GBD study is updated every year and the most recent version provides the burden of diseases according to age, gender and region (369 diseases and injuries in 204 countries and territories) from 1990 to 2019. Our study data acquisition and analysis followed the methodology provided on the GBD website. Our study included 13 neurological diseases (ICD-10 codes) including stroke (I63), Alzheimer's disease and other dementias (F01~03), Parkinson's disease (G20), brain and central nervous system cancer (C71~72), idiopathic epilepsy (G40), motor neuron disease (G12.2), multiple sclerosis (G35), migraine (G43), tension-type headache (G44.2), meningitis (G00~03), encephalitis G04~05), tetanus (A33~35) and other neurological disorders.

*DALYs, YLDs and YLLs*

The burden of each neurological disorder was separately evaluated as incidence, prevalence, death, DALYs, YLDs and YLLs.11 DALYs are defined as the sum of YLDs and YLLs. YLD is the individual sequelae prevalence of each disease multiplied by disability weight, quantifying the severity of the sequelae as a number between 0 (indicating full health) and 1 (indicating death).12 YLL is the number of deaths multiplied by the standard life expectancy at the time of death. Standard life expectancy is obtained from the lowest observed age-specific mortality rate among a world population of over 5 million.11 Disability weights were estimated from nine US population surveys and an open internet survey that asked respondents to choose the healthier option among random pairs of health conditions provided with brief descriptions of key characteristics.12

Detailed methods for obtaining non-fatal estimates and death information have been described in a previous research study.9 Considering DALYs, YLDs and YLLs, the neurological disorders estimates were acquired from disease surveillance systems, registries, survey microdata, health claims data and systematic reviews of reports.9 These datasets are repositioned to the Global Health Data Exchange and data of different characteristics are analyzed using DisMod-MR 2.1, a Bayesian meta-regression tool.13,14 Age-standardized rate, which is a weighted average of the age-specific rates, was calculated to remove the confounding effect of age (Standard age structure: A population structure used in the GBD study to provide a constant distribution of covariates). Data were described using 95% uncertainty intervals (UIs) and changes from 1990 to 2019 as a percentage (95% UIs) provided by the GBD website.

*Asian countries*

In our study, the Asia region was analyzed by dividing it into WHO South-East Asia Region (12 countries) and WHO Western Pacific Region (42 countries) according to the range of locations provided by GBD and the burden of diseases calculated as an age-standardized rate per 100,000 was converted and compared with global data. Age-standardized rate of incidence, prevalence, death, DALYs, YLDs and YLLs, the total number for 1990 and 2019 and changes between 1990 and 2019 were investigated in WHO South-East Asia Region and WHO Western Pacific Region. The WHO South-East Asia Region countries were Bangladesh, Bhutan, Democratic People’s Republic of Korea, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Thailand and Timor-Leste. The WHO Western Pacific Region countries were American Samoa, Australia, Brunei Darussalam, Cambodia, China, Cook Islands, Fiji, Guam, Japan, Kiribati, Lao People’s Democratic Republic, Malaysia, Marshall Islands, Micronesia, Federated States of Mongolia, Nauru, New Zealand, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Philippines, Republic of Korea, Samoa, Singapore, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu and Viet Nam (Supplementary figure 1).

In Asia, the GBD study separates high-income regions (Astralasia: Australia and New Zealand, Asia Pacific countries: Brunei Darussalam, Japan, Republic of Korea and Singapore). Because the income level of the region may have influence on the mortality and prevalence of neurological diseases,15-17 our study investigated changes in DALYs between 1990 and 2019 in neurological disorders in Australasia and high-income Asia and Pacific regions.

*Sociodemographic Index (SDI)*

SDI is an index developed by GBD researchers, which measures degree of socioeconomic deveoplement.18 It is a composite of the rankings of incomes per capita, educational attainment and fertility rates. SDI of 0 means the lowest level of development, while SDI of 1 means the theoretical maximal level. SDI was a predictor of the health-related indexes,19 and widely used in predicting health outcomes and comparing different regions.20,21 The limitations of other GBD indicators also applies to this index, including measurement bias of different sources.22,23

*Patient and public involvement*

Patients and the public were not involved in our research's design, conduct, reporting or dissemination plans.

# Results

*2019 burden of neurological diseases in Asia*

The 2019 DALYs of neurological diseases in WHO South-East Asia and WHO Western pacific regions are shown in Table 1. In 2019, there were 821.8 million cases of newly diagnosed neurological diseases worldwide, 227 million in the WHO South-East Asia region and 178.6 million in the WHO Western Pacific region. The total number of DALYs of neurological diseases was 64.4 million in South-East Asia (95% UI 45.2-94.2) and 85.0 million in Western pacific regions (95% UI 63.0-118.5). Stroke, migraine, Alzheimer's disease and other dementias had the highest DALYs in WHO South-East Asia and WHO Western pacific regions. This pattern was identical to the global trend of neurological diseases. When the incidence, prevalence and mortality of each neurological disease were compared in the two regions, stroke, Alzheimer's disease and other dementias, Parkinson's disease, brain and central nervous system cancer and motor neuron disease were higher in the WHO Western Pacific region, while multiple sclerosis, migraine, tension-type headache, meningitis, encephalitis and tetanus were higher in the WHO South-East Asia regions (Table 1).

Figure 1 shows age-standardized DALYs in the WHO South-East Asia and WHO Western Pacific regions. The burden of age-standardized DALYs was highest in both regions in the order of stroke, Alzheimer's disease and other dementia and migraine. The age-standardized DALYs of stroke, Alzheimer's disease and other dementias, brain and central nervous system cancer were higher in the WHO Western Pacific region. On the other hand, DALYs of multiple sclerosis, idiopathic epilepsy, migraine, meningitis and encephalitis were higher in the WHO South-East Asia region (Figure 1).

