Burden of Stroke in Nepal: Findings from Global Burden of Disease Dataset 2017

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Citation

Pyakurel M, Bhattarai S, Joshi B, Koju RP, Shrestha A. Burden of Stroke in Nepal: Findings from Global Burden of Disease Dataset 2017. *Kathmandu Univ Med J.* 2021; Cardiovascular Diseases (CVDs) Special Issue 75(3):11-7.

ABSTRACT

Background

Stroke is the second leading cause of death and disability worldwide including Asian countries, surpassing ischemic heart disease. Stroke accounts for 10% of global death, of which more than three fourth occur in low- and middle-income countries. An exact estimate of the burden of stroke in Nepal is not available.

Objective

To assess the burden of stroke including disability and death over time in Nepal and compare it with other South Asian countries.

Method

We retrieved data from the Institute of Health Metrics and Evaluation's Global Burden of Diseases database of 2017 on stroke deaths, disability-adjusted life years, incidence, and prevalence rates, for both genders from Nepal, Bangladesh, Pakistan, Bhutan, and India by year. We assessed the trend of deaths and Disability-Adjusted Life Years (DALYs) due to stroke from 1990 to 2017; and the contribution of major risk factors to stroke burden in 2017.

Result

Stroke contributed 7.6% of total deaths and 3.5% of total DALYs in Nepal, with a higher burden among the male and old age population. Intracerebral hemorrhage was the dominant type of stroke in Nepal with the highest proportion of deaths and DALYs. Among the South Asian countries, incidence, prevalence, and burden of stroke were highest in Bangladesh. Intracerebral hemorrhage contributed the highest DALYs in South Asian countries. High systolic blood pressure was contributing the maximum DALYs due to stroke in Nepal.

Conclusion

Hemorrhagic stroke causes high mortality and DALYs in Nepal. Most of the burden of stroke is attributed to high blood pressure in Nepal.

KEY WORDS

Global burden of disease (GBD), Nepal, Prevalence, Risk factor, Stroke

INTRODUCTION

Stroke is the second leading cause of death and disability worldwide, and it is the topmost cause of death and disability in some Asian countries, surpassing ischemic heart disease (IHD).[1] Stroke accounts for 10% of global death, of which more than three fourth occurs in low and middle-income countries.[2,3] Stroke caused 116.4 million Disability Adjusted Life Years (DALYs) globally and 11.6 million DALYs in Southeast Asia.[4] More than 90% of the stroke-related DALYs are attributed to modifiable risk factors such as smoking, diabetes, hypertension, etc.[5] About 15.2 million DALYs are due to metabolic risk factors and 15 million DALYs are due to behavioral risk factors.[5] The increasing demand for treatment and rehabilitation facilities for stroke survivors creates an immense socio-economic burden to countries especially in the low- and middle-income countries.[2,6,7]

An exact estimate of the burden of stroke in Nepal is not available. However, every year 50,000 population are estimated to develop stroke, while 15,000 people die from it.[8] Well-designed population-based studies on stroke epidemiology in Nepal are also lacking.[9] However, to combat the huge burden of health and economic loss, it is essential to have an update on epidemiological studies on stroke.[10] For effective implementation of controlling modifiable risk factors and generating policies to prevent stroke, a well-designed epidemiological study is of utmost importance.

This paper describes the burden of stroke in Nepal including death, disability, incidence, and prevalence over time, by age and gender; and compares the stroke burden with other South Asian countries.

METHODS

We retrieved data from the Institute of Health Metrics and Evaluation's (IHME) Global Burden of Disease (GBD) database from 1990 to 2017. We accessed age-standardized data on stroke deaths, DALYs, incidence, and prevalence rates for both genders of Nepal, Bangladesh, Pakistan, Bhutan, and India. Data on strokes related to other South Asian countries such as Maldives, Afghanistan, and Sri Lanka were not available in the GBD dataset.

