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Prevalence of cardiovascular risk factors and strokes in younger adults

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Abstract

Importance—While stroke mortality rates have decreased substantially in the past two decades, this trend has been primarily limited to older adults. Increasing trends in stroke incidence and hospitalizations have been noted among younger adults, but there has been concern that this reflected improved diagnosis through an increased use of imaging rather than representing a real increase.

Objective—We aimed to determine whether stroke hospitalization rates have continued to increase and to identify the prevalence of associated stroke risk factors among younger adults.

Design, Setting, Participants—Hospitalization data from the National Inpatient Sample from 1995 through 2012 were used to analyze acute stroke hospitalizations rates among young adults aged 18–64. Hospitalization data from 2003–2012 were used to identify the prevalence of associated risk factors for acute stroke. Acute stroke hospitalizations were identified by the principal ICD-9-CM code and associated risk factors were identified by secondary ICD-9-CM codes for each hospitalization.

Main Outcomes—Trends in acute stroke hospitalization rates by stroke type, age, sex, and race/ethnicity, as well as the prevalence of associated risk factors by stroke type, age, and sex.

Results—The major findings in this study are 1) ischemic stroke hospitalization rates increased significantly for both males and females and for certain race/ethnic groups among younger adults aged 18–54 and have almost doubled for males aged 18–34 and 35–44 years since 1995–96, with a

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Study conception and design: George, Tong
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Critical revision: George, Tong, and Bowman
Statistical analysis: Tong
Administrative, technical or material support: Bowman
Tweet: Increasing #Stroke hospitalizations in #YoungAdults with increasing risk factors show worrisome trend

Disclosures
None

41.5% increase among males aged 35–44; 2) the prevalence of stroke risk factors among those hospitalized for acute ischemic stroke continued to increase from 2003–04 through 2011–12 for both males and females aged 18–64; and 3) the prevalence of having multiple risk factors among younger adults experiencing an acute ischemic stroke has nearly doubled over the decade. Hospitalization rates for intracerebral hemorrhage and subarachnoid hemorrhage remained stable.

Conclusions and Relevance—The identification of increasing hospitalization rates for acute ischemic stroke in young adults coexistent with increasing prevalence of traditional stroke risk factors confirms the importance of focusing on prevention in younger adults.

Keywords

hospitalization rate; subarachnoid hemorrhage stroke; intracerebral hemorrhage stroke; acute ischemic stroke; trends

Stroke was the 3rd leading cause of death in the US from 1938 to 2007, and dropped to the 5th leading cause of death in 2013.[1] Yet, the relative rate of decline in mortality among those aged 65 and older is approximately double the rate of decline among those 45–64.[2] The overall decline in stroke mortality over the past 50 years reflects the improved control of hypertension through efforts such as the National Heart Lung Blood Institute's Joint National Commission's guidelines on hypertension control, as well as increased treatment of atrial fibrillation with anticoagulants, increased use of aspirin for secondary prevention, improvements in stroke care through structured quality improvement programs and the development of stroke systems of care that promote the use of evidence-based care.[3]

Against this backdrop of overall declining stroke mortality rates is suggestive evidence that acute stroke incidence rates among younger adults are increasing.[4] In 2011, we reported that acute stroke hospitalization rates were increasing among young adults aged 15–44.[5] Studies since then suggest that this increase is likely not due to increased use of imaging.[4, 6] Additionally, while rates of some traditional stroke risk factors have declined over the past decade in the overall adult population (tobacco smoking), many others have shown little change or have increased (overweight, obesity, diabetes, hypertension, and hypercholesterolemia).[7, 8] It is important to understand whether these risk factor patterns are similar among those experiencing an acute stroke. To identify whether previous trends in stroke hospitalization rates and the patterns of associated risk factors have continued, we examined the hospitalization rates for acute stroke by stroke type along with the prevalence of associated risk factors by sex and age group among younger adults.

Methods

Data Sources and study sample

The National Inpatient Sample (NIS)[9] is part of the Healthcare Cost and Utilization Project (HCUP),[1] sponsored by the Agency for Healthcare Research and Quality (AHRQ). The NIS is a database of hospital inpatient stays derived from billing data submitted by hospitals to statewide data organizations across the U.S. It is a stratified sample that represents discharges from approximately 20% of all community hospitals participating in HCUP; hospitals are selected based on five characteristics: rural/urban location, hospital size, region,

teaching status, and ownership. There were 37 states that participated in 2003 and the number of states increased each year to 44 states in 2012.[9]

International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) were used to identify hospitalizations for subarachnoid hemorrhage (430), intracerebral hemorrhage (431) and acute ischemic stroke (433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91, and 436). For each hospitalization, only the principal diagnosis code was used to identify events, which were then assigned to one of three mutually exclusive categories: subarachnoid hemorrhage (SAH), intracerebral hemorrhage (ICH) and acute ischemic stroke (AIS).

ICD-9-CM code 436 was included in ischemic stroke as recommended by HCUP when doing trend over time analysis across the time as coding instructions changed for this code. The use of this code underwent a change in FY 2005, where coders were instructed to use code 434.91 rather than 436.

Statistical Methods

The unit of analysis was the hospital discharge. In this analysis, hospital discharge records were included if the patient was 18 years or older at the time of the hospital admission. We combined NIS annual data to create 5 consecutive 2-year time periods from 2003–04 through 2011–12. Four age groups were defined: 18–34 years, 35–44 years, 45–54 years, and 55–64 years. Separate stroke hospitalization rates for males and females were estimated for each stroke type and age group. Risk factor prevalence was estimated using secondary ICD-9-CM codes, taking into account changes in ICD-9-CM coding over time. (Supplemental Table 1) Common risk factors for stroke in this population were assessed for linear trends using orthogonal polynomial contrasts. We also looked at the combination of the following 5 traditional cardiovascular risk factors related to the stroke: hypertension, diabetes, lipid disorders, obesity, and tobacco use, identified as none, 1–2 risk factors, or 3–5 risk factors to address the burden of multiple stroke risk factors. Linear trends were not reported if the data were too sparse to report based on HCUP reporting guidelines. Further, trends in stroke hospitalizations for those aged 18–34, 35–44, 45–54, and 55–64 by sex from 1995 to 2012 were assessed across 5 time periods by using linear regression models.

