Trends in Age of First-Ever Stroke Following Increased Incidence and Life Expectancy in a Low-Income Chinese Population

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Background and Purpose—We investigated secular trends in the age of stroke onset and stroke incidence in a low-income population in rural China.

Methods—The study population was recruited from a population-based stroke surveillance study conducted in a township in Tianjin, China, from 1992 to 2014. The trends in mean age and incidence of first-ever stroke were assessed by sex and stroke subtype. Risk factor surveys were conducted in the same population in both 1991 and 2011.

Results—A total of 1053 patients experienced first-ever stroke from 1992 to 2014. The mean age of stroke onset in men significantly decreased by 0.28 years annually overall, by 0.56 years for intracerebral hemorrhage, and by 0.22 years for ischemic stroke (P<0.05). However, a similar trend was not observed in women. The age-standardized first-ever stroke incidence in the same population significantly increased across sex and stroke subtypes, increased by 6.3% overall, 5.5% for men, 7.9% for women, 4.6% for intracerebral hemorrhage, and 7.3% for ischemic stroke (P<0.05) during 1992 to 2014. Concurrently, the prevalence of hypertension, diabetes mellitus, obesity, current smoking, and alcohol consumption increased significantly in young and middle-aged adults from 1991 to 2011.

Conclusions—The age of stroke onset tends to be younger among low-income population in China after the dramatic increased incidence of stroke during the gradual extension of life expectancy of population in China. These findings suggested that stroke burden will continue to increase in the long time, unless the risk factors in low-income populations are effectively controlled. **(*Stroke*. 2016;47:929-935. DOI: 10.1161/STROKEAHA.115.012466.)**

Key Words: age ■ epidemiology ■ incidence ■ stroke ■ trend

Stroke was the second most common cause of death and the third most common cause of disability-adjusted life years worldwide in 2010.[1,2] The latest report showed that the age-standardized stroke incidence rates in low-income and middle-income countries exceeded those in high-income countries by 24% in people <75 years; moreover, the number of stroke incidents in low-income and middle-income countries was 3× greater than that in high-income countries, although the age-standardized incidence of stroke exhibited a nonsignificant increase in low-income and middle-income countries.[3]

Stroke was the leading cause of death in rural areas and the third leading cause of death in urban areas in 2010.[4] In addition, several previous studies have indicated that stroke incidence has increased among urban residents in China over past decades.[5–7] However, the trends in age of stroke onset in China are unknown. In our previous study, we reported that the incidence of first-ever stroke from 1992 to 2012 sharply increased annually by 6.5% overall and increased by 12% among men aged 45 to 64 years in a Chinese low-income rural population.[8] Almost half of the Chinese population lives in rural areas; the reduction of stroke incidence in rural areas is thus crucial to reduce the burden of stroke in China. We aimed to explore the secular trends in age of first-ever stroke incidence in a Chinese low socioeconomic population along with the sharp increased stroke incidence and increasing life expectancy in China.

Methods

The study population was described in previous studies.[7,9] Briefly, the study population was from the Tianjin Brain Study, a population-based stroke surveillance study in a township in Tianjin, China, in 1985. The total population in 1985 was 15438 people distributed within 18 administrative villages. We assessed the age trends in first-ever stroke incidence from 1992 to 2014 because computed tomography was available since 1992.

Received December 15, 2015; final revision received January 15, 2016; accepted January 21, 2016.

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Stroke **is available at http://stroke.ahajournals.org** **DOI: 10.1161/STROKEAHA.115.012466**

A first-ever stroke event was defined as the first occurrence (no history of stroke in prior medical records) of rapidly developing signs of focal neurological disturbance of presumed vascular pathogenesis lasting >24 hours.[10] Hemorrhagic stroke was defined as intracerebral hemorrhage (ICH) or subarachnoid hemorrhage; ischemic stroke (IS) was defined as thrombotic brain infarction, cardioembolic stroke, or lacunar infarct; and undetermined stroke was defined as stroke that could not be classified as any of the previous types. All patients were diagnosed as having fully clinical strokes, with significant clinical symptoms and signs. Subarachnoid hemorrhage and undetermined stroke were excluded because of low numbers. Transient ischemic attacks and silent strokes (diagnosed by imaging only) were excluded, but stroke cases with a history of transient ischemic attack were regarded as incident events. Patients with transient symptoms but with concurrent neuroimaging evidence of a brain infarction were considered stroke cases based on the tissue definition.[11]

A stroke surveillance network was established in 1985, and the details are described in previous reports.[8,9] Briefly, local licensed village doctors reported suspected stroke cases to physicians in the community health center within 24 hours of onset; the physicians then visited patients' homes to confirm stroke events within 72 hours for outpatients and obtained the medical record for inpatients after discharge. They reported the initial confirmed stroke events to neurologists in Tianjin Medical University General Hospital monthly. Finally, the neurologist identified possible stroke events by interview.