The description of metrics, data collection procedures, and analytical approaches used for GBD 2017 are reported elsewhere.[11] Briefly, the prevalence data was modeled using DisMod-MR version 2.1, a standard disease modeling computational program used by GBD for non-fatal health outcomes. The mortality of stroke was estimated by GBD's Cause of Death Ensemble Model (CoDEm), which uses all available data sources to develop a series of plausible models to eventually give the best predictive model. All sources for South Asia GBD 2017 are listed in the data input sources tool.[12] In this input source, a total of 39 sources on stroke, gives a picture of the burden of strokes of South Asia. It includes published articles, survey reports, and hospital records. Epidemiological indicators: deaths, DALYs, incidence, and prevalence were calculated per 100,000 population. We also assessed the trend for death and DALYs due to stroke from 1990 to 2017; and the major risk factors contributing to stroke DALYs in 2017.

Table 1. Percentage of total deaths and DALYs due to stroke by gender in Nepal (all ages, 2017)

	Percentage of total deaths (95% UI)			Percentage of total DALYs (95% UI)		
	Both	Male	Female	Both	Male	Female
Ischemic stroke	2.92 (4.08-2.13)	3.36 (5.23-2.33)	2.38 (3.2-1.67)	1.14 (1.63-0.84)	1.4 (2.23-0.98)	0.87 (1.15-0.64)
Intracerebral hemorrhage	3.99 (4.96-3.11)	4.01 (5.2-2.96)	3.96 (5.39-2.68)	1.98 (2.51-1.52)	2.17 (2.82-1.63)	1.79 (2.47-1.2)
Subarachnoid hemorrhage	0.71 (1.22-0.34)	0.65 (1.19-0.29	0.77 (1.58-0.34)	0.43 (0.72-0.22)	0.43 (0.78-0.21)	0.43 (0.82-0.21)
Total stroke	7.61 (9.14-6.5)	8.03 (9.99-6.7)	7.12 (8.99-5.49)	3.56 (4.43-2.94)	4 (5.06-3.25)	3.09 (3.98-2.38)

RESULTS

In Nepal, a total of 7.61% (UI 9.14-6.5) deaths and 3.56% (UI 4.43-2.94) DALYs were contributed by stroke in 2017 (Table 1). Intracerebral hemorrhage was the dominant type of stroke contributing 3.99% (UI 4.96-3.11) of total deaths and 1.98% (UI 2.51-1.52) to total DALYs. The proportion of deaths and DALYs from stroke in male was 8.03% (UI 9.99-6.7) and 4% (5.06-3.25) while in females it was 0.77% (UI 1.58-0.34) and 0.43% (0.82-0.21) respectively.

The trend of stroke-related DALYs in Nepal showed that the total DALYs contributed by intracerebral hemorrhage were the highest throughout the period (Figure 1). DALYs declined rapidly from 1990 to 2000 from 715 to 541 per

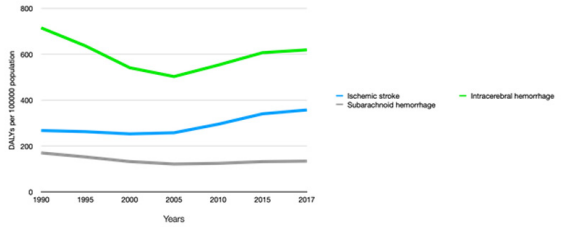

Figure 1. Trend in disability adjusted life years due to stroke in Nepal from 1990 to 2017

100,000 population for intracerebral hemorrhage with decreasing trend till 2005. The DALYs were in increasing trend after 2005 reaching up to 619 per 100,000 population in 2017.

Table 2. Deaths from stroke in Nepal by age group and gender (2017)