Figure 2 shows DALYs of neurological disease in the Asia region by age. The total number of DALYs of stroke, Alzheimer's disease and other dementia were higher in old age in both areas and the age-standardized rate of stroke and dementia increased with age (Figure 2A). However, the total number of DALYs of migraine was relatively higher in the younger generation. The highest DALYs of stroke were in the ages between 60 to 64 in the WHO South-East Asia region and 70 to 74 in the WHO Western Pacific region (Figure 2B). When compared according to sex, the trend of DALYs in neurological disease showed a similar pattern in the WHO South-East Asia and the WHO Western Pacific regions. The number of DALYs of stroke was higher in men, while DALYs of dementia and migraine were higher in women. DALYs according to age and sex are described in the supplementary table 1 and 2.

*The difference of neurological diseases in Asia from 1990 to 2019*

In the WHO South-East Asia region, stroke, tetanus and meningitis had the highest age-standardized DALYs in 1990, which changed to stroke, migraine, Alzheimer's disease and other dementia in 2019. Age-standardized DALYs in the Western Pacific region showed a similar trend between 1990 and 2019, in the order of stroke, Alzheimer’s disease and other dementia and migraine (Table 2). The DALYs of stroke and Alzheimer's disease and other dementia, Parkinson’s disease, brain and central nervous system cancer, multiple sclerosis, migraine and tension-type headache increased in both regions in 2019 compared to 1990. Infectious diseases such as tetanus, meningitis and encephalitis decreased in both regions. The number of DALYs of idiopathic epilepsy and motor neuron disease increased in the WHO South-East Asia region and decreased in the WHO Western Pacific region. The age-standardized rate of stroke incidence (-10%, 157 to 141 in South-East Asia, -12%, 211 to 186 in Western Pacific) and mortality (-30%, 135 to 95 in South-East Asia, -42%, 180 to 104 in Western Pacific) decreased markedly in both regions. The age-standardized incidence of dementia declined in South-East Asia (-3%, 71 to 69), and increased in Western Pacific (14%, 92 to 105). Mortality of dementia was increased in both regions. The age-standardized incidence and prevalence of migraine and tension-type headache in the WHO South-East Asia region did not change since 1990, but increased in the WHO Western Pacific region (Supplementary table 3).

When age-standardized DALYs for each region were compared by income classification, motor neuron disease, multiple sclerosis and encephalitis increased in the Australasia region, in contrast to a decrease in the high-income Asia Pacific region. DALYs for Parkinson's disease increased in the Australasia and the high-income Asia Pacific regions, but DALYs for stroke, idiopathic epilepsy, meningitis and tetanus decreased (Table 3). The age-standardized DALYs of stroke, Alzheimer's disease and other dementias and migraine according to SDI by country are presented in Figures 3-5.

When analyzed by country, DALYs of stroke increased in China and India and decreased in Australia, Japan, the Republic of Korea and Singapore. Stroke mortality was raised in Australia, China, India and Japan and dropped in the Republic of Korea and Singapore. Age-standardized rate of incidence, prevalence, death, DALYs, YLDs and YLLs burden by country are described in the supplementary table 4. DALYs of Alzheimer's disease and other dementia and Parkinson's disease increased in most countries, but decreased in Nauru, Niue and Tokelau. DALYs of motor neuron disease increased in Australia, Singapore and Japan and decreased in China and the Republic of Korea. Mortality increased in Australia, China, Singapore and Japan, but decreased in the Republic of Korea. The DALYs of multiple sclerosis rose in all countries except Niue and Sri Lanka. Brain and CNS cancer decreased in Armenia, Niue and Tokelau, but increased in other countries. DALYs of idiopathic epilepsy increased in Australia and Singapore and decreased in China and the Republic of Korea. Mortality decreased in Japan, Republic of Korea and Singapore. Migraine's DALYs increased in all the Asian countries apart from Armenia, Georgia, Niue, Northern Mariana Islands, Northern Mariana Islands and Tokelau. DALYs of tension-type headaches increased in most countries except for Georgia, Niue and Tokelau. Meningitis decreased in all the countries except Vanuatu, and mortality decreased in all the countries except Guam and Vanuatu. DALYs of Encephalitis increased in Australia, the Republic of Korea and Singapore and decreased in China, Japan and India. Mortality increased in Australia, China, Japan, the Republic of Korea and Singapore. Tetanus increased in Guam, Kiribati, Papua New Guinea, Tajikistan and Vanuatu, but decreased in other countries.

# Discussion

In the WHO South-East Asia and WHO Western pacific regions, neurological diseases accounted for 3% and 5% of age-standardized DALYs in 2019.9 Among the leading causes of the global burden of disease all age DALYs, stroke ranked 3rd and headache disorder ranked 15th. Stroke, migraine and dementia accounted for the highest number of DALYs in the WHO South-East Asia and WHO Western pacific regions, which did not differ significantly from the global trend. High DALYs of neurological disease in the Asia region is thought to be due to increased life expectancy, as DALYs of neurological diseases were higher in the elderly. In particular, stroke and dementia have a higher incidence with advancing age, and the long life expectancy of these patients increases as medical technology advances. Headache disorder frequently occurred in the young population. The increase in the burden of headaches might be due to changes in recognition of the disease and diagnostic criteria.