The risk factor survey was conducted in the same population in both 1991 and 2011. The detailed methods are described in a previous study.[12] The risk factors assessed included hypertension, diabetes mellitus, obesity, current smoking status, and alcohol consumption. Hypertension was defined as systolic blood pressure ≥140 mm Hg and diastolic blood pressure ≥90 mm Hg or use of antihypertension medication. Diabetes mellitus was defined as self-reported previous diabetes mellitus history or use of antidiabetic medications. Obesity was defined as body mass index ≥28 kg/m^2; body mass index was calculated as weight in kilograms divided by the square of height in meters.[13] Current smoking was defined as ≥1 cigarette/d for at least 1 year, and alcohol consumption was defined as ≥1 alcoholic drink weekly for at least 1 year.

The age-standardized incidence rates were calculated with the direct method using the world standard population.[14] Trends in age and age-standardized incidence of stroke were calculated from the annual change by sex and stroke subtype (ICH and IS) using a regression model: $\log(r_i)=a+bt$, where log denotes the natural logarithm and t is the year. The trend b was estimated from the ordinary regression,[3] where a represents the constant and b represents the estimated annual change of age. The differences in prevalence of risk factors between 1991 and 2011 were analyzed using the χ^2 test, and systolic blood pressure, diastolic blood pressure, and body mass index were compared between the 2 surveys using the Student's t test. Statistical significance was defined as $P<0.05$. SPSS version 15.0 for Windows (SPSS Inc, Chicago, IL) was used for the analyses.

The ethics committee of Tianjin Medical University General Hospital approved the study, and written informed consent was obtained from all residents during recruitment.

Results

A total of 1054 patients with a first-ever stroke were identified during 332 709 person-years of surveillance from 1992 to 2014; 630 (59.8%) cases occurred in men and 424 (40.2%) in women. The age at incidence of first-ever stroke was similar in men and in women (65.3 years versus 65.5 years) over the 23-year study period. Regarding stroke subtype, 23.6% of cases (23.8% in men and 23.5% in women) were ICH and 76.4% (76.2% in men and 76.7% in women) were IS. The proportion of diagnoses by neuroimaging was 78.3% overall, 77.6% in men, and 79.2% in women (Table 1).

Table 2 shows that the onset age of first-ever stroke decreased by 0.16 years annually overall (P=0.056); there was a statistically significant decrease (by 0.28 years; P=0.002) in men and no significant changed in women from 1992 to 2014. Simultaneously, the age-standardized incidence rate increased by 6.3% overall, 5.5% in men, and 7.9% in women (P<0.001). Nevertheless, although the age-standardized incidence of ICH and IS increased significantly both in men and in women, the onset age of first-ever stroke decreased by 0.55 years annually in men with ICH (P<0.001) and decreased by 0.21 years annually in men with IS (P=0.036); however, no statistically significant decrease was found in women across stroke subtypes.

Figure shows that the mean age of stroke onset decreased in this study population from 1992 to 2014, whereas the incidence of stroke increased in the same population, and the life expectancy in China gradually rose over the corresponding time period.[15]

The ratio of stroke patients aged <65 years increased by 1.17% annually from 1992 to 2014 and by 1.32% from 1992 to 2011 overall (P<0.05); similar trends were observed in men, increasing by 1.67% from 1992 to 2014 (P<0.001) and by 1.77% from 1992 to 2011 (P=0.002; Table 3).

The prevalence of hypertension, diabetes mellitus, obesity, and alcohol consumption increased significantly from 1991 to 2011 (P<0.001). There was a 30% increase in hypertension, 48% increase in diabetes mellitus, 242% increase in obesity, and 395% increase in alcohol consumption; notably, the prevalence rates of risk factors in young and middle-aged people showed greater increases than those observed in elderly people. Of note, the prevalence of hypertension increased by 48% in those aged <45 years and by 33% in those aged 45 to 64 years; there was no change in patients aged ≥65 years. Similar trends were found in the prevalence of alcohol consumption. There were greater increases in the prevalence rates of diabetes mellitus and obesity among the elderly than among the young

Table 1. The Demographical Characteristics of Patients With Stroke in Study Population During 1992 to 2014

Category	Men	Women	Total
Number, n (%)	630 (59.77)	424 (40.23)	1054 (100)
<65 y	297 (47.14)	199 (46.93)	496 (47.06)
≥65 y	333 (52.86)	225 (53.07)	558 (52.94)
Age, y, mean (SD)	65.26 (11.43)	65.47 (12.28)	65.34 (11.77)
Education level, mean (SD), y	3.69 (3.34)	2.35 (2.94)	3.15 (3.25)
ICH, n (%)	150 (23.81)	99 (23.45)	249 (23.62)
<65 y	78 (52.00)	54 (54.55)	132 (53.01)
≥65 y	72 (48.00)	45 (45.45)	117 (46.99)
IS, n (%)	480 (76.19)	325 (76.65)	805 (76.38)
<65 y	219 (45.63)	146 (44.92)	365 (45.34)
≥65 y	259 (54.37)	178 (55.08)	437 (54.66)
Imaging confirmation, n (%)	489 (77.62)	335 (79.20)	824 (78.25)
<65 y	272 (91.58)	184 (92.46)	456 (91.94)
≥65 y	217 (65.17)	149 (66.22)	366 (65.59)

ICH indicates intracerebral hemorrhage; and IS, ischemic stroke.

