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Body Mass Index and Risk of Stroke among Chinese Men and Women

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Abstract

Objective—The relationship between body mass index (BMI) and stroke incidence and mortality remains controversial, particularly in Asian populations.

Methods—We conducted a prospective cohort study in a nationally representative sample of 169,871 Chinese men and women age 40 years or older. Data on body weight was obtained at baseline examination in 1991 using a standard protocol. Follow-up evaluation was conducted in 1999 to 2000, with a response rate of 93.4%.

Results—After excluding those participants with missing body weight or height values, 154,736 adults were included in the analysis. During a mean follow-up of 8.3 years, 7,489 strokes occurred (3,924 fatal). After adjustment for age, gender, physical inactivity, urbanization, geographic variation, cigarette smoking, diabetes, and education, compared with participants of normal weight (BMI 18.5–24.9), relative hazard (95% confidence interval) of incident stroke was 0.86 (0.80–0.93) for participants who were underweight (BMI < 18.5), 1.43 (1.36–1.52) for those who were overweight (BMI 25–29.9), and 1.72 (1.55–1.91) for those who were obese (BMI ≥ 30). The corresponding relative hazards were 0.76 (0.66–0.86), 1.60 (1.48–1.72), and 1.89 (1.66–2.16) for ischemic stroke and 1.00 (0.89–1.13), 1.18 (1.06–1.31), and 1.54 (1.27–1.87) for hemorrhagic stroke. For stroke mortality, the corresponding relative hazards were 0.94 (0.86–1.03), 1.15 (1.05–1.25), and 1.47 (1.26–1.72). Linear trends were significant for all outcomes ($p < 0.0001$).

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

Additional Supporting Information may be found in the online version of this article.

Interpretation—These results suggest that elevated BMI increases the risk of both ischemic and hemorrhagic stroke incidence, and stroke mortality in Chinese adults.

Stroke is the third leading cause of death and the leading cause of long-term disability worldwide.[1] The burden of stroke is growing in economically developing nations such as China, where stroke is the leading cause of death.[2] However, a number of important questions remain unanswered, including the relationship between body mass index (BMI) and stroke incidence and stroke mortality.

Some studies have reported a significant relationship between stroke incidence and BMI,[3–11] whereas others have reported no relationship[12–15] or an inverse relationship,[16,17] sometimes even within the same cohort.[11,12] When examined by subtype, ischemic stroke is more consistently associated with BMI than hemorrhagic stroke[7–10]; however, few early studies examined subtype of stroke.[3,4,6,13]

Recent studies have examined the association in Asian populations, where BMI tends to be lower and stroke incidence higher, as compared to Western populations.[18–22] Among these studies there are also conflicting results. A study of 104,928 Japanese identified an inverse association between BMI and mortality from stroke and intraparenchymal hemorrhage.[20] In contrast, in a large cohort of Korean men, a J-shaped association was observed for BMI and hemorrhagic stroke, and a linear association between BMI and ischemic stroke.[21] One of the few studies examining a Chinese population focused solely on men and examined only deaths from stroke.[22] In this study, we examined the relationship between BMI and stroke incidence, overall and by subtype, and stroke mortality in a nationally representative population of Chinese men and women.

Subjects and Methods

Study Population

In the 1991 China National Hypertension Survey, a multistage random cluster sampling design was used to select a representative sample of the general Chinese population aged 15 years or older from all 30 provinces in mainland China.[23] In 1999, investigators from each province were invited to participate in the China National Hypertension Survey Epidemiology Follow-up Study. Of the 30 provinces, 13 were not included in the follow-up because study participants' contact information was not available. However, the sampling process was conducted independently within each province in the 1991 China National Hypertension survey, and the 17 provinces included in the follow-up study were evenly distributed in different geographic regions representing various economic developing statuses in China (Fig 1). In total, 83,533 men and 86,338 women who were aged 40 years or older at their baseline examination were eligible to participate in the follow-up study. From this population, a total of 158,666 study participants (93.4%) were identified and interviewed as part of the follow-up study. After excluding participants who were missing body weight or height values, data from 154,736 study participants were used in our analysis.