Stroke was the most common neurologic disease in 1990 and 2019; compared to 1990, the total DALYs of stroke increased in both regions, but the age-standardized incidence and mortality rate decreased. Risk factors included hypertension, diabetes, dyslipidemia, atrial fibrillation, smoking, alcohol, OSA and other minor elements.24,25 The mortality attributed to hypertension and diabetes significantly reduced between 1990-2019.26,27 As awareness of the effects of these diseases on stroke has increased and the change of public health policies, there is a possibility that it may have had the effect of reducing the burden. In addition, with the gradual development of medical treatment methods for each disease, the preventive effect of a stroke may have increased. Medications for hypertension, diabetes and dyslipidemia have been continuously developed for decades, and researchers are focusing on the impact of these drugs on cardiovascular risk reduction.28-30 For atrial fibrillation, non-vitamin K antagonist oral anticoagulants, which have lower hemorrhagic complication rates than warfarin,31 are being used widely. Treatment methods for stroke have also made great strides. Intravenous thrombolytic therapy and endovascular thrombectomy are widely used and can effectively reduce mortality and disability after stroke.32,33 Furthermore, it is possible to maximize the treatment effect by educating the general public about the importance of the time window, developing a patient transport system, and the use of stroke units. When the age-standardized DALYs according to SDI for each country were plotted, high-income countries showed lower DALYs. This suggests that there may be differences in access to medical care and preventive medicine depending on economic status. Therefore, it is necessary to develop prevention and treatment strategies for stroke in low-income countries.

DALYs of Alzheimer's disease and other dementias were increased in both the WHO South-East Asia and WHO Western pacific regions, which may be the consequence of an increased ageing population. However, the age-standardized rate of dementia in the WHO South-East and WHO Western Pacific regions showed somewhat different patterns. In the WHO South-East region, the change of dementia incidence was -3%, prevalence did not change and mortality and DALYs were increased by 10% and 7% each. In the WHO Western Pacific region, the incidence, prevalence, mortality and DALYs of dementia were increased by 14%, 25%, 7% and 9%, respectively. In the 2019 GBD report, DALYs of Alzheimer’s disease and other dementia was slightly increased from 1990.9 The exact cause of these differences is unknown, but nutrition, physical activity, genetic influence and access to health care may have affected the results.34,35 As for dementia, there seems to be no significant improvement compared to 1990, which could be attributed to the lack of development of new powerful preventive and therapeutic drugs.36,37 Considering the current global change into an ageing society, medical research and social support for dementia are essential.

Age-standardized incidence and prevalence of epilepsy increased, but YLL and mortality were markedly decreased, and YLD did not show significant change. It is estimated that there will be an impact from the development of various anti-epileptic drugs and advances in critical care medicine.38 The incidence of infectious diseases such as meningitis and encephalitis is decreasing worldwide,9 but that of encephalitis has increased in the Australasia region. Further investigations are needed to determine the exact cause of the increase in encephalitis in this region.

The neurological diseases show various patterns in each country, which is in line with previous reports.6,15-17,39,40 Environmental factors and latitudinal gradient may have influenced this results.41,42 Health care strategy suitable for each country should be applied based on the results of this study.

*Limitation*

General limitations of the GBD study also apply to this report. First, the quality of the information varies across the countries, and there may be incomplete data. Because we do not have access to the original dataset, we could not conduct further statistical analysis to reduce bias. Second, the definition of cause of death may vary across different medical data sources; a study in India reported that there is marked heterogeneity in reporting of deaths across states of India.43 These restrictions apply to other Asian countries as well. The results of this study should be interpreted with caution, due to limited access to original data, and most of the results are derived from the computation of a large dataset. However, the GBD study takes these differences into account to make standard definitions and standard health indicators that can be compared among regions, countries and subnational settings. Third, the disability weights used to calculate YLD may vary across the countries. Fourth, a wide 95% UI is frequently noted, which implies the low precision of the estimate. Fifth, other neurological diseases, including peripheral neuropathy, tremor, dizziness and sleep disorders were not included in the analysis because the GBD dataset does not have information on these diseases. Sixth, We could not suggest genetic epidemiological evidence for the Asian regions, which is a major limitation of our study. In a further study, information on the financial burden of neurological diseases will be helpful in making health policy decisions in Asia.

# Conclusion

This study described the burden of neurological diseases in Asia. Although the DALYs of some neurological diseases are decreasing, it is necessary to pay attention to the diseases that are increasing. To reduce the burden of neurologic disease, strategies suited to the reality of each country’s healthcare needs and challenges are needed, and this study can serve as the cornerstone of such effective strategies. Also, as COVID-19 became pandemic in 2019, further research will help identify changes in disease burden before and after covid. Due to the possible bias resulting from the limitations of the GBD research method, additional research is needed for accurate statistics for each country.

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Not applicable.

**Authors' contributions**

All authors contributed and approved the study’s protocol. YC drafted the first draft of the manuscript, SK, SE and TJS analysed data. AK, LJ, LS and JIS critically revised manuscript. All authors read, edited, and approved the final version of the manuscript.

**Conflict of interest statements**

None.

**Data sharing**

Data are publicly available at the Institute for Health Metrics and Evaluation (IHME) website (http://www.ghdx.healthdata.org/gbd-results-tool).