National estimates were obtained by using individual discharge sampling weights. As a result of changes implemented in the redesign of 2012 NIS data, we used trend weights developed by AHRQ to make estimates comparable for data prior to 2012. All statistical analyses were conducted using SAS 9.3-callable SUDAAN (Research Triangle Institute, Research Triangle Park, NC) to account for the multistage, disproportionate stratified sampling design.

Because the data are publicly available and do not contain direct personal identifiers, this study was exempt from review by the institutional review board.

Results

Among acute ischemic stroke (AIS) hospitalizations, rates increased from 2003–04 through 2011–12 for all race groups, males, females among age groups 18–34, 35–44, and 45–54, except among non-Hispanic blacks and other races for ages 18–34 years. Among those aged 55–64 years, only Hispanics showed a significant increase in AIS hospitalization rates (from 181.8/10,000 to 199.7/10,000, p=0.02), but there was no change in stroke hospitalization rates in this age group by sex or among other non-Hispanic race groups. (Table 1)

Hospitalization rates for males aged 18–34 increased from 11.2 to 18.0/10,000 hospitalizations, females aged 18–34 increased from 3.8 to 5.8/10,000 hospitalizations, males aged 35–44 increased from 37.7 to 68.2 per 10,000 hospitalizations, and females aged 35–44 increased from 24.8 to 35.8 per 10,000 hospitalizations from 1995–96 through 2011–12 (relative percent increases were 74.8%, 65.7%, 91.0%, and 53.6% respectively). (Supplemental Figure and Supplemental Table 2)

Table 2 shows the prevalence of stroke-related risk factors among adults admitted for AIS by age and sex. Across all age groups and both sexes, increasing prevalence was seen in hypertension, lipid disorders, diabetes, tobacco use, obesity, and among multiple risk factors. The prevalence of three or more traditional risk factors (hypertension, diabetes, lipid disorders, obesity, and tobacco use) roughly doubled among all age groups for both males and females while the prevalence of none of these risk factors decreased. Notably, during the study period of 2003–04 through 2011–12, hypertension increased from 34.0% to 41.3%, and lipid disorders increased from 14.6% to 29.1% among males aged 18–34 years. Smaller increases were seen among females aged 18–34 years, although in 2011–12, 30.7% had hypertension, 21.7% had lipid disorders, 26.5% used tobacco, and 15.7% were obese. One in seven males aged 18–34 and one in three males aged 35–44 had three to five traditional risk factors. There were small but significant increases in the prevalence of atrial fibrillation among the older two age groups for both males and females. Among those with AIS, the prevalence of ischemic heart disease declined among males ages 45–54 and 55–64, yet increased among females ages 18–34. There were no changes among the other sex/age groups. (Table 2)

There were no changes in intracerebral hemorrhage (ICH) hospitalization rates by age or by race by sex from 2003–04 through 2011–12. (Table 3) However, males had significantly higher hospitalization rates than females among all age groups. The relative difference between males and females decreased with increasing age group.

Among those with ICH, the prevalence of hypertension among males in 2011–12 was 44.1% (aged 18–34 years), 73.8% (aged 35–44 years), and 81.4% (aged 45–54 and 55–64 years), and the prevalence of hypertension among males aged 18–34 and 35–44 with ICH was higher than the prevalence among their counterparts with AIS. Rates of hypertension among females with ICH were comparable to those with AIS. (Table 2 & 4) Tobacco use increased among all male age groups and among females aged 18–34, 45–54, and 55–64. There was a significant trend towards increasing prevalence of having multiple stroke risk factors among males and females across all age groups among those hospitalized for ICH. (Table 4)

From 2003–04 through 2011–12 hospitalization rates for subarachnoid hemorrhage (SAH) declined among all age groups, but significantly only among males aged 45–54 years (13.2/10,000 to 10.3/10,000, p=0.01), non-Hispanic whites (14.5/10,000 to 11.9/10,000, p=0.045) and non-Hispanic blacks (15.8/10,000 to 11.5/10,000, p=0.006). SAH rates among Hispanics aged 45–54 and 55–64 were significantly higher compared to non-Hispanic whites and non-Hispanic blacks. The hospitalization rate for males aged 18–35 were three times the rate of females, but females had significantly higher hospitalization rates for SAH among those aged 45–54 and 55–64. (Table 3)

Significant increases in the prevalence of stroke risk factors were seen among hospitalizations for SAH across all age groups of males for hypertension, obesity, tobacco use, and for lipid disorders and diabetes among males aged 35–44, 45–54, and 55–64 years. Among females with acute SAH hospitalizations, the prevalence of hypertension increased among all age groups, and the prevalence of diabetes, obesity, and lipid disorders increased among age groups 35–44, 45–54, and 55–64. Females aged 45–54 years had an increased prevalence of alcohol abuse and tobacco use. The presence of multiple risk factors (inclusive of hypertension diabetes, lipid disorders, obesity, and tobacco use) shifted towards a greater number of risk factors among both males and females across all age groups. (Table 5)

For most age groups and stroke types there were trends of decreasing in-hospital death and increasing trends of transfer to skilled nursing units/rehabilitation facilities/ long-term care facilities. (Supplemental Tables 3–5). While this data set lacks important socioeconomic data, we found that among all age groups and stroke types, between 56%–60% of stroke hospitalizations occurred among the lower 50th percentile of median household income of the patient's zip code, with no change over time.