Baseline Examination

Baseline data were collected at a single clinic visit by specially trained physicians and nurses using standardized methods with stringent levels of quality control.[23] Data on demographic characteristics, medical history, and lifestyle risk factors were obtained using a standard questionnaire administered by trained staff. Work-related physical activity was assessed because leisure-time physical activity was uncommon at that time. Work-related physical activity was classified based on occupation and classified into 3 levels: low (primarily desk work, retired, or disabled), medium (service sector, students), and high (farm labor, fishing, herding). Education was dichotomized as less than or at least high school graduate. Alcohol consumption was defined as drinking alcohol at least 12 times during the last year. The amount and type of alcohol consumed during the past year was collected. Cigarette smokers were defined as having smoked at least 1 cigarette per day for 1 or more years during their lifetime. Current cigarette smoking was defined as answering "Yes" to the question, "Do you smoke now?" Three blood pressure readings were obtained after the study participant had been seated quietly for 5 minutes. Hypertension was defined as a mean systolic blood pressure of at least 140mmHg and/or a diastolic blood pressure of at least 90mmHg and/or use of antihypertensive medication. Body weight and height were measured in light indoor clothing without shoes, using a standard protocol. Height was measured with the participant standing on a firm, level surface at a right angle to the vertical board of the height measurement device. A height board mounted at a 90°angle to a calibrated vertical height bar was used. Body mass index was then calculated as weight in kilograms divided by height in square meters.

Follow-up Data Collection

The follow-up examination, which was conducted between 1999 and 2000, included tracking study participants or their proxies to a current address, performing in-depth interviews to ascertain disease status and vital information, and obtaining hospital records and death certificates. All stroke events and death reported during the in-person interview were verified by obtaining medical records or death certificates from the local hospital, public health department, or police department. If hospitalization due to stroke occurred, the participant's hospital records, including medical history, physical examination findings, laboratory test results, computed tomography (CT) scan, magnetic resonance imaging (MRI), discharge diagnosis, and/or autopsy reports, were abstracted by trained staff using a standard form. In addition, photocopies of selected sections of the participant's inpatient record, discharge summary, and pathology reports were obtained.

End-Point Assessment and Classification

A study-wide end-point assessment committee at the Chinese Academy of Medical Sciences in Beijing, China, which included a neurologist, reviewed all medical and death records and determined the final diagnosis or underlying cause of death. Two committee members independently verified the diagnosis or cause of death from clinical symptoms and medical records. There was 87.7% ascertainment of medical records for persons reporting a stroke diagnosis. Discrepancies were adjudicated by discussion involving additional committee members. All members of the committee were blinded to the participant's baseline risk factor information.

Incident stroke was defined as evidence of sudden or rapid onset of neurological symptoms lasting for >24 hours or leading to death in the absence of evidence for a nonstroke cause using criteria adapted from the Atherosclerosis Risk in Communities study.[24] Exclusions included major brain trauma, neoplasm, coma attributable to metabolic disorders of fluid and electrolyte imbalance, vasculitis involving the brain, peripheral neuropathy, hematological abnormalities, and central nervous system infections. Transient ischemic attacks and silent brain infarctions (cases without clinical symptoms and signs) were not included. Incident strokes were further classified into ischemic (including thrombotic brain infarct, cardioembolic stroke, and lacunar infarct) or hemorrhagic (including intracerebral hemorrhage and subarachnoid hemorrhage) categories. Strokes that were classified as both ischemic and hemorrhagic were excluded from stroke subtype analysis. Imaging consisting of a CT or MRI scan was available for 62.4% of all stroke events. Fatal stroke was defined as a stroke event that led to death within 30 days of stroke diagnosis.

This study was approved by the Tulane University Health Sciences Center Institutional Review Board and the Cardiovascular Institute and Fu Wai Hospital Ethics Committee. Written informed consent was obtained from all study participants at their follow-up visit.