**Ethics committee approval**

Our study was also approved by the Institutional Review Board at Ewha Womans University Seoul hospital for the data use. (SEUMC202108006)

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# Tables

Table 1. Global burden of neurologic diseases, comparison of South-East Asia and Western Pacific regions

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| --- | --- | --- | --- | --- | --- | --- |
|  | WHO South-East Asia Region | | WHO Western Pacific Region | | Global | |
|  | age standarized rate per 100,000 | total | age standarized rate per 100,000 | total | age standarized rate per 100,000 | total |
| All neurologic disorders | | | | | | |
| Incidence | 10994 (9744 to 12287) | 226998829 (200601270 to 254330446) | 8916 (7883 to 9979) | 178623423 (158333885 to 200437404) | 10470 (9238 to 11694) | 821776610 (727488041 to 919318436) |
| Prevalence | 43051 (37682 to 48745) | 894030244 (780335832 to 1016465795) | 35568 (31066 to 40414) | 756740040 (664386310 to 859419226) | 41772 (36516 to 47456) | 3325372960 (2907966956 to 3769513797) |
| Deaths | 131 (104 to 177) | 1887646 (1588078 to 2451216) | 140 (106 to 193) | 3461708 (2675849 to 4704952) | 123 (96 to 167) | 9381103 (7434071 to 12592144) |
| DALYs | 3634 (2610 to 5245) | 64373789 (45229328 to 94249122) | 3432 (2486 to 4891) | 85008645 (63024027 to 118461528) | 3464 (2521 to 4945) | 273063453 (199632801 to 388511035) |
| YLDs | 994 (353 to 1981) | 19737182 (6512402 to 40284964) | 1032 (442 to 1915) | 23834461 (10847769 to 42769329) | 1066 (430 to 2030) | 84664628 (34113447 to 161432585) |
| YLLs | 2640 (2176 to 3361) | 44636607 (37336170 to 55748014) | 2400 (1919 to 3103) | 61174183 (49197722 to 79105935) | 2398 (2004 to 3013) | 188398824 (158532246 to 234960422) |
| Stroke | | | | | | |
| Incidence | 141 (128 to 157) | 2459950 (2228862 to 2738665) | 186 (166 to 211) | 4968330 (4390222 to 5682575) | 151 (137 to 167) | 12224551 (11041816 to 13589312) |
| Prevalence | 1006 (916 to 1102) | 18711833 (17039072 to 20483835) | 1432 (1299 to 1580) | 38077336 (34325689 to 42131345) | 1240 (1140 to 1353) | 101474558 (93211910 to 110526302) |
| Deaths | 95 (85 to 104) | 1409305 (1266526 to 1544474) | 104 (91 to 117) | 2657992 (2329878 to 2992210) | 84 (77 to 90) | 6552725 (5995200 to 7015139) |
| DALYs | 2008 (1811 to 2193) | 34460498 (31035171 to 37670399) | 2121 (1891 to 2369) | 56185166 (49950162 to 62813530) | 1768 (1641 to 1889) | 143232184 (133095809 to 153241824) |
| YLDs | 173 (124 to 221) | 3170198 (2279562 to 4040730) | 299 (211 to 384) | 7861628 (5539716 to 10094189) | 218 (157 to 277) | 17741742 (12759419 to 22587415) |
| YLLs | 1835 (1647 to 2016) | 31290299 (28062279 to 34507727) | 1822 (1592 to 2058) | 48323539 (42236848 to 54716916) | 1550 (1435 to 1661) | 125490442 (116154749 to 134427938) |
| Alzheimer's disease and other dementias | | | | | | |
| Incidence | 69 (59 to 79) | 914160 (784215 to 1050976) | 105 (89 to 120) | 2647125 (2240264 to 3036566) | 95 (82 to 108) | 7236385 (6217239 to 8232672) |
| Prevalence | 470 (402 to 541) | 6282408 (5348571 to 7222877) | 775 (658 to 893) | 19243137 (16313439 to 22148027) | 682 (585 to 783) | 51624193 (44276969 to 59021502) |
| Deaths | 20 (5 to 53) | 209371 (50293 to 569326) | 25 (6 to 64) | 559566 (141027 to 1435145) | 23 (6 to 59) | 1623276 (407465 to 4205719) |
| DALYs | 278 (114 to 644) | 3485650 (1444595 to 8150443) | 377 (170 to 797) | 9195842 (4102641 to 19647700) | 339 (151 to 731) | 25276989 (11204523 to 54558243) |
| YLDs | 66 (47 to 89) | 857947 (607194 to 1145962) | 113 (79 to 152) | 2774288 (1946073 to 3737698) | 99 (70 to 133) | 7417069 (5226780 to 9927706) |
| YLLs | 212 (51 to 576) | 2627704 (618718 to 7280232) | 264 (66 to 682) | 6421554 (1608173 to 16980491) | 240 (58 to 627) | 17859920 (4374613 to 47064787) |
| Parkinson's disease | | | | | | |
| Incidence | 10 (9 to 12) | 164617 (141238 to 188411) | 14 (12 to 16) | 381973 (323674 to 440966) | 13 (12 to 15) | 1081723 (953265 to 1211202) |
| Prevalence | 79 (66 to 93) | 1236275 (1036369 to 1470605) | 131 (109 to 154) | 3532065 (2939286 to 4199916) | 106 (91 to 122) | 8511022 (7288530 to 9841378) |
| Deaths | 5 (4 to 6) | 66316 (58359 to 75120) | 4 (4 to 5) | 110560 (97589 to 122300) | 5 (4 to 5) | 362907 (326855 to 388200) |