Table 2. The Trends of Onset Age and Incidence of Stroke in Study Population During 1992 to 2014 in Men and Women

	Overall						ICH						IS					
	Onset Age*			Incidence†			Onset Age*			Incidence†			Onset Age*			Incidence†		
Year	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total
1992	71.8	70.1	71.1	118.0	77.9	98.0	71.4	64.4	68.8	55.4	27.7	41.7	72.2	73.6	72.8	62.6	50.2	56.4
1993	71.8	67.0	70.3	179.6	66.8	122.6	72.0	64.3	69.5	76.4	31.1	48.8	71.7	69.0	70.9	102.8	35.7	68.6
1994	72.0	70.9	71.5	114.0	80.5	96.4	69.0	…	69.0	30.0	0	14.3	73.1	70.9	72.0	83.9	80.5	82.0
1995	63.3	62.9	63.2	185.5	101.0	157.0	71.5	59.0	66.1	41.9	26.6	33.2	61.0	64.0	62.3	131.6	104.4	118.4
1996	65.3	64.3	64.9	229.2	123.5	185.8	63.7	61.2	62.8	91.9	40.9	65.9	66.4	66.0	66.2	125.5	82.7	103.0
1997	66.7	57.0	64.0	165.0	48.6	105.0	67.7	53.0	64.8	46.4	9.1	27.3	66.4	57.8	63.8	119.6	39.5	77.8
1998	68.3	56.3	64.6	168.7	83.2	121.4	74.3	58.0	67.3	44.2	26.9	34.7	66.3	55.0	63.5	124.5	42.5	83.1
1999	67.8	54.0	64.3	178.2	62.0	118.1	69.5	55.0	65.9	63.7	23.9	36.9	66.9	53.5	63.6	114.4	38.1	74.4
2000	64.4	63.6	64.1	215.2	174.9	193.5	63.5	64.7	64.2	18.1	30.6	24.3	64.5	63.3	64.0	197.1	133.5	164.0
2001	66.3	67.8	66.8	189.2	88.0	136.3	67.5	75.5	70.2	11.2	9.1	10.1	66.0	65.6	65.9	149.7	68.2	107.2
2002	63.6	63.7	63.7	184.4	177.2	179.1	61.8	63.9	63.1	37.3	75.8	56.2	64.2	63.6	63.9	136.1	101.4	117.9
2003	63.1	69.9	65.4	329.9	168.5	257.0	54.5	63.4	58.7	78.2	71.3	74.1	65.7	74.5	68.1	267.1	97.2	181.6
2004	66.4	64.5	65.5	250.6	196.4	220.1	69.8	62.8	66.9	67.8	63.8	65.8	65.0	65.1	65.0	174.7	132.6	150.6
2005	68.9	63.6	66.8	216.8	156.7	181.4	53.5	63.5	56.9	42.9	20.2	32.3	72.5	63.6	68.8	173.1	135.9	149.7
2006	62.9	61.6	62.5	207.2	94.0	148.5	58.4	57.0	58.0	48.9	14.2	30.5	64.4	62.7	63.8	147.6	79.8	113.2
2007	68.3	67.9	68.1	364.9	342.0	353.2	72.6	66.3	69.8	100.5	90.2	93.5	66.6	68.4	67.5	254.0	243.1	230.0
2008	65.7	66.5	66.0	464.7	224.3	338.8	62.8	62.7	62.8	87.4	32.3	58.9	66.4	67.3	66.7	375.7	183.1	275.1
2009	66.4	68.1	67.2	437.6	363.3	398.1	59.9	61.7	60.6	127.7	69.6	97.0	68.9	69.5	69.2	309.9	293.7	301.1
2010	65.3	64.7	65.1	442.0	261.9	352.6	62.8	64.0	63.4	101.2	99.9	101.9	65.9	65.2	65.7	340.9	153.2	245.9
2011	60.1	61.2	60.5	383.3	251.6	315.7	55.8	55.3	55.7	100.4	40.4	69.2	61.7	61.9	61.8	282.9	211.5	246.7
2012	62.7	67.7	65.1	327.1	314.3	320.4	59.5	62.9	61.3	80.0	90.6	84.7	63.8	69.7	66.6	247.1	223.7	235.8
2013	62.7	65.1	63.5	613.0	344.8	475.4	57.0	59.8	58.1	75.7	64.1	66.7	63.5	65.9	64.3	537.4	280.8	408.7
2014	65.2	67.2	66.2	280.0	308.8	297.4	65.4	67.0	66.1	71.9	42.8	58.6	65.2	67.3	66.3	208.2	266.0	238.8
Trends	−0.28‡	−0.14	−0.16	0.055‡	0.079‡	0.063‡	−0.55‡	0.06	−0.36‡	0.034‡	0.049‡	0.046‡	−0.21‡	0.05	−0.12	0.066‡	0.084‡	0.073‡