Statistical Analysis

Study participants were grouped into 4 categories of BMI. These categories were underweight (BMI < 18.5), normal weight (BMI 18.5–24.9), overweight (BMI 25.0–29.9), and obese (BMI ≥ 30.0).[25] We also examined BMI by quintiles among men and women. Person-years of follow-up were calculated from the date of baseline examination until the date of incident or fatal stroke, death from other causes, or follow-up interview, whichever came first, for each study participant and grouped according to age in 5-year categories. Age-standardized stroke incidence and mortality were calculated using the age distribution of the Chinese population from year 2000 census data. Cox proportional hazards regression models were stratified by province to account for the multistage sampling design, and adjusted for baseline age, cigarette smoking, work-related physical activity (low, moderate, high), education (less than high school or high school graduate), geographic region (north vs south), and urbanization (urban vs rural). Because BMI may affect stroke risk through blood pressure and development of diabetes, we did not adjust for blood pressure and development of diabetes in the multivariate-adjusted models. Rather, we created a mediator model that included all of the variables in the multivariate-adjusted models with the addition of systolic blood pressure and development of diabetes, which may be involved in the causal pathway between BMI and risk of stroke. Adjusted relative risks were calculated using study participants who were normal weight as the reference group. The presence of a linear trend was tested using the medians of BMI for each group treated as a continuous variable. The presence of a J-shaped association was tested using quadratic terms. Subgroup analyses by age group, gender, cigarette smoking, hypertension, diabetes, education level, regular alcohol consumption, and physical inactivity were conducted. All statistical analyses were performed using SAS statistical software version 9.1 (SAS Institute, Cary, NC).

Results

Baseline characteristics of the study participants are presented according to BMI category in Table 1. On average, participants with elevated BMI were less often smokers, less often men, and more often classified as physically inactive. They also had diagnoses of hypertension and diabetes more often than participants with a BMI in the normal or underweight range. In general, participants with an elevated BMI were more likely to live in Northern China, in an urban residence, and/or to have graduated high school than participants with a BMI in the normal or underweight ranges.

During an average follow-up of 8.3 years, there were a total of 7,489 strokes and 3,924 deaths from stroke. Strokes that were classified as both hemorrhagic and ischemic subtypes (n = 257) were not included in the stroke subtype analysis. Age-standardized rates per 100,000 person-years for stroke incidence and mortality are presented by sex and quintile of BMI in Figures 2 and 3. Significant, linear trends were present for total stroke incidence, ischemic stroke incidence, and hemorrhagic stroke incidence for both men and women.

Age and multivariate-adjusted hazard ratios (HRs) with 95% confidence intervals (CIs) for stroke incidence and mortality in relation to BMI category are presented in Table 2. After stratification by province and adjustment for age, sex, cigarette smoking, alcohol consumption, physical inactivity, educational level, residence in Northern China, and residence in an urban area, there was a statistically significant linear relationship between BMI category and stroke incidence in age-adjusted and multivariate-adjusted Cox proportional hazards models ($p < 0.0001$). Similarly, for ischemic and hemorrhagic stroke incidence, significant linear trends were present in age-adjusted and multivariate-adjusted linear models ($p < 0.0001$ for multivariate-adjusted models). Stroke mortality was also significantly, linearly related to BMI category in age-adjusted ($p = 0.02$), and multivariate-adjusted models ($p < 0.0001$).

In mediator models, the addition of diabetes and systolic blood pressure did not decrease the significance of the linear relationships between BMI category and stroke incidence or ischemic stroke incidence ($p < 0.0001$); however, point estimates of the HRs were attenuated. For example, for participants with BMI < 18.5, HR (95% CI) for overall stroke incidence was 1.01 (0.94–1.10); for participants in the overweight range, it was 1.16 (1.10–1.23), and for participants in the obese range, it was 1.19 (1.07–1.32). Corresponding values for ischemic stroke were 0.89 (0.78–1.02), 1.31 (1.21–1.41), and 1.31 (1.14–1.49). In mediator models, linear trends for hemorrhagic stroke incidence and stroke mortality were marginally significant ($p = 0.085$ for hemorrhagic stroke incidence and $p = 0.059$ for stroke mortality). Corresponding HR (95% CI) values were 1.18 (1.04–1.33), 0.95 (0.85–1.05), and 1.06 (0.87–1.29) for hemorrhagic stroke incidence and 1.10 (1.00–1.21), 0.93 (0.86–1.02), and 1.02 (0.87–1.20) for stroke mortality. Tests for quadratic trend were nonsignificant in all models.