| DALYs | 81 (72 to 91) | 1197394 (1057423 to 1339100) | 79 (70 to 89) | 2090741 (1839874 to 2355241) | 80 (73 to 87) | 6292616 (5769210 to 6827207) |
| YLDs | 11 (8 to 15) | 174558 (118998 to 238504) | 19 (13 to 26) | 509134 (346961 to 702768) | 15 (10 to 20) | 1210093 (841166 to 1640683) |
| YLLs | 70 (62 to 79) | 1022835 (900696 to 1152766) | 60 (53 to 67) | 1581607 (1390754 to 1758379) | 65 (60 to 69) | 5082522 (4673385 to 5409853) |
| Brain and central nervous system cancer | | | | | | |
| Incidence | 2 (2 to 3) | 43379 (31926 to 50978) | 5 (4 to 6) | 120200 (90121 to 140470) | 4 (3 to 5) | 347992 (262084 to 388896) |
| Prevalence | 4 (3 to 5) | 77034 (57609 to 91309) | 22 (16 to 25) | 453450 (335491 to 524264) | 13 (10 to 15) | 1065294 (800441 to 1199906) |
| Deaths | 2 (2 to 2) | 36918 (27664 to 42969) | 3 (2 to 4) | 75706 (56624 to 89363) | 3 (2 to 3) | 246253 (185642 to 270930) |
| DALYs | 80 (60 to 93) | 1532948 (1153447 to 1796140) | 112 (86 to 132) | 2470092 (1887397 to 2919034) | 109 (85 to 121) | 8659871 (6718029 to 9574458) |
| YLDs | 1 (0 to 1) | 13122 (8509 to 18098) | 2 (1 to 3) | 49116 (32267 to 68440) | 2 (1 to 2) | 129402 (83870 to 174962) |
| YLLs | 79 (59 to 92) | 1519827 (1144514 to 1778575) | 110 (84 to 130) | 2420976 (1851199 to 2860880) | 107 (83 to 119) | 8530468 (6625077 to 9447558) |
| Idiopathic epilepsy | | | | | | |
| Incidence | 34 (24 to 46) | 670517 (458321 to 902665) | 28 (20 to 38) | 480158 (339198 to 630891) | 39 (28 to 51) | 2898222 (2098718 to 3823376) |
| Prevalence | 288 (211 to 369) | 5683680 (4118542 to 7301504) | 235 (170 to 305) | 4468232 (3248818 to 5776859) | 326 (248 to 408) | 25111110 (19033571 to 31433013) |
| Deaths | 2 (2 to 2) | 38242 (31793 to 45119) | 1 (1 to 1) | 15594 (13564 to 17955) | 1 (1 to 2) | 114011 (100178 to 129928) |
| DALYs | 187 (146 to 237) | 3721812 (2894671 to 4718264) | 102 (73 to 137) | 1909337 (1365698 to 2534086) | 171 (130 to 218) | 13077624 (9986730 to 16734086) |
| YLDs | 97 (59 to 142) | 1932824 (1148469 to 2830045) | 66 (38 to 100) | 1224420 (702688 to 1851608) | 101 (63 to 147) | 7740804 (4810323 to 11216664) |
| YLLs | 90 (75 to 109) | 1788988 (1513365 to 2157506) | 36 (32 to 42) | 684917 (598182 to 792351) | 69 (62 to 81) | 5336821 (4722718 to 6170046) |
| Motor neuron disease | | | | | | |
| Incidence | 0 (0 to 1) | 7877 (6454 to 9715) | 1 (1 to 1) | 14425 (12435 to 17144) | 1 (1 to 1) | 63700 (57296 to 71343) |
| Prevalence | 2 (1 to 2) | 36074 (28793 to 45132) | 3 (3 to 4) | 64252 (53666 to 76668) | 3 (3 to 4) | 268674 (231894 to 310664) |
| Deaths | 0 (0 to 0) | 2144 (1699 to 2602) | 0 (0 to 0) | 6851 (6172 to 7509) | 0 (0 to 1) | 39081 (36567 to 41130) |
| DALYs | 4 (3 to 5) | 78631 (64804 to 93556) | 8 (8 to 9) | 195642 (178225 to 213956) | 13 (12 to 13) | 1034607 (979911 to 1085401) |
| YLDs | 0 (0 to 1) | 7663 (5233 to 10701) | 1 (0 to 1) | 13652 (9353 to 18660) | 1 (0 to 1) | 57068 (39982 to 76338) |
| YLLs | 4 (3 to 5) | 70968 (57011 to 85840) | 8 (7 to 8) | 181990 (165357 to 200233) | 12 (11 to 13) | 977539 (926348 to 1025430) |
| Multiple sclerosis | | | | | | |
| Incidence | 0 (0 to 0) | 7326 (5919 to 8777) | 0 (0 to 0) | 4884 (4075 to 5745) | 1 (1 to 1) | 59345 (51818 to 66943) |
| Prevalence | 7 (5 to 8) | 133149 (104679 to 162846) | 4 (3 to 5) | 97656 (78961 to 117302) | 21 (19 to 24) | 1756792 (1531919 to 1973623) |
| Deaths | 0 (0 to 0) | 3090 (2588 to 3850) | 0 (0 to 0) | 2678 (2239 to 3506) | 0 (0 to 0) | 22439 (20226 to 27792) |
| DALYs | 7 (6 to 9) | 147786 (124902 to 179583) | 4 (4 to 6) | 113019 (95485 to 141751) | 14 (12 to 17) | 1159832 (1001180 to 1381870) |
| YLDs | 2 (1 to 3) | 37457 (24802 to 52575) | 1 (1 to 2) | 26837 (17991 to 37122) | 5 (4 to 7) | 451204 (320712 to 591541) |
| YLLs | 6 (5 to 7) | 110328 (92181 to 139573) | 3 (3 to 4) | 86182 (71800 to 112420) | 9 (8 to 11) | 708628 (645137 to 897753) |
| Migraine | | | | | | |
| Incidence | 1230 (1076 to 1380) | 26046477 (22798840 to 29262475) | 1013 (887 to 1140) | 18292329 (16118069 to 20494099) | 1143 (996 to 1289) | 87648969 (76635688 to 98654602) |
| Prevalence | 14982 (13027 to 17162) | 316734874 (274176841 to 363846694) | 12187 (10561 to 14040) | 260784747 (226812263 to 301419267) | 14107 (12270 to 16239) | 1128087261 (979598830 to 1298138078) |
| DALYs | 543 (67 to 1250) | 11496964 (1378922 to 26551209) | 456 (66 to 1047) | 9804347 (1563046 to 22190876) | 526 (79 to 1194) | 42077666 (6418383 to 95645211) |