ICH indicates intracerebral hemorrhage; and IS, ischemic stroke.
*Average age of stroke onset, years.
†Incidence of stroke per 100 000 person-year.
‡*P* for trends <0.05.

and middle-aged people; the prevalence of current smoking decreased over the past 2 decades, but a 58% increase was observed among those aged <45 years (Table 4).

Discussion

This is the first report on the trends in onset age of first-ever stroke among a low socioeconomic population in China following report of the dramatic increase in the incidence of first-ever stroke and life expectancy.

Stroke incidence has substantially decreased in developed countries.[3,16] First-ever stroke incidence decreased by 29% in the Oxford Vascular Study between 1981 and 2004.[17] A 22% decrease in the age-standardized incidence rates of stroke was reported in an Asian population from 2006 to 2010.[18] However, several studies have shown that the incidence of first-ever stroke in young and middle-aged adults increased in different races over the last 2 decades.[19,20] Authoritative statistics indicated that the mean age of people with stroke significantly increased from 73.9 years in 1990 to 74.5 years in 2010 in high-income countries and from 68.8 years in 1990 to 69.4 years in 2010 in low-income and middle-income countries.[3]

Contrary to these previous studies, we found a dramatic increase in the incidence of first-ever stroke and a striking decrease in the mean age of stroke patients from 1992 to 2014 among a low-income population in China. The mean age of stroke onset decreased by 0.36 years annually for ICH; however, in men, the mean age of stroke onset significantly decreased by 0.28 years overall, by 0.55 years for ICH, and by 0.21 years for IS. The corresponding incidence of first-ever stroke increased annually by 6.3% overall, by 4.6% for ICH, and by 7.3% for IS; in men, the incidence of first-ever stroke increased annually by 5.5% overall, by 3.4% for ICH, and by 6.6% for IS; in women, the incidence of first-ever stroke increased annually by 7.9% overall, by 4.9% for ICH, and by 8.4% for IS. It is alarming that the mean age of stroke patients significantly decreased, whereas the incidence of stroke obviously increased in this low-income population, particularly when the life expectancy in China has increased.