We conducted subgroup analyses to further examine the relationship between BMI and stroke incidence and mortality (Table 3). Relationships were generally consistent in direction, although not in magnitude, for BMI and risk of stroke across categories except for stroke mortality in underweight participants ≤60 years old. The results of additional subgroup analyses are presented in the online Supplemental Table.

Discussion

In this prospective cohort study of 154,736 Chinese men and women, BMI was linearly related to increased stroke incidence and mortality. This statistically significant linear relationship remained present after adjustment for age, sex, cigarette smoking, physical inactivity, education, regular alcohol consumption, urbanization (urban vs rural), and geographic variation (north vs south). In fully adjusted models, hazard of stroke incidence was 72% higher among participants with a BMI of ≥30 than for participants who had a BMI in the normal range (18.5–24.9). The corresponding hazards for other outcomes we examined were 89% higher for ischemic stroke incidence, 54% higher for hemorrhagic stroke incidence, and 47% higher for stroke mortality.

Our study examined both incidence and mortality from stroke among Chinese men and women, and examined incidence of stroke by subtype. These results greatly expand on the results of Zhou and colleagues, whose study did not examine stroke incidence in relationship to BMI and also did not include women.[22] In the latter study, BMI was related to stroke mortality nonlinearly and only in the overweight or obese ranges (BMI >25kg/m^2). In contrast, our study found a significant linear trend in stroke incidence and mortality across all BMI categories. Some of this difference in results may have been due to the smaller number of events and lack of imaging results available in the cohort studied by Zhou and colleagues.[22] Our study results are most consistent with those of the Asia-Pacific Cohort Studies Collaboration, which identified a linear relationship between BMI and both ischemic and hemorrhagic stroke incidence.[18] Similarly, linear relationships were present between BMI and total and ischemic stroke incidence among Korean men and women, but not for hemorrhagic stroke incidence.[19,21]

Unique strengths of this study include its large sample size, the high follow-up rate, the nationally representative nature of the sample, and the stringent quality control procedures that were conducted throughout. We achieved 87.7% ascertainment of medical records for persons reporting a stroke diagnosis, and imaging was available for >60% of stroke events that occurred in the population. Body weight and height were measured in our study according to a standard protocol rather than self-reported, as has been the case in other studies.[20] The major limitation of our study was that body weight changes over time were not measured. Therefore, we were not able to evaluate the association between weight change and incidence of or mortality from stroke. We were not able to collect data on serum lipid levels or lipid-lowering medication use; however, the use of lipid-lowering agents was relatively rare in China during the decade of the 1990s.[26] We also did not collect dietary data in the current study. However, we adjusted for urbanization (urban vs rural) and geographic region (north vs south), the 2 most important factors affecting dietary habits in China.

Other considerations include the potential effect of censoring due to coronary heart disease and choice of adiposity measures. Given the differences in the magnitude between deaths due to coronary heart disease in Western countries as compared with China, one would expect that censoring due to diseases of the heart would have a lesser effect on the results presented here than on studies conducted in the United States or European locations. Measures of body composition and distribution of fatty tissues may play a role in the association between adiposity and stroke incidence and prevalence. In this study, we chose to focus on BMI as the primary measure of adiposity, because international health recommendations principally use this measure.[25]

Hemorrhagic stroke is more common in Asian populations than in Western populations, accounting for up to 50% of all strokes in China but <20% of strokes in most Western countries.[27] In our sample, of all confirmed strokes with CT or MRI imaging, 31% were identified as possible or confirmed hemorrhagic subtype. This likely represents an underestimate of this subtype due to a high case–fatality rate during the acute phase of stroke. Among underweight participants, risk for ischemic stroke was lower than that for normal weight participants, whereas for hemorrhagic stroke, risk was no different from that for normal weight participants. It is possible that this finding may reflect the role of serum lipid levels, which have different associations with stroke subtypes.[28–30] Because this population is leaner than those in most Western countries, and relatively more participants are underweight, the relationship between being underweight and stroke can be estimated with greater precision.