	Deaths per 100,000 (95% UI)			Percentage of total death (95% UI)		
Age groups (years)	**Both**	**Male**	**Female**	**Both**	**Male**	**Female**
1 to 4	0.1 (0.2-0.05)	0.1 (0.3-0.06)	0.07 (0.1-0.02)	0.001 (0.002-0.0004)	0.001 (0.003-0.0005)	0.0006 (0.001-0.0002)
5 to 9	0.1 (0.2-0.05)	0.1 (0.2-0.05)	0.10 (0.1-0.04)	0.002 (0.004-0.001)	0.002 (0.005-0.0009)	0.002 (0.004-0.001
10 to 14	0.1 (0.3-0.07)	0.2 (0.4-0.06)	0.1 (0.2-0.04)	0.004 (0.007-0.001)	0.004 (0.009-0.001)	0.003 (0.006-0.0013)
15 to 19	0.7 (1.2-0.4)	1.2 (2.1-0.6)	0.3 (0.5-0.1)	0.009 (0.01-0.005)	0.01 (0.1-0.005)	0.005 (0.009-0.002)
20 to 24	1.2 (2.06-0.7)	2.03 (3.06-1.02)	0.6 (1.1-0.3)	0.01 (0.01-0.007)	0.01 (0.02-0.007)	0.008 (0.01-0.004)
25 to 30	1.5 (2.3-0.8)	1.9 (3.3-0.9)	1.1 (1.9-0.5)	0.01 (0.01-0.007)	0.01 (0.02-0.005)	0.01 (0.02-0.005)
31 to 34	2.7 (4.5-1.2)	3.6 (6.8-1.1)	2.1 (3.7-0.9)	0.01 (0.02-0.008)	0.01 (0.03-0.006)	0.01 (0.02-0.007)
35 to 39	5.8 (9.06-3.05)	7.07 (12.4-2.2)	4.8 (8.2-2.4)	0.02 (0.04-0.01)	0.02 (0.04-0.009)	0.02 (0.04-0.01)
40 to 44	13.08 (19.7-7.9)	15.2 (24.7-7.6)	11.3 (18.5-6.3)	0.04 (0.05-0.02)	0.04 (0.06-0.02)	0.04 (0.06-0.02)
45 to 50	26.3 (39.1-16.7)	29.04 (46.8-15.5)	23.9 (38.7-13.7)	0.05 (0.07-0.03)	0.05 (0.08-0.03)	0.05 (0.09-0.03)
51 to 55	54.7 (77.3-38.06)	68.5 (103.7-41.9)	41.5 (63.7-24.4)	0.07 (0.09-0.05)	0.07 (0.1-0.04)	0.06 (0.09-0.04)
56 to 59	100.4 (142.5-69.03)	126.1 (187.07-79.3)	75.8 (117.2-45.3)	0.08 (0.1-0.06)	0.08 (0.12-0.06)	0.08 (0.1-0.05)
60 to 64	188.2 (254.9-129.3)	235.8 (343.9-149.06)	143.8 (212.9-91.5)	0.1 (0.13-0.07)	0.1 (0.1-0.07)	0.09 (0.1-0.06)
65 to 69	315.04 (422.1-226.9)	401.7 (577.2-264.1)	236.2 (345.6-150.3)	0.1 (0.1-0.08)	0.1 (0.1-0.08)	0.09 (0.1-0.06)
70 to 74	511.9 (690.7-373.2)	614.6 (872.2-414.5)	412.8 (605.8-260.4)	0.109 (0.1-0.08)	0.1 (0.1-0.07)	0.1 (0.1-0.06)
75 to 79	824.3 (1087.09-605.5)	934.2 (1291.4-640.3)	717.6 (1040.5-449.3)	0.112 (0.1-0.08)	0.1 (0.1-0.08)	0.1 (0.1-0.06)
80 above	1292.8 (1632.8-1015)	1497.5 (1976.6-1127.6)	1114.4 (1525.2-771.8)	0.8 (0.1-0.07)	0.09 (0.1-0.07)	0.07 (0.1-0.05)
Total	48.1 (59.4-38.3)	58.1(75.0-45.2)	39(50.8-29.1)	0.07(0.09-0.06)	0.08(0.09-0.06)	0.07(0.08-0.05)

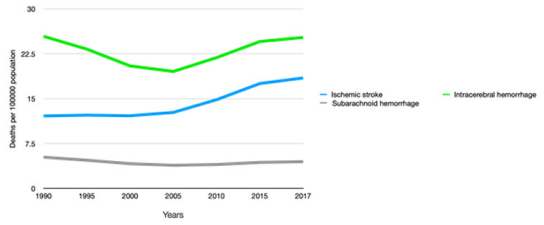

Figure 2. Deaths by types of strokes in Nepal from 1990 to 2017

The trend in stroke-related deaths showed that the deaths were highest for intracerebral hemorrhage throughout 1990-2017, followed by ischemic stroke (Figure 2). Intracerebral hemorrhage deaths declined from 25 per 100,000 population in 1990 to 19 per 100,000 population in 2005. After 2005 intracerebral hemorrhage surged up to 25 per 100,000 population in 2017. A similar rising trend was seen for ischemic stroke with 12 per 100,000 population in 2005 up to 18 per 100,000 population in 2017. The least common type, subarachnoid hemorrhage, had the lowest stroke-related death throughout the study period.