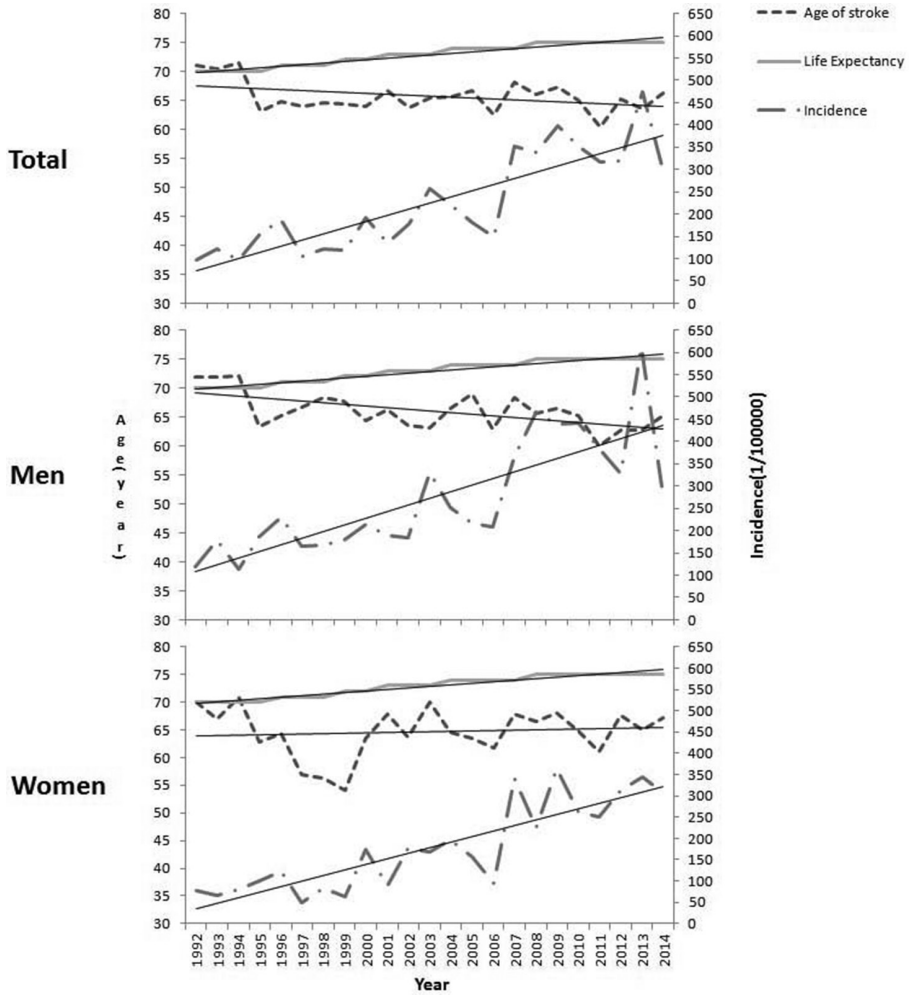

Figure. Trends in age of stroke onset after the incidence from 1992 to 2014. The mean age of stroke onset decreased in this study population from 1992 to 2014, whereas the incidence of stroke increased in the same population, and the life expectancy in China gradually rose over the corresponding time period.

According to previous research, the incidence of stroke in people aged <65 years constituted 35.6% of stroke cases in low-income and middle-income countries in 2010.[3] However, in this study, there was a higher proportion of stroke patients aged <65 years in 2014 (49.2% overall, 53.1% in men) compared with the WHO report. Moreover, a dramatic increasing trend was observed in men, and the proportion of stroke patients aged <65 years increased annually by 1.67% over the 23-year period.

The increased stroke incidence in young adults has been found to be associated with the rising prevalence of vascular risk factors, including hypertension, hypercholesterolemia, diabetes mellitus, obesity, current smoking, and alcohol abuse in this age group.[19,21–23] In accordance with these findings, in the present study, the striking increased prevalence rates of hypertension, diabetes mellitus, obesity, current smoking, and alcohol consumption in young adults may have accounted for the decreased mean age of first-ever stroke onset in this population. Furthermore, the obvious increase in the prevalence of obesity (871%), smoking (25%), and alcohol consumption (125%) in men aged <45 years may contribute to the earlier age of first-ever stroke among young men in this low-income population. The lower frequency of neuroimaging utilization for elderly patients may contribute to an underestimation of stroke in this patient population, thus contributing to the younger age at stroke onset observed in this low-income population.

There were several limitations in this study. First, this was not a nationally representative population; this study was conducted in a township in northern China. However, stroke incidence has been monitored in this population for 23 years, which may reflect the secular trends of stroke in a specific population. Second, the number of strokes may be underestimated because some stroke victims may have died before seeking medical attention; in addition, there is no national registration of stroke incidents. However, the 3-level stroke surveillance network used in this study can overcome this situation because local licensed village doctors are the first medical professional to treat patients in rural China. Third, risk factors were only monitored twice during the study period. However, we conducted 2 surveys of risk factors in the same population from the same area. At least 100 000 person-years of observation during the 23-year study period fulfills the criteria for population studies and follows the guidelines for a

Table 3. Trends in the Percentage of Stroke Patients Aged <65 Years From 1992 to 2014 (%)

Year	Total	Men	Women
1992	15.8	9.1	25.0
1993	26.1	18.8	42.9
1994	15.8	18.2	12.5
1995	56.3	55.6	57.1
1996	50.0	45.5	57.1
1997	59.1	43.8	100.0
1998	39.1	25.0	71.4
1999	37.5	27.8	66.7
2000	33.3	30.0	37.5
2001	32.1	36.8	22.2
2002	51.4	52.9	50.0
2003	44.2	54.3	23.5
2004	39.5	37.5	42.1
2005	34.3	28.6	42.9
2006	67.7	65.0	72.7
2007	42.3	37.1	47.2
2008	47.1	46.8	47.8
2009	43.9	50.0	36.8
2010	51.4	52.2	50.0
2011	68.7	70.0	66.7
2012	55.7	61.1	50.0
2013	55.0	59.1	47.1
2014	49.2	53.1	45.5
Trend, change annually (%)*	1.17 (0.40–1.95)†	1.67 (0.89–2.45)†	0.19 (-1.09–1.48)
Trend, change annually (%)‡	1.32 (0.29–2.35)†	1.77 (0.73–2.80)†	0.35 (-1.37–2.07)

*Trends from 1992 to 2014.
†$P<0.05$ for trends.
‡Trends from 1992 to 2011.

stroke incidence study.[24] Finally, in this study, the frequency of neuroimaging utilized was relatively low, especially early in the study period. However, we assessed the trends of age and incidence of symptomatic stroke in this study, and all stroke events were verified by a senior neurologist from Tianjin Medical University General Hospital. Thus, the limited utilization of neuroimaging would not increase the numbers of false-positive cases of stroke overall, but may affect data on stroke subtypes.