In subgroup analyses, stroke mortality and hazard of either hemorrhagic or ischemic stroke incidence was more strongly related to BMI among participants who were younger (≤60 years). This finding is consistent with those of other studies examining this issue.[18,19] It has been suggested that the modification of this relationship by age is multifaceted and potentially related to the biological processes of aging, detection and diagnosis, comorbidities, competing risks, and a variety of other factors. Additional subgroup analyses showed no evidence of interaction for factors such as alcohol consumption, physical inactivity, and hypertension status (see online Supplemental Table). For factors such as educational level, trends were consistent in direction but not always in magnitude.

On average, men and women in China are leaner and tend to have lower serum cholesterol levels than in most Western countries; however, the prevalence of hypertension is high, and awareness and control of hypertension remain lower.[31] Obesity often results in higher blood pressures, diabetes, and high cholesterol levels, and these characteristics may be links on a causal pathway from obesity to increased stroke risk. Controlling for these variables in examinations of the effect of BMI on cardiovascular disease outcomes has been a source of debate.[32] We chose to distinguish between multivariate-adjusted models and mediator models in this analysis. The addition of blood pressure to our models led to the attenuation of the association between BMI and stroke outcomes, although the linear associations remained statistically significant for overall stroke incidence and ischemic stroke incidence. This is consistent with the results of other studies examining the relationship between BMI and stroke,[18,20–22] and may reflect the contribution of a variety of different factors related to obesity. Rather than lessening the importance of BMI as a predictor of stroke risk, the uniformity of this result across studies robustly supports the value of maintaining a BMI within the normal range as an essential tool in strategies for the prevention of stroke.

These results have important clinical and public health implications. In China, stroke is the leading cause of death and accounted for 1,652,885 deaths in 2002.[1] Moreover, stroke was the third most common cause of death in the world. In this study we found that BMI was significantly, linearly related to increased stroke incidence, overall and by subtype, and to mortality from stroke. Maintaining a BMI in the normal range, preventing excess weight gain, and encouraging weight loss among those who are overweight or obese should be a public health priority in Asian countries, where the burden of stroke is high, and brisk economic development has brought about significant and rapid changes in lifestyle.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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FIGURE 1.
Map of China with participating provinces highlighted.