The stroke death rate was 48.1 per 100,000 population in Nepal with significantly higher rates among the age group of 50 years and above in 2017 (Table 2). The death rate was higher in male than females in all age groups. The death rate from stroke was the highest among 80 years above with 1292.8 per 100,000 population.

The overall deaths, DALYs, incidence, and prevalence of stroke in South Asia in 2017 were 89.4 (UI 93.7-84.5), 1786.9 years (UI 1869.2-1701.1), 110.1 (UI 118.9-102.5), and 916.8 (UI 977.4-866.5) per 100,000 population respectively (Table 3). Ischemic stroke was the commonest type of stroke in South Asia, with incidence and prevalence of 66.9 (75.3-59.7) and 710.3 (768.9-658.2) per 100,000 population respectively. Bangladesh had the highest incidence, prevalence, and DALYs due to stroke followed by Pakistan. Among the types of strokes, intracerebral hemorrhage contributed the highest DALYs in all the South Asian countries.

Table 3. **Country specific comparison of DALYs and Deaths of South Asia**

Types of stroke	Bangladesh Estimates (UI)	Bhutan Estimates (UI)	India Estimates (UI)	Nepal Estimates (UI)	Pakistan Estimates (UI)	South Asia Estimates (UI)
DALYs (Disability-Adjusted Life Years) per 100,000 population						
Intracerebral hemorrhage	1476.3 (1739.2-1232.3)	595.3 (755-463.1)	809.7 (888.3- 704.9)	729.6 (870.9- 567)	1289.6 (1562-1038.7)	909.8 (991.4-791.6)
Ischemic stroke	1135.3(1406.5-917.1)	492.4(614.4 -385.9)	619.3 (732- 534.3)	598 (717.1- 478.2)	997.1 (1206-791.8)	698.6 (830.8-598.8)
Subarachnoid hemorrhage	258.2 (329.8-207.7)	139.2 (188.8-102.6)	162.6 (193.4-139.3)	126.4 (165.2-94.1)	247.1 (343.1-187.4)	178.5 (216.3-154.1)
Stroke	2869.9(3155.2-2603.1)	1227.1(1523.2-984.7)	1591.6(1665.1-1508.7)	1454.1(1677.5-1230.2)	2533.9(2947.5-2117.4)	1786.9(1869.2-1701.1)
Deaths per 100,000 population						
Intracerebral hemorrhage	71.8 (86.3-58.4)	29.3 (36.8-23.1)	37 (41.2-31.3)	35.1 (42.5-27.1)	62.7 (75.6-50.6)	42.5 (47-35.9)
Ischemic stroke	71.8 (87.7-58.6)	28.9 (37-21.7)	34.7 (40.8-30.2)	34.4 (41.9-27.3)	61.9 (75.4-48.9)	40.7 (47.9-35.4)
Subarachnoid hemorrhage	9.2 (11.7-7.3)	5 (7-3.6)	5.62 (6.8-4.7)	4.5 (6.1-3.2)	9 (13-6.6)	6.2 (7.7-5.3)
Stroke	153 (168.1-138.8)	63.3(78.4-50)	77.4 (81.1-72.7)	74.1 (85.3-63)	133.7 (155.6-112.6)	89.4 (93.7-84.5)
Incidence per 100,000 population						
Intracerebral hemorrhage	46 (50.1-42)	24.7 (27.5-22.2)	31.4 (34.5-28.6)	29.4 (32.4-26.5)	40.4 (44.6-36.6)	33.5 (36.8-30.5)
Ischemic stroke	78.7 (88.6-70.2)	60.8(69.4-53.3)	64.1 (72.3-57.2)	66.9 (76.0-59)	80.4 (90.4-71.6)	66.9 (75.3-59.7)
Subarachnoid hemorrhage	10.9 (12.6-9.5)	10.3 (11.6-9.2)	9.4 (10.5-8.3)	10.1 (11.5-9)	10.6 (12.1-9.3)	9.7(10.8-8.5)
Stroke	135.6(146.4-126.1)	95.9 (104.6-88)	105 (113.6-97.5)	106.5 (115.6-98.3)	131.6 (142.5-121.7)	110.1 (118.9-102.5)
Prevalence per 100,000 population						
Intracerebral hemorrhage	300.2 (332.3-266.9)	154.4(172.5-137.8)	149 (165.1-133)	158 (177-142.7)	232.3 (257.7-206.5)	170.4 (188.5-152.6)
Ischemic stroke	905.3 (991.1-834.8)	619.6 (658.5-581.4)	676.4 (732.8-625.7)	658.2 (701.4-615.7)	833 (896.9-772.5)	710.3 (768.9-658.2)
Subarachnoid hemorrhage	97.9 (107.4-89.2)	90.7 (98.4-82.9)	84 (94-75.2)	88 (95.5-81)	92.2 (100.8-84.8)	86.1 (95.4-77.9)
Stroke	1246.0 (1337.8-1168)	817 (860.6-773.2)	860.9 (918.8-811.1)	856 (905.8-809.3)	1101.5 (1175.2-1034.6)	916.8 78 (977.4-866.5)