This is the first report of trends in the mean age of stroke onset and a dramatic increase in incidence of first-ever stroke among a low-income population after increased life expectancy in China. We found that the mean age of stroke onset significantly decreased after the increased incidence of first-ever stroke; this was particularly noted in men, as the mean age for both ICH and IS were significantly decreased. The remarkable increasing prevalence of hypertension, smoking, and alcohol consumption in young adults may explain the younger-age trend in stroke incidence in this population. These findings suggested that stroke burden will continue to increase in the long time, unless the risk factors in low-income populations are effectively controlled.

Acknowledgments

We thank all participants of the Tianjin Brain Study and local medical care professionals for their valuable contributions.

Sources of Funding

This study was funded by the Ministry of Science and Technology of the People's Republic of China and Tianjin Medical University General Hospital.

Disclosures

None.

References

1. Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012;380:2095–2128. doi: 10.1016/S0140-6736(12)61728-0.
2. Murray CJ, Vos T, Lozano R, Naghavi M, Flaxman AD, Michaud C, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012;380:2197–2223. doi: 10.1016/S0140-6736(12)61689-4.
3. Feigin VL, Forouzanfar MH, Krishnamurthi R, Mensah GA, Connor M, Bennett DA, et al; Global Burden of Diseases, Injuries, and Risk Factors Study 2010 (GBD 2010) and the GBD Stroke Experts Group. Global and regional burden of stroke during 1990-2010: findings from the Global Burden of Disease Study 2010. *Lancet*. 2014;383:245–254.
4. The Ministry of Health of the People's Republic of China. The causes of death, disease, and hurt in residents. *China Health Statistics Yearbook 2011*. Beijing: China Union Medical University Press; 2011:287–338.
5. Zhao D, Liu J, Wang W, Zeng Z, Cheng J, Liu J, et al. Epidemiological transition of stroke in China: twenty-one-year observational study from the Sino-MONICA-Beijing Project. *Stroke*. 2008;39:1668–1674. doi: 10.1161/STROKEAHA.107.502807.
6. Jiang B, Wang WZ, Chen H, Hong Z, Yang QD, Wu SP, et al. Incidence and trends of stroke and its subtypes in China: results from three large cities. *Stroke*. 2006;37:63–68. doi: 10.1161/01.STR.0000194955.34820.78.
7. Cheng XM, Ziegler DK, Lai YH, Li SC, Jiang GX, Du XL, et al. Stroke in China, 1986 through 1990. *Stroke*. 1995;26:1990–1994.
8. Wang J, An Z, Li B, Yang L, Tu J, Gu H, et al. Increasing stroke incidence and prevalence of risk factors in a low-income Chinese population. *Neurology*. 2015;84:374–381. doi: 10.1212/WNL.0000000000001175.
9. Wang J, Ning X, Yang L, Tu J, Gu H, Zhan C, et al. Sex differences in trends of incidence and mortality of first-ever stroke in rural Tianjin, China, from 1992 to 2012. *Stroke*. 2014;45:1626–1631. doi: 10.1161/STROKEAHA.113.003899.
10. Aho K, Harmsen P, Hatano S, Marquardsen J, Smirnov VE, Strasser T. Cerebrovascular disease in the community: results of a WHO collaborative study. *Bull World Health Organ*. 1980;58:113–130.
11. Easton JD, Saver JL, Albers GW, Alberts MJ, Chaturvedi S, Feldmann E, et al; American Heart Association; American Stroke Association Stroke Council; Council on Cardiovascular Surgery and Anesthesia; Council on Cardiovascular Radiology and Intervention; Council on Cardiovascular Nursing; Interdisciplinary Council on Peripheral Vascular Disease. Definition and evaluation of transient ischemic attack: a scientific statement for healthcare professionals from the American Heart Association/American Stroke Association Stroke Council; Council on Cardiovascular Surgery and Anesthesia; Council on Cardiovascular Radiology and Intervention; Council on Cardiovascular Nursing; and the

Table 4. The Prevalence of Cardiovascular Risk Factors in the Study Population From 1991 to 2011