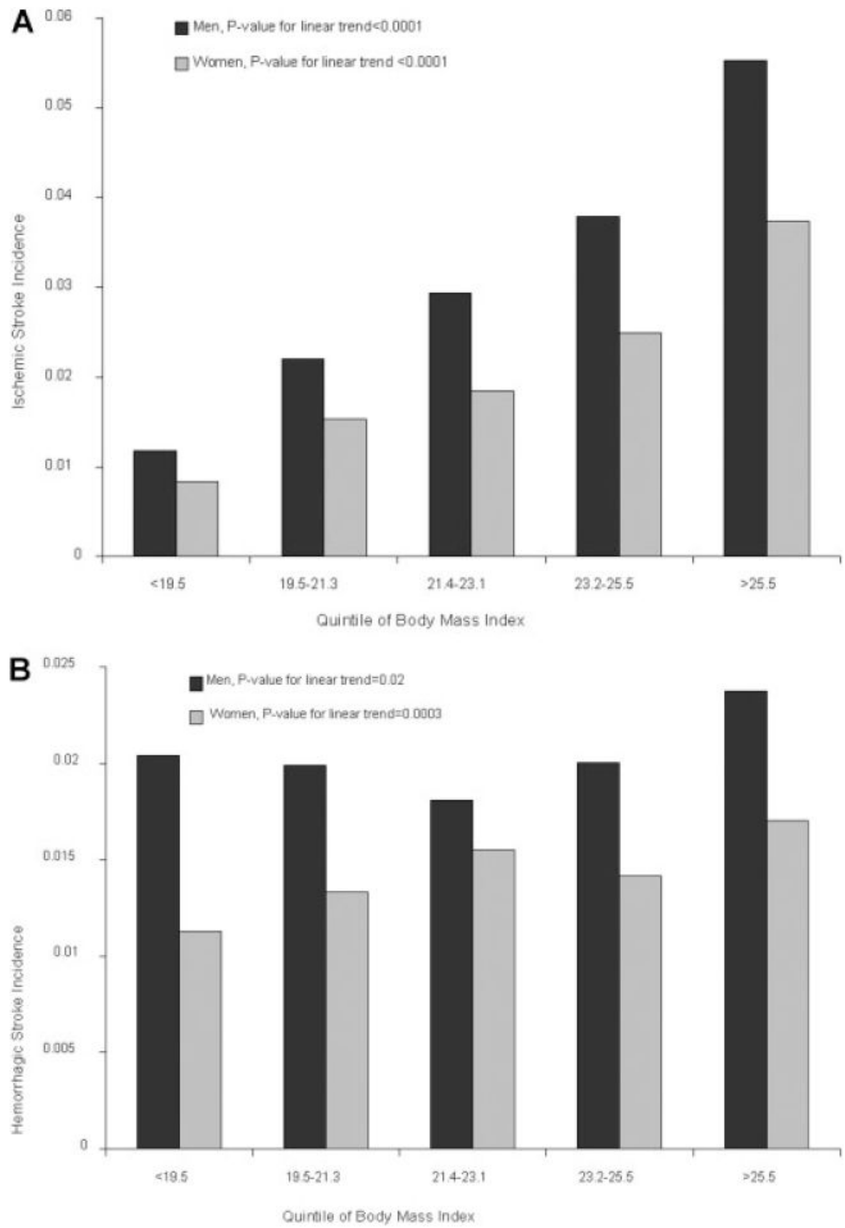

FIGURE 2.

Stroke incidence by subtype and quintile of body mass index per 100,000 person-years standardized by age and to the Chinese population using year 2000 census data.