Overall, AIS hospitalizations among those aged 18–64 increased from an average of 141,474/year in 2003–04 to 171,386/year in 2011–12. SAH hospitalizations declined from an average of 17,598/year in 2003–04 to 15,974/year in 2011–2012. There was little change in the in the number of hospitalizations for ICH (22,097/year in 2003–04 vs. 23,545/year in 2011–12).

Discussion

The major findings in this study are 1) acute ischemic stroke hospitalization rates increased for both males and females and for certain race/ethnic groups among younger adults aged 18–54, and have almost doubled for males aged 18–34 and 35–44 years since 1995–96, while rates for males and females aged 55–64 have not changed from 2003–04; 2) the hospitalization rates for ICH did not change from 2003–04 to 2011–12 among those aged 18–64 while the only change in hospitalization rates for SAH was a decrease among males and non-Hispanics ages 45–54; 3) the prevalence of multiple risk factors associated with people experiencing AIS and ICH hospitalizations have continued to increase for both males and females of all age groups studied over the most recent decade of available data, and are consistent with increases seen from 1995–96 and 2007–08; and 4) the prevalence of having multiple traditional stroke risk factors among young adults experiencing an AIS has doubled over the decade 2003–04 through 2011–12.

The increasing trends in AIS hospitalization rates among the three younger age groups (18–34 years, 27.3% increase: 35–44 years, 35.6% increase; and 45–54 years, 20.5% increase) are consistent with other studies[4, 11] as well as earlier hospitalization trends[5] and are associated with high and increasing trends in the prevalence of having multiple traditional cardiovascular risk factors.[11–14] This is also consistent with a clinical study reported 25 years ago which found that among young adults aged 15–45 years, the cause of AIS was due to atherosclerotic disease in one-third of patients.[15] Both small and large vessel disease have been identified as an increasing cause of AIS beginning at age 30.[16] It is unclear why hospitalization rates among non-Hispanic blacks ages 18–34 remained stable, however Kissela et al. noted a non-significant increase in incident stroke rates among blacks ages 20–44 from 1993–2005 and yet a significant increase among whites.[4] The young adult population experiencing AIS has rates of traditional stroke risk factors that are also nearly double that of their peers in the general population or greater.[8] Approximately 12% of the general population aged 45–64 years has diabetes,[8] yet approximately 40% of those hospitalized with an acute ischemic stroke had diabetes. Tobacco use is high among males of all age groups experiencing an acute ischemic stroke, at rates nearly double the national rate among adults. In comparison with European studies on stroke in young adults, we found similar rates of lipid disorders, atrial fibrillation, and tobacco use, but much higher rates of hypertension, diabetes, and ischemic heart disease.[16] We found a lower prevalence of obesity than other traditional risk factors and yet obesity has been identified as a major risk factor for stroke in young adults.[17–19] This could be due to under-reporting in an administrative dataset. The shift to an increasing number of multiple traditional risk factors for stroke and the extremely high and increasing prevalence of hypertension among those hospitalized with all stroke types is of particular concern, as the hypertension control rate among males aged 18–39 is only 27.9%.[20]

One in three acute stroke hospitalizations for all stroke, AIS, and ICH occurs among those aged 18–64 years, while 60% of SAH hospitalizations occurs among adults aged 18–64, when adults are in their prime years for productive careers and busy family lives.[10] Most age, race, and sex groups had non-significant decreasing trends in hospitalization rates for SAH, with only modest, though significant, decreases among males aged 45–54 years. Hypertension, tobacco use, and alcohol use are among the most important risk factors for SAH.[21] We saw significant increases in hypertension, tobacco use, and drug abuse only among males and females aged 55–64 and among females aged 45–54, but no significant increase in alcohol abuse among those with SAH. With increasing prevalence of key risk factors for SAH the trend toward stable or decreasing hospitalizations for SAH are difficult to explain. There are improved diagnostic modalities for other cerebral conditions that could be leading to increased incidental findings of aneurysms from imaging for other reasons. Management and prophylactic treatment prior to rupture when indicated could in part explain decreases in hospitalizations for SAH.[22]

Nearly 40% of ICH hospitalizations occur in those aged 18–64 years.[10] Because intracerebral hemorrhage can result in significant morbidity and mortality, the relatively high prevalence of unhealthy lifestyle behaviors among males 18–34 years (drug abuse, 14.3%, tobacco use, 25.8%), and hypertension (44.1%, among males, and 28.1% among females, aged 18–34 years), suggests that many of these strokes are likely preventable, although we

are not able to determine the cause of stroke in this study. The findings that Hispanics and non-Hispanic blacks have ICH hospitalization rates 1.5–2 time the rates for whites is not inconsistent with the findings from Walsh[23] which found an increased risk of ICH among Hispanics and non-Hispanic blacks with treated or untreated hypertension among younger age groups compared to whites. They concluded that untreated hypertension confers a greater ICH risk in blacks and Hispanics relative to whites.