The leading risk factors associated with the highest DALYs in Nepal in 2017 were high systolic blood pressure 684 (UI 900 - 478), diet low in fruits 368 (UI 578 - 189), diet low in whole grains 285 (UI 421 - 168), high body mass index 258 (UI 426 - 125) and high fasting plasma glucose 253 (UI 410 - 146) per 100,000 population (Figure 3).

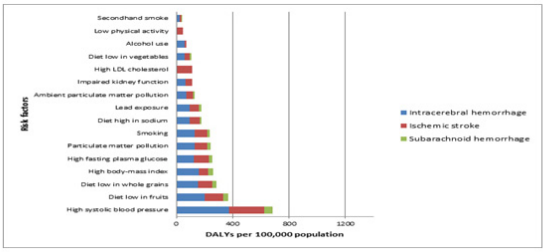

Figure 3. **Risk factors contributing to DALYs for different types of strokes in Nepal (all ages, 2017)**

DISCUSSION

This is the first study to report the burden of stroke in Nepal comparing it with other countries in South Asia. Our results suggested high death and disability from stroke in Nepal and other South Asian countries. Increased socioeconomic status of people of developing countries, luxurious lifestyles, and unhealthy food behaviors could be the reason behind the escalating cases of stroke. Total DALYs and deaths rate of intracerebral hemorrhage were higher than ischemic stroke and subarachnoid hemorrhage throughout the last two decades in South Asia, corresponding with existing mortality rates in other countries.[13,14] Pathophysiological effect of hemorrhagic stroke-causing pressure on vital areas of the brain leads to a high chance of death compared to ischemic stroke.[15]

Ischemic stroke was the most common type of stroke in Nepal, in line with studies done by Shaik and Pokharel.[16,17] In

GBD 2017, the proportion of deaths and DALYs from stroke were higher in male compared to female corresponding with GBD 2013 data.[18] However, higher mortality was reported among female population in other studies. This can be explained by the longer lifespan of the female population and effects of female hormones etc.[1] Now life expectancy for male has also increased and might have resulted in increased stroke mortality among the male population of South Asian countries. The death rate for the hemorrhagic type of stroke was highest in South Asia, similar findings were reported from studies of Nepal and Rwanda but the death rate was highest in ischemic stroke in Ethiopia.[19-21] It suggests burden caused by types of stroke may vary in low-income countries, therefore epidemiological studies are needed to provide conclusive results in those countries.