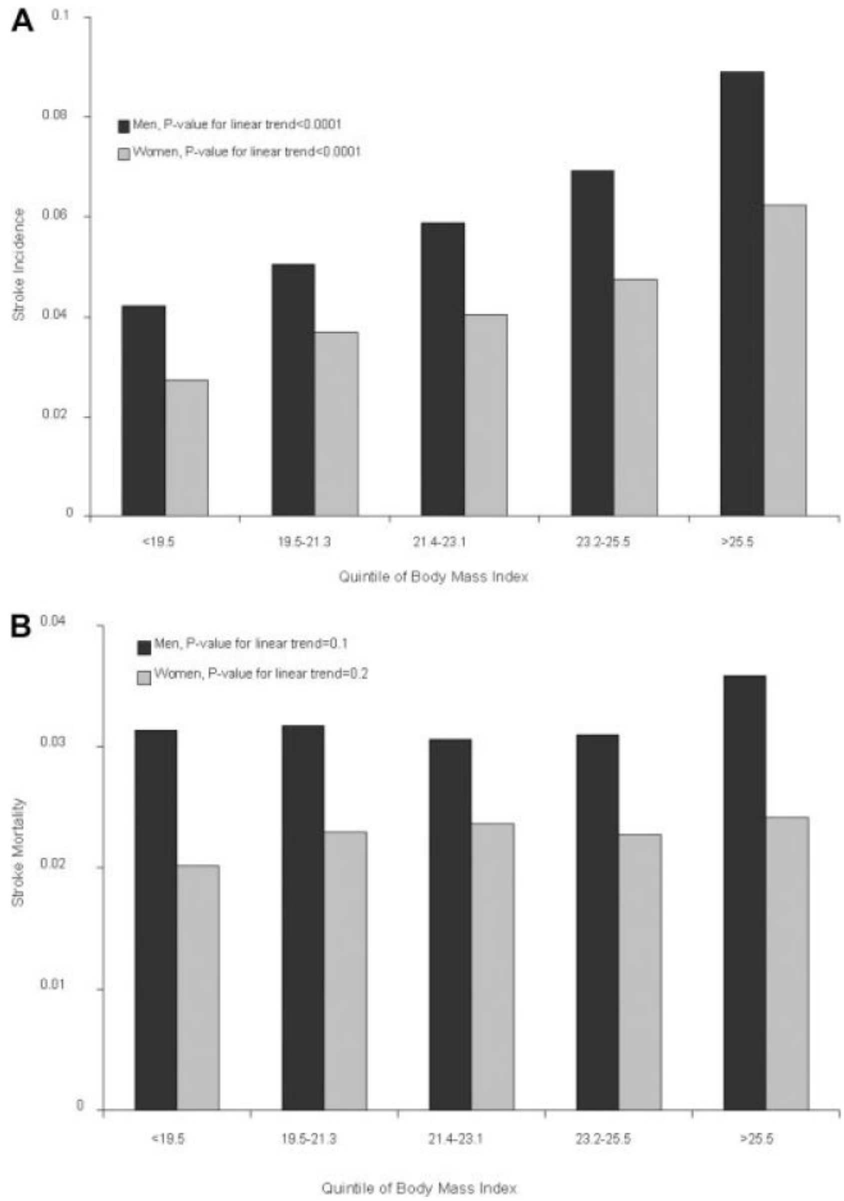

FIGURE 3.

Stroke incidence and mortality by quintile of body mass index per 100,000 person-years standardized by age and to the Chinese population using year 2000 census data.

TABLE 1

Baseline Characteristics according to Body Mass Index among 154,736 Chinese Men and Women[a]

Characteristics	Body Mass Index			
	< 18.5, n = 17,998	18.5–24.9, n = 99,935	25.0–29.9, n = 31,693	≥ 30.0, n = 5,110
Age, yr	60.5 ± 11.6	55.2 ± 10.6	55.4 ± 9.8	57.5 ± 9.6
Men, %	45.2	51.4	46.0	30.8
Current cigarette smoker, %	43.8	39.6	31.3	24.8
Regular alcohol consumption, %	17.2	21.3	18.1	11.3
Physical inactivity, %[b]	33.2	34.6	44.9	46.8
High-school graduate, %	11.7	23.2	33.5	26.8
Systolic blood pressure, mmHg	122.4 ± 23.3	124.8 ± 21.7	133.6 ± 22.5	141.4 ± 24.1
Diastolic blood pressure, mmHg	72.7 ±11.9	76.6 ±11.6	82.5 ± 12.0	85.9 ± 12.3
Hypertension, %[c]	21.3	24.0	41.5	55.8
Diabetes, %[d]	0.5	1.4	4.5	7.0
Living in Northern China, %	42.2	63.3	80.7	88.0
Urban residence, %	37.6	56.5	83.3	86.5
Weight, kg	42.8 ± 5.9	55.9 ± 8.0	69.7 ± 8.2	80.3 ± 10.1
Body mass index, kg/m^2	17.2 ± 1.1	21.7 ± 1.8	26.9 ± 1.3	32.3 ± 2.6

[a]Plus–minus values are means ± standard deviation.

[b]Physical activity was assessed by categorizing the physical labor involved in a participant's work at the time of the study.

[c]Hypertension was defined as mean systolic blood pressure ≥140mmHg and/or diastolic blood pressure ≥90mmHg, and/or the use of antihypertensive medications.

[d]Diabetes was assessed at follow-up.