These findings of increasing AIS hospitalization rates among those ages 18–54 and no change among those ages 55–64 reveals an inflection point in stroke hospitalization rates when compared to findings of decreasing AIS hospitalization rates among those ages 65–74, 75–84, and a non-significant decline among those 85 and older. [24, 25] We identified no change in the hospitalization rate for ICH among those age 18–64, while others have seen decreasing rates among those with ICH ages 65–74, 75–84, and 85 and older. [24] It's possible that these findings represent better hypertension control over time among the elderly compared to younger adults. We only noted a decrease in SAH hospitalization rates among those age 45–54, others also noted no change in rates among the three oldest age groups. [24]

Limitations

This paper has several strengths in that the data are nationally representative of hospitalizations in the United States and provides the ability to report trends over time. The reported comorbidities and risk factors were documented in the medical record using ICD-9-CM codes. However there are some limitations. First, a person who experiences more than one hospitalization for an acute stroke during a two-year analytic period would be represented for each acute stroke hospitalization event. Second, while one can identify the prevalence of multiple comorbidities we are unable to characterize stroke severity nor the cause of the stroke. Third, while we can't rule out any influence of increased use of advanced imaging over time, Kissella et al. found high rates of the use of computed tomography (87%) and magnetic resonance imaging (60–70%) among younger adults by 2005, and the impact of MRI findings does not appear to influence stroke incidence,[6] making it unlikely that the trends in stroke hospitalizations among younger adults are due solely to increased imaging and hence increased detection. Finally, we are unable to account for several important risk factors such as family history or the use of estrogen-based medications.

Conclusion

The young adult population is experiencing an increase in a serious yet largely preventable disease. We note the trend of increasing AIS among Hispanics (a small but relative increase of 41% among those aged 18–34 years) of all age groups as a particularly important demographic to assure access to adequate stroke prevention. The significant increases in ischemic stroke hospitalizations and associated traditional stroke risk factors from 2003–2012, which is consistent with rates from 1995–96 and 2007–08[5] among those experiencing an acute stroke should serve as a call to action to focus on improving the health of younger adults. Preventing and controlling stroke risk factors among young working age adults can save lives, reduce disability, decrease societal health care costs, and improve the quality of

life for hundreds of thousands of Americans and their families. Identifying the high and rising prevalence of stroke risk factors among younger adults presenting with acute stroke should prompt a sense of urgency among younger adults, public health practitioners, clinicians, and policy makers to engage adolescents and their families, as well as younger adults, to identify and treat stroke risk factors and promote opportunities that allow for healthy lifestyles to prevent the tragedy of stroke at such early ages.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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X. Tong had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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Key Points

Question

Are stroke hospitalization rates for younger adults continuing to increase, and is the prevalence of associated risk factors increasing among those hospitalized for acute stroke?

Findings

Stroke hospitalization rates from 2003–2012 significantly increased for acute ischemic stroke hospitalization rates among males (41.5%) and females (30.0%) aged 35–44, with a near doubling of the prevalence of three or more of five common stroke risk factors among both males and females aged 18–64 hospitalized for acute ischemic stroke.

Meaning

Hospitalization rates for acute ischemic stroke in younger adults continued to increase since 1995–96, coexistent with increasing prevalence of stroke risk factors.

Table 1

Prevalence of Acute Ischemic Stroke as the Principal Diagnosis by Age, Sex, and Race

	Acute Ischemic Stroke					
	2003–2004		2011–2012			
	Weighted N	Rates/10,000 hospitalizations (s.e)	Weighted N	Rates/10,000 Hospitalizations (s.e)	Relative change[a]	p value for trends[b]
Age 18–34 years old	8,275	6.6 (0.2)	10.178	8.4 (0.3)	27.30%	<0.0001
Male	3,787	15.6 (0.7)	4,634	18.0 (0.6)	15.40%	0.003
Female	4,483	4.4 (0.2)	5,539	5.8 (0.2)	31.80%	<0.0001
Non-Hispanic White	3,034	6.1 (0.3)	4,974	8.2 (0.3)	34.40%	<0.0001
Non-Hispanic Black	1,728	11.1 (0.7)	2,354	11.9 (0.6)	7.20%	0.31
Hispanic	845	4.4 (0.5)	1,300	6.2 (0.4)	40.90%	0.001
Other	460	6.4 (0.8)	775	7.9 (0.7)	23.40%	0.12
Age 35–44 years old	25,350	35.1 (0.9)	28,287	47.6 (1.0)	35.60%	<0.0001
Male	12,923	48.2 (1.3)	14,813	68.2 (1.6)	41.50%	<0.0001
Female	12,417	27.5 (0.8)	13,463	35.8 (1.0)	30.20%	<0.0001
Non-Hispanic White	10,052	30.5 (1.0)	13,551	42.1 (1.2)	38.00%	<0.0001
Non-Hispanic Black	5,594	54.0 (2.7)	7,633	72.4 (2.3)	34.10%	<0.0001
Hispanic	1,939	28.4 (1.6)	2,995	37.3 (1.6)	31.30%	0.0001
Other	940	29.4 (2.5)	1,985	44.5 (2.5)	51.40%	<0.0001
Age 45–54 years old	82,271	102.0 (1.7)	102,082	122.9 (1.6)	20.50%	<0.0001
Male	46,275	120.1 (2.3)	59,472	144.1 (2.1)	20.00%	<0.0001
Female	35,896	86.2 (1.7)	42,583	102.1 (1.6)	18.40%	<0.0001
Non-Hispanic White	35,056	90.2 (2.0)	55,229	111.4 (1.7)	23.50%	<0.0001
Non-Hispanic Black	16,563	146.1 (5.1)	24,862	160.9 (3.5)	10.10%	0.003
Hispanic	5,604	94.5 (3.7)	9,005	112.5 (3.3)	19.00%	0.0001
Other	3,260	117.5 (7.2)	6,127	142.6 (5.3)	21.40%	0.007
Age 55–64 years old	167,053	200.9 (0.9)	202,227	202.5 (0.6)	0.80%	0.44
Male	94,659	228.8 (3.4)	118,598	234.6 (2.7)	2.50%	0.10
Female	72,353	173.4 (2.7)	83,607	169.5 (2.0)	−2.20%	0.34
Non-Hispanic White	82,415	189.6 (3.5)	121,360	187.4 (2.4)	−1.20%	0.78