| YLDs | 543 (67 to 1250) | 11496964 (1378922 to 26551209) | 456 (66 to 1047) | 9804347 (1563046 to 22190876) | 526 (79 to 1194) | 42077666 (6418383 to 95645211) |
| Tension-type headache | | | | | | |
| Incidence | 9427 (8378 to 10520) | 195278793 (172937877 to 218506222) | 7535 (6682 to 8414) | 151301373 (134464822 to 169511609) | 8968 (7932 to 9991) | 706190114 (626723555 to 788575302) |
| Prevalence | 25984 (22866 to 29186) | 540547852 (474735815 to 610313741) | 20692 (18177 to 23301) | 428252237 (378886064 to 480860531) | 25113 (22021 to 28316) | 1995172549 (1751946846 to 2242204885) |
| DALYs | 52 (15 to 193) | 1079949 (299851 to 4031993) | 47 (14 to 160) | 1041113 (336537 to 3331809) | 56 (17 to 189) | 4541689 (1395546 to 14981336) |
| YLDs | 52 (15 to 193) | 1079949 (299851 to 4031993) | 47 (14 to 160) | 1041113 (336537 to 3331809) | 56 (17 to 189) | 4541689 (1395546 to 14981336) |
| Meningitis | | | | | | |
| Incidence | 37 (30 to 44) | 669482 (552202 to 794001) | 9 (7 to 11) | 132795 (109381 to 157159) | 35 (30 to 42) | 2507224 (2113069 to 2988698) |
| Prevalence | 127 (109 to 150) | 2569405 (2186846 to 3028860) | 26 (22 to 31) | 509277 (436456 to 591205) | 100 (86 to 119) | 7683540 (6590288 to 9132199) |
| Deaths | 3 (2 to 3) | 45101 (39479 to 51199) | 1 (1 to 1) | 11158 (10023 to 12372) | 3 (3 to 4) | 236222 (204381 to 277426) |
| DALYs | 157 (136 to 181) | 2853048 (2491747 to 3283248) | 45 (40 to 51) | 638116 (570390 to 710280) | 234 (196 to 283) | 16333198 (13775122 to 19609767) |
| YLDs | 12 (8 to 16) | 245531 (171501 to 332356) | 3 (2 to 3) | 45970 (31976 to 61948) | 9 (6 to 12) | 683333 (480874 to 924320) |
| YLLs | 145 (124 to 170) | 2607517 (2246012 to 3042005) | 43 (37 to 48) | 592146 (524401 to 665944) | 225 (187 to 273) | 15649865 (13102961 to 18930650) |
| Encephalitis | | | | | | |
| Incidence | 39 (36 to 43) | 707383 (636882 to 776165) | 18 (15 to 21) | 275200 (238867 to 314275) | 19 (17 to 22) | 1444722 (1280147 to 1614941) |
| Prevalence | 100 (74 to 124) | 1976424 (1473377 to 2443468) | 60 (46 to 75) | 1241619 (945430 to 1551531) | 57 (43 to 70) | 4499425 (3372091 to 5573174) |
| Deaths | 3 (3 to 5) | 57265 (45832 to 89466) | 0 (0 to 1) | 7899 (6843 to 9310) | 1 (1 to 2) | 89897 (76532 to 122874) |
| DALYs | 149 (119 to 231) | 2734495 (2187604 to 4270395) | 37 (31 to 42) | 551783 (478145 to 627604) | 65 (55 to 87) | 4797407 (4059493 to 6418088) |
| YLDs | 11 (8 to 15) | 221171 (157506 to 297608) | 6 (4 to 8) | 123120 (85292 to 166065) | 6 (4 to 8) | 482436 (343282 to 647343) |
| YLLs | 138 (109 to 220) | 2513325 (1971560 to 4065901) | 30 (25 to 35) | 428663 (361548 to 508836) | 59 (50 to 81) | 4314970 (3623222 to 5928341) |
| Tetanus | | | | | | |
| Incidence | 2 (1 to 2) | 28867 (18533 to 41397) | 0 (0 to 0) | 4630 (2756 to 5906) | 1 (1 to 1) | 73662 (53347 to 101149) |
| Prevalence | 1 (1 to 2) | 29238 (21190 to 38358) | 0 (0 to 0) | 5883 (3918 to 8256) | 1 (1 to 1) | 61660 (44603 to 81241) |
| Deaths | 1 (0 to 1) | 11901 (7465 to 16276) | 0 (0 to 0) | 1508 (888 to 1890) | 0 (0 to 1) | 34684 (25943 to 48457) |
| DALYs | 44 (28 to 62) | 741167 (478331 to 1059882) | 4 (3 to 5) | 68690 (43256 to 82825) | 34 (26 to 48) | 2316381 (1770002 to 3279408) |
| YLDs | 0 (0 to 0) | 792 (456 to 1234) | 0 (0 to 0) | 145 (78 to 243) | 0 (0 to 0) | 1745 (1022 to 2663) |
| YLLs | 44 (28 to 62) | 740375 (477596 to 1059241) | 4 (3 to 5) | 68544 (43146 to 82653) | 34 (26 to 48) | 2314636 (1768800 to 3276980) |
| Other neurological disorders | | | | | | |
| Incidence | 0 (0 to 0) | 0 (0 to 0) | 0 (0 to 0) | 0 (0 to 0) | 0 (0 to 0) | 0 (0 to 0) |
| Prevalence | 1 (0 to 1) | 11999 (8128 to 16565) | 1 (0 to 1) | 10147 (6829 to 14054) | 1 (0 to 1) | 56882 (39066 to 77832) |
| Deaths | 0 (0 to 1) | 7993 (6087 to 10812) | 1 (0 to 1) | 12195 (11002 to 13391) | 1 (1 to 1) | 59610 (55082 to 64551) |
| DALYs | 43 (31 to 56) | 843447 (617859 to 1104911) | 39 (31 to 48) | 744757 (613170 to 892837) | 56 (45 to 68) | 4263390 (3458864 to 5174136) |
| YLDs | 25 (16 to 36) | 499006 (311400 to 733949) | 20 (12 to 29) | 360690 (235791 to 507905) | 28 (18 to 40) | 2130376 (1392089 to 3016404) |
| YLLs | 18 (13 to 25) | 344440 (252238 to 478649) | 19 (17 to 21) | 384066 (346315 to 426832) | 28 (25 to 31) | 2133013 (1915236 to 2381088) |