	Men		Women		Total	
Risk Factors	1991	2011	1991	2011	1991	2011
Participants, n	1032	865	1164	1074	2196	1939
Hypertension, % (SE)	38.7 (1.1)	50.3 (1.7)*	41.1 (1.4)	53.6 (1.5)*	39.9 (1.1)	51.7 (1.1)*
<45 y	23.5 (2.1)	31.2 (3.2)*	23.7 (1.8)	39.9 (3.9)*	23.6 (1.4)	34.9 (2.4)*
45–64 y	42.0 (2.3)	58.9 (2.3)*	45.4 (2.2)	57.6 (1.8)*	43.7 (1.6)	58.1 (1.4)*
≥65 y	66.1 (3.9)	68.4 (3.3)	71.4 (3.6)	74.1 (3.1)	68.6 (2.6)	71.2 (2.2)
SBP, mm Hg, mean (SD)	130.5 (18.7)	140.7 (22.3)*	132.0 (23.7)	141.7 (22.2)*	131.3 (21.5)	141.7 (22.3)*
<45 y	123.6 (12.7)	128.1 (18.0)*	123.0 (16.5)	132.7 (19.2)*	123.3 (15.0)	130.1 (18.6)*
45–64 y	131.5 (18.1)	142.8 (21.2)*	134.9 (22.9)	142.7 (21.5)*	133.2 (20.8)	142.7 (21.4)*
≥65 y	144.0 (23.6)	149.1 (23.1)*	152.6 (30.2)	149.7 (24.1)	148.1 (27.3)	149.4 (23.6)
DBP, mm Hg, mean (SD)	81.9 (11.2)	86.2 (13.6)*	81.5 (12.5)	85.8 (12.1)*	81.7 (11.9)	86.0 (12.8)*
<45 y	79.1 (10.1)	81.1 (12.8)*	78.7 (11.1)	83.4 (10.5)*	78.9 (10.7)	82.1 (11.9)*
45–64 y	82.8 (10.9)	88.5 (13.5)*	82.4 (12.4)	86.2 (12.4)*	82.6 (11.7)	87.1 (12.9)*
≥65 y	86.4 (12.7)	86.3 (13.0)	87.9 (14.4)	86.6 (12.2)	87.1 (13.5)	86.4 (12.6)
Diabetes mellitus, % (SE)	1.4 (3.2)	3.5 (3.2)*	3.5 (2.9)	3.9 (2.5)*	2.5 (2.2)	3.7 (2.0)*
<45 y	1.0 (0.5)	0.9 (0.7)	2.7 (0.7)	0.6 (0.6)	2.0 (0.05)	0.8 (0.05)
45–64 y	2.0 (0.7)	4.9 (1.0)*	4.9 (1.0)	5.8 (0.9)	3.5 (0.6)	5.4 (0.7)*
≥65 y	0.6 (0.6)	4.4 (1.4)*	0.6 (0.6)	8.3 (1.9)*	0.6 (0.4)	6.3 (1.2)*
Obesity, % (SE)	2.6 (3.2)	17.8 (1.3)*	8.4 (2.8)	20.9 (2.7)*	5.7 (2.1)	19.5 (2.0)*
<45 y	1.7 (0.7)	16.5 (2.6)*	7.2 (1.1)	18.1 (3.1)*	4.8 (0.7)	17.2 (1.9)*
45–64 y	3.1 (2.8)	18.4 (1.8)*	9.8 (1.3)	22.3 (1.6)*	6.6 (0.8)	20.8 (1.2)*
≥65 y	3.5 (1.4)	18.5 (2.7)*	6.7 (2.0)	21.2 (2.9)*	5.0 (1.2)	20.2 (2.0)*
BMI, kg/m^2, mean (SD)	22.5 (2.4)	25.0 (3.4)*	23.3 (3.3)	25.4 (3.7)*	22.9 (2.9)	25.2 (3.6)*
<45 y	22.6 (2.2)	25.2 (3.4)*	23.5 (2.9)	24.8 (3.3)*	23.1 (2.7)	25.1 (3.4)*
45–64 y	22.6 (2.5)	25.0 (3.3)*	23.3 (3.5)	25.6 (3.7)*	23.0 (3.1)	25.4 (3.6)*
≥65 y	22.0 (3.5)	24.7 (3.5)*	22.3 (3.6)	25.3 (3.9)*	22.2 (3.1)	24.0 (3.7)*
Smoking, % (SE)	46.0 (2.2)	36.8 (2.7)*	3.7 (2.9)	4.7 (3.0)	23.6 (1.9)	19.0 (2.0)*
<45 y	50.9 (2.5)	63.5 (3.3)*	1.3 (0.5)	0.6 (0.6)	23.0 (1.4)	36.3 (2.5)*
45–64 y	45.9 (2.3)	37.6 (6.9)*	5.9 (1.1)	4.5 (0.8)	25.3 (1.4)	17.4 (1.1)*
≥65 y	34.9 (3.7)	7.3 (1.8)*	4.5 (1.7)	8.7 (2.0)	20.3 (2.2)	8.0 (1.3)*
Alcohol used, % (SE)	18.9 (2.8)	31.6 (2.8)*	0.3 (1.5)	4.5 (3.0)*	9.1 (2.0)	16.6 (2.1)*
<45 y	21.1 (2.0)	47.4 (3.4)*	0.2 (0.2)	0.6 (0.6)	9.3 (1.0)	30.1 (2.4)*
45–64 y	18.0 (1.8)	31.4 (2.2)*	0.4 (0.3)	4.1 (0.7)*	9.0 (0.9)	14.7 (1.0)*
≥65 y	16.0 (2.8)	10.2 (2.1)	0.6 (0.6)	8.7 (2.0)*	8.6 (1.6)	9.5 (1.4)

BMI indicates body mass index; DBP, diastolic blood pressure; and SBP, systolic blood pressure.
*P<0.05 for comparison between 2 surveys.