	Acute Ischemic Stroke					
	2003–2004		2011–2012			
	Weighted N	**Rates/10,000 hospitalizations (s.e)**	**Weighted N**	**Rates/10,000 Hospitalizations (s.e)**	**Relative change[a]**	**p value for trends[b]**
Non-Hispanic Black	23,807	265.0 (6.4)	39,076	252.0 (4.3)	−4.90%	0.12
Hispanic	9,740	181.8 (6.0)	15,147	199.7 (4.6)	9.80%	0.02
Other	6,353	231.6 (11.6)	11,824	240.3 (6.7)	3.80%	0.29

[a]Relative change = (2011/2012-2003/2004)/ 2003/2004

[b]P value was obtained by using linear regression model to assess the linear trends across the 5 time period

Table 2

Prevalence (%) of Risk Factors among Patients Hospitalization with Acute Ischemic Stroke by Age and Sex

										Risk factors (HTN, Diabetes, Lipid Disorder, Obesity, and Tobacco Use)		
			HTN	Lipid disorders	Diabetes	Tobacco use	Obesity	AFib	IHD	None of above	One or two risk factors	Three to five risk factors
Male	Age 18–34	2003–04	34.0 (1.9)	14.6 (1.3)	15.3 (1.4)	23.1 (1.8)	6.8 (0.9)	2.1 (0.5)	6.4 (0.9)	42.0 (1.9)	48.9 (1.8)	9.1 (1.1)
		2011–12	41.3 (1.7)[b]	29.1 (1.5)[c]	15.2 (1.1)	35.7 (1.6)[c]	13.3 (1.1)[c]	2.9 (0.5)	5.5 (0.7)	27.9 (1.6)[c]	55.9 (1.7)[a]	16.2 (1.2)[c]
	Age 35–44	2003–04	54.5 (1.1)	29.0 (0.9)	24.3 (0.8)	31.3 (1.2)	7.7 (0.5)	3.2 (0.4)	11.1 (0.6)	22.8 (0.8)	58.6 (0.9)	18.6 (0.8)
		2011–12	65.9 (0.9)[c]	47.8 (1.0)[c]	30.3 (0.9)[c]	41.7 (1.0)[c]	15.2 (0.7)[c]	4.3 (0.4)	11.2 (0.6)	12.1 (0.6)[c]	52.9 (0.9)[c]	35.0 (0.9)[c]
	Age 45–54	2003–04	69.7 (0.5)	34.6 (0.6)	32.4 (0.5)	32.5 (0.8)	6.1 (0.3)	4.4 (0.2)	21.7 (0.5)	13.2 (0.4)	62.4 (0.6)	24.4 (0.5)
		2011–12	76.3 (0.4)[c]	54.7 (0.5)[c]	37.9 (0.5)[c]	47.3 (0.6)[c]	11.7 (0.3)[c]	6.0 (0.2)[c]	20.5 (0.4)[b]	6.9 (0.3)[c]	48.9 (0.5)[c]	44.2 (0.5)[c]
	Age 55–64	2003–04	73.7 (0.4)	38.3 (0.5)	35.9 (0.4)	30.8 (0.8)	5.4 (0.2)	7.0 (0.2)	32.3 (0.5)	10.5 (0.3)	63.0 (0.4)	26.4 (0.5)
		2011–12	81.1 (0.3)[c]	58.6 (0.4)[c]	41.0 (0.4)[c]	43.8 (0.4)[c]	9.7 (0.2)[c]	9.8 (0.2)[c]	29.5 (0.3)[c]	5.6 (0.2)[c]	47.9 (0.4)[c]	46.5 (0.4)[c]
Female	Age 18–34	2003–04	26.1 (1.5)	9.6 (1.0)	11.8 (1.2)	21.1 (1.5)	9.1 (1.0)	1.7 (0.4)	2.1 (0.5)	48.6 (1.7)	45.8 (1.6)	5.6 (0.8)
		2011–12	30.7 (1.4)[a]	21.7 (1.3)[c]	15.5 (1.1)[a]	26.5 (1.4)[b]	15.7 (1.0)[c]	1.8 (0.4)	3.9 (0.6)[a]	38.5 (1.5)[c]	48.0 (1.6)	13.5 (1.0)[c]
	Age 35–44	2003–04	50.1 (1.2)	20.8 (0.9)	24.2 (0.9)	26.9 (1.0)	10.9 (0.7)	1.2 (0.2)	7.3 (0.5)	28.1 (1.1)	56.5 (1.1)	15.4 (0.8)
		2011–12	57.3 (1.0)[c]	37.8 (1.0)[c]	31.4 (0.9)[c]	35.8 (1.0)[c]	21.0 (0.8)[c]	2.3 (0.3)[b]	7.2 (0.5)	18.6 (0.8)[c]	49.9 (0.9)[c]	31.6 (0.9)[c]
	Age 45–54	2003–04	69.8 (0.6)	32.4 (0.7)	35.2 (0.6)	27.4 (0.8)	9.9 (0.5)	3.0 (0.2)	15.1 (0.4)	13.8 (0.5)	61.1 (0.7)	25.0 (0.6)
		2011–12	73.7 (0.6)[c]	50.9 (0.6)[c]	39.6 (0.6)[c]	43.5 (0.6)[c]	17.0 (0.5)[c]	3.9 (0.2)[b]	16.1 (0.4)	8.4 (0.4)[c]	47.9 (0.6)[c]	43.7 (0.6)[c]
	Age 55–64	2003–04	76.0 (0.4)	36.7 (0.5)	41.0 (0.5)	24.6 (0.7)	8.2 (0.3)	6.0 (0.2)	22.9 (0.4)	10.0 (0.3)	63.3 (0.5)	26.7 (0.5)
		2011–12	81.1 (0.3)[c]	58.0 (0.4)[c]	46.2 (0.4)[c]	36.5 (0.5)[c]	15.6 (0.3)[c]	7.8 (0.2)[c]	22.4 (0.4)	5.8 (0.2)[c]	46.3 (0.4)[c]	47.9 (0.5)[c]

[a] p value for trend <0.05;

[b] p value for trend <0.01;

[c] p value for trend <0.001.