WHO: World Health Organization, DALYs: disability-adjusted life-years, YLDs: years lived with disability, YLLs: years of life lost

Table 2. Trends of neurological diseases in South-East Asia and Western Pacific regions between 1990 and 2019

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **WHO South-east asia region** | | | | | | **WHO Western pacific region** | | | | | |
|  | Age standarized rate 1990 | Age standarized rate 2019 | Change from 1990 to 2019 | Total, 1990 | Total, 2019 | Change from 1990 to 2019 | Age standarized rate 1990 | Age standarized rate 2019 | Change from 1990 to 2019 | Total, 1990 | Total, 2019 | Change from 1990 to 2019 |
| **Stroke** | | | | | | | | | | | | |
| DALYs | 2839 (2594 to 3097) | 2008 (1811 to 2193) | -29% (-38 to -21) | 20183896 (18482460 to 21850550) | 34460498 (31035171 to 37670399) | 71% (51 to 90) | 3584 (3250 to 3984) | 2121 (1891 to 2369) | -41% (-49 to -32) | 40811727 (36975527 to 45349220) | 56185166 (49950162 to 62813530) | 38% (18 to 60) |
| **Alzheimer's disease and other dementias** | | | | | | | | | | | | |
| DALYs | 260 (108 to 623) | 278 (114 to 644) | 7% (-1 to 16) | 990724 (415186 to 2337548) | 3485650 (1444595 to 8150443) | 252% (222 to 284) | 345 (145 to 784) | 377 (170 to 797) | 9% (-1 to 21) | 2711166 (1136067 to 6270660) | 9195842 (4102641 to 19647700) | 239% (202 to 284) |
| **Parkinson's disease** | | | | | | | | | | | | |
| DALYs | 82 (71 to 100) | 81 (72 to 91) | -1% (-17 to 13) | 417460 (358716 to 506514) | 1197394 (1057423 to 1339100) | 187% (140 to 229) | 86 (78 to 95) | 79 (70 to 89) | -8% (-18 to 3) | 854035 (768070 to 944762) | 2090741 (1839874 to 2355241) | 145% (117 to 176) |
| **Brain and central nervous system cancer** | | | | | | | | | | | | |
| DALYs | 84 (59 to 129) | 80 (60 to 93) | -6% (-44 to 28) | 1103726 (707940 to 1781878) | 1532948 (1153447 to 1796140) | 39% (-21 to 101) | 138 (104 to 189) | 112 (86 to 132) | -19% (-48 to 8) | 2033299 (1521466 to 2779444) | 2470092 (1887397 to 2919034) | 21% (-21 to 61) |
| **Idiopathic epilepsy** | | | | | | | | | | | | |
| DALYs | 259 (186 to 322) | 187 (146 to 237) | -28% (-41 to 0) | 3545290 (2494855 to 4454038) | 3721812 (2894671 to 4718264) | 5% (-16 to 48) | 144 (114 to 178) | 102 (73 to 137) | -29% (-44 to -9) | 2301988 (1834995 to 2835846) | 1909337 (1365698 to 2534086) | -17% (-35 to 7) |
| **Motor neuron disease** | | | | | | | | | | | | |
| DALYs | 3 (3 to 4) | 4 (3 to 5) | 27% (5 to 49) | 34733 (28437 to 41104) | 78631 (64804 to 93556) | 126% (89 to 164) | 14 (13 to 15) | 8 (8 to 9) | -40% (-46 to -31) | 199306 (181271 to 217406) | 195642 (178225 to 213956) | -2% (-13 to 13) |
| **Multiple sclerosis** | | | | | | | | | | | | |
| DALYs | 7 (5 to 10) | 7 (6 to 9) | 5% (-17 to 38) | 69126 (51225 to 96038) | 147786 (124902 to 179583) | 114% (67 to 179) | 5 (5 to 6) | 4 (4 to 6) | -19% (-34 to 5) | 77463 (63701 to 91450) | 113019 (95485 to 141751) | 46% (19 to 92) |
| **Migraine** | | | | | | | | | | | | |
| DALYs | 545 (67 to 1258) | 543 (67 to 1250) | 0% (-3 to 3) | 6637060 (720531 to 15495588) | 11496964 (1378922 to 26551209) | 73% (66 to 93) | 423 (69 to 949) | 456 (66 to 1047) | 8% (-5 to 13) | 6768009 (1059137 to 15293657) | 9804347 (1563046 to 22190876) | 45% (36 to 55) |
| **Tension-type headache** | | | | | | | | | | | | |
| DALYs | 51 (14 to 194) | 52 (15 to 193) | 1% (-5 to 8) | 589905 (155480 to 2406405) | 1079949 (299851 to 4031993) | 83% (60 to 99) | 47 (15 to 163) | 47 (14 to 160) | 0% (-7 to 10) | 719450 (222679 to 2586630) | 1041113 (336537 to 3331809) | 45% (21 to 63) |
| **Meningitis** | | | | | | | | | | | | |
| DALYs | 632 (546 to 727) | 157 (136 to 181) | -75% (-80 to -70) | 10288577 (8807057 to 11946290) | 2853048 (2491747 to 3283248) | -72% (-77 to -66) | 247 (217 to 279) | 45 (40 to 51) | -82% (-85 to -78) | 3808929 (3340387 to 4298041) | 638116 (570390 to 710280) | -83% (-86 to -80) |
| **Encephalitis** | | | | | | | | | | | | |
| DALYs | 400 (319 to 493) | 149 (119 to 231) | -63% (-72 to -38) | 6110657 (4667671 to 7761085) | 2734495 (2187604 to 4270395) | -55% (-68 to -23) | 75 (51 to 90) | 37 (31 to 42) | -51% (-61 to -31) | 1165784 (795140 to 1399876) | 551783 (478145 to 627604) | -53% (-62 to -31) |
| **Tetanus** | | | | | | | | | | | | |
| DALYs | 808 (681 to 945) | 44 (28 to 62) | -95% (-96 to -92) | 14068396 (11826744 to 16609293) | 741167 (478331 to 1059882) | -95% (-97 to -92) | 130 (102 to 156) | 4 (3 to 5) | -97% (-98 to -95) | 1980966 (1551335 to 2373157) | 68690 (43256 to 82825) | -97% (-98 to -95) |
| **Other neurological disorders** | | | | | | | | | | | | |
| DALYs | 39 (28 to 49) | 43 (31 to 56) | 9% (-7 to 37) | 552728 (368319 to 701791) | 843447 (617859 to 1104911) | 53% (30 to 98) | 35 (30 to 41) | 39 (31 to 48) | 10% (-5 to 30) | 538294 (454920 to 639130) | 744757 (613170 to 892837) | 38% (21 to 60) |