Interdisciplinary Council on Peripheral Vascular Disease. The American Academy of Neurology affirms the value of this statement as an educational tool for neurologists. *Stroke*. 2009;40:2276–2293. doi: 10.1161/STROKEAHA.108.192218.

12. Wang J, Ning X, Yang L, Lu H, Tu J, Jin W, et al. Trends of hypertension prevalence, awareness, treatment and control in rural areas of northern China during 1991-2011. *J Hum Hypertens*. 2014;28:25–31. doi: 10.1038/jhh.2013.44.
13. Disease control, Ministry of Health of the People's Republic of China. *The Guidelines of Chinese Adult Overweight and Obesity Prevention and Control*. Beijing: People's Medical Publishing House; 2006:1–3.
14. Ahmad OB, Boschi-Pinto C, Lopez AD, Murray CJL, Lozano R, Inoue M. *Age Standardization of Rates: A New WHO World Standard. GPE Discussion Paper Series: No. 31*. Geneva: EIP/GPE/EBD World Health Organization; 2001, Page 10.
15. World Bank. *Life Expectancy at Birth, Total (Years)*. Available at http://data.worldbank.org/indicator/SP.DYN.LE00.IN/countries/CN. Accessed March 1, 2015.
16. Lackland DT, Roccella EJ, Deutsch AF, Fornage M, George MG, Howard G, et al; American Heart Association Stroke Council; Council on Cardiovascular and Stroke Nursing; Council on Quality of Care and Outcomes Research; Council on Functional Genomics and Translational

Biology. Factors influencing the decline in stroke mortality: a statement from the American Heart Association/American Stroke Association. *Stroke*. 2014;45:315–353. doi: 10.1161/01.str.0000437068.30550.cf.
17. Rothwell PM, Coull AJ, Giles MF, Howard SC, Silver LE, Bull LM, et al; Oxford Vascular Study. Change in stroke incidence, mortality, case-fatality, severity, and risk factors in Oxfordshire, UK from 1981 to 2004 (Oxford Vascular Study). *Lancet*. 2004;363:1925–1933. doi: 10.1016/S0140-6736(04)16405-2.
18. Kim RB, Kim BG, Kim YM, Seo JW, Lim YS, Kim HS, et al. Trends in the incidence of hospitalized acute myocardial infarction and stroke in Korea, 2006-2010. *J Korean Med Sci*. 2013;28:16–24. doi: 10.3346/jkms.2013.28.1.16.
19. Kissela BM, Khoury JC, Alwell K, Moomaw CJ, Woo D, Adeoye O, et al. Age at stroke: temporal trends in stroke incidence in a large, biracial population. *Neurology*. 2012;79:1781–1787. doi: 10.1212/WNL.0b013e318270401d.
20. Béjot Y, Daubail B, Jacquin A, Durier J, Osseby GV, Rouaud O, et al. Trends in the incidence of ischaemic stroke in young adults between 1985 and 2011: the Dijon Stroke Registry. *J Neurol Neurosurg Psychiatr*. 2014;85:509–513.
21. Kittner SJ, Singhal AB. Premature atherosclerosis: a major contributor to early-onset ischemic stroke. *Neurology*. 2013;80:1272–1273. doi: 10.1212/WNL.0b013e31828ab3a4.
22. O'Donnell MJ, Xavier D, Liu L, Zhang H, Chin SL, Rao-Melacini P, et al; INTERSTROKE investigators. Risk factors for ischaemic and intracerebral haemorrhagic stroke in 22 countries (the INTERSTROKE study): a case-control study. *Lancet*. 2010;376:112–123. doi: 10.1016/S0140-6736(10)60834-3.
23. Kanny D, Liu Y, Brewer RD. Vital signs: binge drinking among high school students and adults—United States, 2009. *MMWR Morb Mortal Wkly Rep* 2010;59:1–6.
24. Coull AJ, Silver LE, Bull LM, Giles MF, Rothwell PM; Oxford Vascular (OXVASC) Study. Direct assessment of completeness of ascertainment in a stroke incidence study. *Stroke*. 2004;35:2041–2045. doi: 10.1161/01.STR.0000137605.48864.2f.

Trends in Age of First-Ever Stroke Following Increased Incidence and Life Expectancy in a Low-Income Chinese Population

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Stroke. 2016;47:929-935; originally published online February 11, 2016;
doi: 10.1161/STROKEAHA.115.012466
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

Print ISSN: 0039-2499. Online ISSN: 1524-4628