HTN=hypertension, Afib=atrial fibrillation, IHD=ischemic heart disease

Table 3

Prevalence of Subarachnoid and Intracerebral Hemorrhage as the Principal Diagnosis by Age, Sex, and Race

	Subarachnoid Hemorrhagic Stroke						Intracerebral Hemorrhage Stroke					
	2003–2004		2011–2012				2003–2004		2011–2012			
	Weighted N	Rates[a] (s.e)	Weighted N	Rates[a] (s.e)	Relative change[b]	P value for trends[c]	Weighted N	Rates[a] (s.e)	Weighted N	Rates[a] (s.e)	Relative change[b]	p value for trends[c]
Age 18–34 years old	3,567	2.8 (0.2)	3,411	2.8 (0.2)	0	>0.99	2,772	2.2 (0.2)	2,888	2.4 (0.2)	9.10%	0.45
Male	1,810	7.5 (0.6)	1,646	6.4 (0.5)	−14.70%	0.1	1,695	7.0 (0.5)	1,621	6.3 (0.4)	−10.00%	0.18
Female	1,742	1.7 (0.2)	1,765	1.9 (0.1)	11.80%	0.45	1,059	1.0 (0.1)	1,251	1.3 (0.1)	30.00%	0.07
NHW	1,313	2.6 (0.3)	1,362	2.2 (0.2)	−15.40%	0.15	927	1.9 (0.2)	1,139	1.9 (0.2)	0	0.96
NHB	523	3.4 (0.4)	831	4.2 (0.4)	23.50%	0.29	486	3.1 (0.4)	593	3.0 (0.3)	−3.20%	0.65
Hispanic	490	2.5 (0.3)	629	3.0 (0.3)	20.00%	0.53	475	2.5 (0.3)	565	2.7 (0.4)	8.00%	0.53
Other	199	2.8 (0.3)	310	3.2 (0.5)	14.30%	0.41	175	2.4 (0.4)	323	3.3 (0.4)	37.50%	0.21
Age 35–44 years old	7,427	10.3 (0.7)	5,282	8.9 (0.5)	−13.60%	0.08	6,056	8.4 (0.4)	5,169	8.7 (0.4)	3.60%	0.43
Male	2,997	11.2 (0.9)	2,123	9.8 (0.7)	−12.50%	0.17	3,587	13.4 (0.8)	3,152	14.5 (0.8)	8.20%	0.20
Female	4,420	9.8 (0.7)	3,159	8.4 (0.6)	−14.30%	0.09	2,469	5.5 (0.3)	2,017	5.4 (0.3)	−1.80%	0.95
NHW	2,729	8.3 (0.7)	2,455	7.6 (0.6)	−8.40%	0.44	2,026	6.1 (0.4)	1,783	5.5 (0.4)	−9.80%	0.43
NHB	1,264	12.2 (1.1)	1,044	9.9 (0.9)	−18.90%	0.08	1,547	14.9 (1.2)	1,423	13.5 (1.0)	−9.40%	0.52
Hispanic	758	11.1 (1.4)	758	9.4 (0.9)	−15.30%	0.28	610	8.9 (1.0)	843	10.5 (1.0)	18.00%	0.44
Other	330	10.3 (1.7)	588	13.2 (1.6)	28.20%	0.24	451	14.1 (1.8)	741	16.6 (1.6)	17.70%	0.18
Age 45–54 years old	13,474	16.7 (1.2)	11,408	13.7 (0.7)	−18.00%	0.038	15,858	19.7 (0.9)	16,467	19.8 (0.7)	0.50%	0.83
Male	5,095	13.2 (1.0)	4,245	10.3 (0.6)	−22.00%	0.01	9,606	24.9 (1.1)	9,854	23.9 (1.0)	−4.00%	0.48
Female	8,284	19.9 (1.5)	7,151	17.1 (1.0)	−14.10%	0.15	6,228	15.0 (0.9)	6,613	15.9 (0.7)	6.00%	0.34
NHW	5,644	14.5 (1.2)	5,895	11.9 (0.7)	−17.90%	0.045	5,146	13.2 (0.7)	6,455	13.0 (0.6)	−1.50%	0.61
NHB	1,793	15.8 (1.7)	1,779	11.5 (0.9)	−27.20%	0.006	4,231	37.3 (0.3)	4,792	31.0 (1.6)	−16.90%	0.08
Hispanic	1,139	19.2 (1.8)	1,565	19.6 (1.6)	2.10%	0.81	1,716	28.9 (0.3)	2,223	27.8 (1.8)	−3.80%	0.63
Other	660	23.8 (1.4)	1,171	27.3 (2.8)	14.70%	0.27	1,027	37.0 (3.7)	1,709	39.8 (2.8)	7.60%	0.47
Age 55–64 years old	10,728	12.9 (0.9)	11,848	11.9 (0.6)	−7.80%	0.47	19,508	23.5 (0.8)	22,568	22.6 (0.7)	−3.80%	0.58
Male	3,972	9.6 (0.7)	4,484	8.9 (5.2)	−7.30%	0.47	11,250	27.2 (1.0)	13,421	26.5 (0.8)	−2.60%	0.79
Female	6,755	16.2 (1.3)	7,364	14.9 (0.8)	−8.00%	0.56	8,258	19.8 (0.8)	9,147	18.5 (0.7)	−6.60%	0.33
NHW	5,129	11.8 (1.0)	6,770	10.5 (0.6)	−11.00%	0.26	7,809	18.0 (0.8)	11,141	17.2 (0.6)	−4.40%	0.30
NHB	1,020	11.4 (1.1)	1,577	10.2 (0.8)	−10.50%	0.48	3,625	40.4 (2.4)	5,547	35.8 (1.8)	−11.40%	0.23