WHO: World Health Organization, DALYs: disability-adjusted life-years, YLDs: years lived with disability, YLLs: years of life lost

Table 3. Trends of neurological diseases in high-income Asia and Pacific regions between 1990 and 2019

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **High-income Asia & Pacific** | | | | | |
| **Australasia** | | | **High-income Asia Pacific** | | |
| 1990 | 2019 | change | 1990 | 2019 | change |
| Stroke | 1076 (1005 to 1132) | 461 (414 to 503) | -57% (-60 to -55) | 1936 (1815 to 2030) | 739 (659 to 814) | -62% (-64 to -59) |
| Alzheimer's disease and other dementias | 327 (147 to 726) | 320 (146 to 682) | -2% (-6 to 3) | 323 (144 to 711) | 385 (179 to 792) | 19% (11 to 26) |
| Parkinson's disease | 80 (73 to 86) | 84 (75 to 93) | 6% (0 to 12) | 53 (49 to 57) | 58 (51 to 63) | 10% (-2 to 15) |
| Brain and central nervous system cancer | 174 (152 to 217) | 145 (110 to 161) | -17% (-46 to -7) | 59 (52 to 82) | 59 (36 to 67) | 0% (-56 to 16) |
| Idiopathic epilepsy | 138 (83 to 221) | 116 (66 to 198) | -16% (-53 to 49) | 103 (70 to 146) | 80 (51 to 125) | -22% (-44 to 7) |
| Motor neuron disease | 46 (44 to 48) | 55 (50 to 60) | 20% (8 to 32) | 21 (19 to 23) | 15 (13 to 16) | -30% (-39 to -22) |
| Multiple sclerosis | 25 (20 to 31) | 29 (23 to 35) | 18% (-10 to 33) | 6 (5 to 8) | 6 (4 to 8) | -9% (-23 to 5) |
| Migraine | 495 (85 to 1112) | 496 (84 to 1113) | 0% (-3 to 3) | 410 (83 to 928) | 410 (82 to 923) | 0% (-3 to 3) |
| Tension-type headache | 60 (18 to 190) | 60 (18 to 188) | 0% (-6 to 8) | 63 (18 to 214) | 64 (18 to 213) | 1% (-4 to 5) |
| Meningitis | 50 (45 to 55) | 14 (13 to 16) | -71% (-75 to -67) | 49 (45 to 54) | 10 (8 to 11) | -80% (-83 to -77) |
| Encephalitis | 4 (4 to 6) | 6 (5 to 7) | 51% (-8 to 87) | 14 (12 to 17) | 11 (10 to 13) | -18% (-29 to -9) |
| Tetanus | 0 (0 to 0) | 0 (0 to 0) | -63% (-83 to -43) | 2 (1 to 2) | 0 (0 to 0) | -86% (-89 to -81) |
| Other neurological disorders | 66 (56 to 80) | 72 (59 to 92) | 9% (-12 to 36) | 47 (41 to 55) | 51 (43 to 63) | 8% (-5 to 25) |