The leading risk factors associated with the highest DALYs were high systolic blood pressure and a diet low in fruits and whole grains. Controlling hypertension is particularly important to prevent stroke. It is alarming as high blood pressure remains underdiagnosed and under-controlled in Nepal.[22] It can be a result of, lack of awareness on regular blood pressure monitoring; unavailability, unaffordability of antihypertensive drugs in essential health care service; increasing fast food intake; sedentary lifestyle, etc.[23] In addition, dietary risks like diets low in fruits, whole grains, and vegetables contribute to stroke DALYs in Nepal. Not surprisingly, the traditional Nepali diet remains high in refined grains and low in fruits, vegetables, nuts, and seeds.[24,25] Diet influences a wide range of cardiometabolic risk factors through multiple pathways, including energy intake and expenditure, blood pressure, lipoprotein concentration, and body fat composition.[26] The emergence of new risk factors such as C-reactive proteins, homocysteine, vitamin D, genetic variants, etc makes it difficult to follow anyone's stroke risk assessment tool.[27-30] Furthermore there is inadequate knowledge on causes and risk factors for developing non-communicable diseases (NCD) poses a barrier to behavior change in Nepal.[31] Prevention and management of common risk factors: hypertension, diabetes mellitus, and dyslipidemia are crucial to prevent the occurrence of first stroke.[32]

There are many probable barriers to access and utilization of stroke care services in Nepal and other low-resource settings like lack of infrastructure, understaffed radiologists, neurologists and physiotherapists in rural areas, inadequate transportation, and high cost of medicine.

The burden of stroke has a profound economic impact globally.[33] In Nepal poor households have 10 to 15% out-of-pocket expenditure for health care while 13.8% of households experience catastrophic expenditure for hypertension. Diabetes and heart disease are associated with an increased risk of catastrophic expenditure.[34] The cost of stroke services depends on the length of hospital stay, severity, and type of stroke. Pakistan, a South Asian country has the second-highest mean cost of stroke treatment ($5230) after Nigeria among low- and middle-income countries (LMIC).[35] In Pakistan, the cost of hemorrhagic stroke treatment is higher than other types. The cost of medicines required for stroke is highest in India ($1094).[35] A study from Bangladesh showed $328 as an average monthly stroke rehabilitation cost which was more than 20% of per capita gross domestic product (GDP) of the country.[36] Increasing number of hypertensive population warns the economic burden for stroke in future.[23]

Given the high cost of treatment and rehabilitation and limited resources available in low-income countries, it would be best to emphasize effective population-wide interventions to control or reduce exposure to major risk factors. Polypill strategy, salt reduction along with other dietary interventions, mHealth, etc can be effective prevention strategies for stroke. Interventions such as effective tobacco control and salt intake reduction have been implemented as cost-effective primary prevention in developing countries and can be applied in our setting.[37] Ignorance in managing hypertension, diabetes, and lack of understanding of secondary prophylaxis causes recurrence of stroke.[30] The health system should also focus on individual-based strategies to screen for high-risk strokes and enhance healthy behavior.

This is among the very few studies to report on trends and distribution of stroke at the national level for Nepal and compared with South Asia. Data from the GBD database, that we used for this study, uses standardized methods to estimate metrics creating comparable data between countries. We explored mortality and DALYs of stroke among five South Asian countries, imparting the brief status of stroke in South Asia. The study has some limitations. Firstly, Nepal does not have a national recording and surveillance system to determine the cause of death, nor has a validated autopsy for all deaths to detect stroke-related mortality. Thus, data were largely imputed using statistical models. However, in a low resource setting like Nepal, where reliable health statistics on stroke are limited, GBD data provides a significant basis for setting health priorities. Secondly, we could not explore relationships between variables as the GBD dataset of stroke we used were descriptive.

CONCLUSION

Hemorrhagic stroke causes more deaths in Nepal compared to other stroke types. Intracerebral hemorrhage contributed the highest DALYs. High blood pressure is the most common risk factor for stroke in Nepal. Stroke incidence and prevalence are highest in Bangladesh and Pakistan. The increasing trend for stroke mortality and DALYs in South Asian countries warns for further well-designed epidemiological studies to fill the dearth of

research gaps in stroke and take public health action.

Disclaimer

Research reported in this publication was supported by the National Heart, Lung, And Blood Institute of the National Institutes of Health under Award Number U24HL136789. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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