	Subarachnoid Hemorrhagic Stroke						Intracerebral Hemorrhage Stroke					
	2003–2004		2011–2012				2003–2004		2011–2012			
	Weighted N	Rates[a] (s.e)	Weighted N	Rates[a] (s.e)	Relative change[b]	P value for trends[c]	Weighted N	Rates[a] (s.e)	Weighted N	Rates[a] (s.e)	Relative change[b]	p value for trends[c]
Hispanic	920	17.2 (1.9)	1,189	15.7 (1.6)	−8.70%	0.48	1,753	32.7 (2.4)	2,263	29.8 (2.0)	−8.90%	0.29
Other	549	20.0 (1.2)	1,139	23.1 (2.4)	15.50%	0.16	1,378	50.2 (4.3)	2,055	41.8 (2.7)	−16.70%	0.11

[a] Rates are per 10,000 hospitalizations

[b] Relative change = (2011/2012-2003/2004)/ 2003/2004

[c] p value was obtained by using linear regression model to assess the linear trends across the 5 time period

Abbreviations NHW = non-Hispanic white, NHB = non-Hispanic Black

Table 4

Prevalence (%) of Risk Factors among Patients Hospitalization with Intracerebral Hemorrhage by Age and Sex

									Risk factors (HTN, Diabetes, Lipid Disorder, Obesity, and Tobacco Use)		
			HTN	Lipid disorders	Diabetes	Tobacco use	Obesity	AVM	None of above	One or two risk factors	Three to five risk factors
Male	**Age 18–34**	**2003–04**	34.7 (2.6)	2.9 (0.9)	6.8 (1.4)	13.2 (1.7)	2.7 (0.8)	9.9 (1.6)	54.5 (2.7)	43.4 (2.6)	*d*
		2011–12	44.1 (2.7)[b]	6.0 (1.2)[a]	10.3 (1.9)[a]	25.8 (2.4)[c]	7.1 (1.4)[b]	11.7 (1.9)	39.0 (2.6)[c]	53.5 (2.7)[b]	7.4 (1.5)
	Age 35–44	**2003–04**	64.5 (1.8)	9.8 (1.1)	15.4 (1.3)	16.2 (1.5)	4.3 (0.7)	4.1 (0.7)	27.0 (1.6)	65.8 (1.6)	7.3 (0.9)
		2011–12	73.8 (1.7)[c]	14.3 (1.3)$_c$	21.2 (1.6)[c]	22.2 (1.6)[b]	10.1 (1.3)[c]	4.2 (0.9)	16.1 (1.5)[c]	71.8 (1.8)[a]	12.1 (1.2)[c]
	Age 45–54	**2003–04**	73.2 (1.0)	10.8 (0.7)	20.4 (0.9)	18.5 (1.1)	4.7 (0.5)	1.0 (0.2)	18.6 (0.9)	71.8 (1.0)	9.6 (0.7)
		2011–12	81.4 (1.0)[c]	23.3 (1.0)[c]	28.2 (0.9)[c]	26.9 (1.1)[c]	9.9 (0.7)[c]	2.4 (0.4)[b]	10.9 (0.8)[c]	67.7 (1.0)[b]	21.4 (0.9)[c]
	Age 55–64	**2003–04**	78.3 (0.9)	16.0 (0.8)	28.2 (1.0)	16.4 (0.9)	4.2 (0.4)	1.4 (0.2)	14.6 (0.7)	72.8 (1.0)	12.5 (0.8)
		2011–12	81.4 (0.8)[c]	31.3 (0.9)[c]	35.0 (0.9)[c]	26.7 (0.9)[c]	7.9 (0.5)[c]	1.8 (0.3)	10.5 (0.6)[c]	63.8 (0.9)[c]	25.7 (0.8)[c]
Female	**Age 18–34**	**2003–04**	25.5 (2.9)	*d*	5.9 (1.5)	8.6 (1.8)	*d*	12.2 (2.3)	64.7 (3.1)	34.9 (3.1)	*d*
		2011–12	28.1 (2.9)	*d*	8.0 (1.8)	23.9 (2.9) [c]	9.4 (1.9)	13.0 (2.1)	47.0 (3.6)[c]	50.2 (3.5)[c]	*d*
	Age 35–44	**2003–04**	52.9 (2.2)	6.9 (1.1)	10.1 (1.3)	16.2 (1.8)	7.1 (1.1)	4.7 (0.9)	35.8 (2.1)	58.0 (2.3)	6.2 (1.1)
		2011–12	60.1 (2.6)[a]	11.6 (1.6)[b]	22.2 (2.1)[c]	16.0 (1.9)	15.2 (1.8)[c]	6.2 (1.3)	29.3 (2.3)[b]	55.8 (2.5)	14.9 (1.9)§
	Age 45–54	**2003–04**	71.0 (1.5)	9.1 (0.9)	21.7 (1.1)	14.3 (1.1)	7.4 (0.8)	2.5 (0.5)	21.0 (1.3)	71.6 (1.4)	7.4 (0.7)
		2011–12	76.7 (1.2)[c]	18.7 (1.1)[c]	29.3 (1.2)[c]	25.2 (1.4)[c]	13.5 (1.0)[c]	3.2 (0.5)	13.9 (1.0)[c]	66.3 (1.3)[c]	19.9 (1.2)§
	Age 55–64	**2003–04**	73.7 (1.1)	15.6 (0.9)	27.3 (1.1)	13.1 (1.0)	6.1 (0.6)	1.8 (0.3)	18.3 (0.9)	70.9 (1.0)	10.8 (0.8)
		2011–12	81.0 (1.1)[c]	29.7 (1.2)[c]	33.8 (1.1)[c]	20.8 (1.1)[c]	12.5 (0.8)[c]	1.5 (0.3)	10.8 (0.8)[c]	65.4 (1.2)[b]	23.8 (1.2)[c]

[a] p value for trend <0.05;

[b] p value for trend <0.01;

[c] p value for trend <0.001.

[d] Not reportable based on the estimates with a relative standard error greater than 0.30 HTN=hypertension, AVM=arteriovenous malformation

Table 5

Prevalence (%) of Risk Factors among Patients Hospitalization with Subarachnoid Hemorrhage by Age and Sex

									Risk factors (HTN, Diabetes, Lipid Disorder, Obesity, and Tobacco Use)		
			HTN	Lipid disorders	Diabetes	Tobacco use	Obesity	Other drug abuse	None of above	One or two risk factors	Three to five risk factors
Male	Age 18–34	2003–04	20.0 (2.0)	*d*	*d*	17.9 (2.2)	2.7 (0.8)	14.3 (1.8)	65.6 (2.4)	33.1 (2.4)	*d*
		2011–12	32.8 (2.6)[c]	4.3 (1.1)	7.5 (1.5)	33.9 (2.7)[c]	5.9 (1.2)[b]	17.7 (2.1)	41.0 (2.7)[c]	55.7 (2.8)[c]	3.3 (1.0)
	Age 35–44	2003–04	35.5 (1.8)	6.2 (0.9)	5.8 (0.8)	25.7 (2.1)	1.9 (0.5)	6.6 (1.0)	44.3 (2.2)	53.3 (2.1)	2.4 (0.6)
		2011–12	48.0 (2.5)[c]	13.9 (1.7)[c]	18.9 (2.2)[c]	35.4 (2.6)[b]	6.7 (1.2)[c]	7.7 (1.3)	28.6 (2.4)[c]	58.5 (2.3)[a]	12.9 (1.7)[c]
	Age 45–54	2003–04	48.1 (1.7)	8.2 (0.9)	10.3 (0.9)	25.4 (1.7)	3.5 (0.6)	5.9 (0.8)	36.8 (1.8)	57.9 (1.6)	5.3 (0.6)
		2011–12	60.1 (1.8)[c]	16.5 (1.3)[c]	19.2 (1.5)[c]	35.3 (1.8)[c]	6.5 (0.9)[b]	7.9 (1.0)	23.4 (1.5)[c]	62.8 (1.6)[a]	13.8 (1.2)[c]
	Age 55–64	2003–04	56.3 (1.8)	16.5 (1.4)	14.8 (1.2)	21.5 (1.6)	3.0 (0.6)	1.7 (0.4)	29.6 (1.7)	61.5 (1.8)	9.0 (1.1)
		2011–12	68.5 (1.6)[c]	29.8 (1.6)[c]	25.5 (1.5)[c]	33.9 (1.6)[c]	5.8 (0.8)[b]	2.8 (0.5)	15.2 (1.3)[c]	65.5 (1.7)	19.3 (1.3)[c]
Female	Age 18–34	2003–04	22.4 (2.4)	*d*	*d*	14.5 (1.9)	*d*	11.0 (2.1)	67.2 (2.8)	32.1 (2.7)	*d*
		2011–12	31.4 (2.5)[b]	3.2 (0.9)	12.4 (1.9)	26.2 (2.3)[c]	8.8 (1.5)	10.6 (1.7)	45.9 (2.8)[c]	48.9 (2.8)[c]	5.2 (1.2)
	Age 35–44	2003–04	39.6 (1.5)	2.6 (0.5)	4.0 (0.7)	26.9 (1.7)	3.7 (0.6)	7.4 (0.9)	42.4 (1.6)	56.2 (1.6)	1.4 (0.4)
		2011–12	50.4 (1.9)§	6.4 (1.0)[c]	13.7 (1.5)[c]	28.4 (1.8)	9.6 (1.5)[c]	7.1 (1.0)	32.2 (1.8)[c]	59.0 (1.9)[a]	8.8 (1.2)[c]
	Age 45–54	2003–04	44.8 (1.5)	6.3 (0.6)	8.1 (0.7)	22.5 (1.4)	3.9 (0.5)	4.5 (0.5)	39.4 (1.6)	57.0 (1.5)	3.6 (0.5)
		2011–12	56.5 (1.5)§	14.2 (1.0)[c]	18.0 (1.2)[c]	35.5 (1.5)[c]	8.9 (0.8)[c]	6.0 (0.7)	22.8 (1.2)[c]	63.9 (1.2)[c]	13.2 (0.9)[c]
	Age 55–64	2003–04	54.1 (1.7)	12.2 (1.0)	11.8 (1.0)	20.3 (1.5)	2.8 (0.5)	1.3 (0.3)	33.2 (1.7)	60.1 (1.5)	6.7 (0.7)
		2011–12	64.1 (1.4)§	24.7 (1.2)[c]	22.6 (1.3)[c]	29.6 (1.3)[c]	6.9 (0.7)[c]	1.9 (0.3)	19.6 (1.1)[c]	64.0 (1.2)[a]	16.4 (1.2)[c]

[a] p value for trend <0.05

[b] p value for trend <0.01

[c] p value for trend <0.001

[d] Not reportable based on the estimates with a relative standard error greater than 0.30 HTN=hypertension