TABLE 2

Hazard Ratios and 95% Confidence Intervals for Stroke Incidence and Mortality according to Body Mass Index among 154,736 Chinese Men and Women

Stroke Incidence/Mortality	Body Mass Index				*p* Value for Linear Trend
	<18.5	**18.5–24.9**	**25.0–29.9**	**≥30.0**	
Stroke incidence					
No. of cases	797	4,271	2,000	421	
Person-years of follow-up	122,143	724,615	229,039	35,953	
Age-standardized rate/100,000 person-years[a]	369.8	497.0	722.2	852.0	
Age adjusted	0.86 (0.80–0.93)	1.00	1.37 (1.30–1.45)	1.56 (1.41–1.73)	<0.0001
Multivariate Model 1[b]	0.88 (0.82–0.95)	1.00	1.41 (1.33–1.49)	1.71 (1.54–1.89)	<0.0001
Multivariate Model 2[c]	0.86 (0.80–0.93)	1.00	1.43 (1.36–1.52)	1.72 (1.55– 1.91)	<0.0001
Ischemic stroke incidence					
No. of cases	263	1,961	1,225	266	
Person-years of follow-up	121,648	719,871	225,751	35,178	
Age-standardized rate/100,000 person-years[a]	136.4	229.7	441	597.3	
Age adjusted	0.72 (0.64–0.83)	1.00	1.60 (1.49–1.72)	1.79 (1.58–2.04)	<0.0001
Multivariate Model 1[b]	0.75 (0.65–0.85)	1.00	1.64 (1.52–1.76)	1.97 (1.73–2.25)	<0.0001
Multivariate Model 2[c]	0.76 (0.66–0.86)	1.00	1.60 (1.48–1.72)	1.89 (1.66–2.16)	<0.0001
Hemorrhagic stroke incidence					
No. of cases	346	1,499	521	116	
Person-years of follow-up	122,006	723,353	228,536	35,833	
Age-standardized rate/100,000 person-years[a]	168.5	176.5	194.5	236.3	
Age adjusted	1.00 (0.89–1.13)	1.00	1.12 (1.01–1.24)	1.39 (1.14–1.68)	0.0016
Multivariate Model 1[b]	1.02 (0.91–1.15)	1.00	1.15 (1.04–1.28)	1.52 (1.25–1.84)	0.0002
Multivariate Model 2[c]	1.00 (0.89–1.13)	1.00	1.18 (1.06–1.31)	1.54 (1.27–1.87)	<0.0001
Stroke mortality					
No. of cases	595	2,380	773	176	

Stroke Incidence/Mortality	Body Mass Index				*p* Value for Linear Trend
	<18.5	**18.5–24.9**	**25.0–29.9**	**≥30.0**	
Person-years of follow-up	122,262	725,291	229,510	36,099	
Age-standardized rate/100,000 person-years[a]	268.4	283.1	292.5	364.4	
Age adjusted	0.98 (0.89–1.08)	1.00	1.03 (0.95–1.12)	1.26 (1.07–1.47)	0.0225
Multivariate Model 1[b]	1.00 (0.91–1.10)	1.00	1.06 (0.97–1.15)	1.38 (1.18–1.61)	0.0028
Multivariate Model 2[c]	0.94 (0.86–1.03)	1.00	1.15 (1.05–1.25)	1.47 (1.26–1.72)	<0.0001

[a] Standardized to the year 2000 Chinese census population.

[b] Stratified by province and adjusted for age and sex.

[c] Stratified by province and adjusted for age, sex, cigarette smoking, alcohol consumption, physical inactivity, education, residence in Northern China, and residence in urban area.

TABLE 3

Multivariate-Adjusted Hazard Ratio and 95% Confidence Interval for Stroke Incidence and Mortality by Specific Characteristics[a]

Stroke Incidence/Mortality	Body Mass Index				*p* Value for Interaction
	<18.5	18.5–24.9	25.0–29.9	≥30.0	
Stroke incidence					
Gender					
Male	0.90 (0.81–0.99)	1.00	1.49 (1.39–1.61)	1.68 (1.43–1.97)	0.0008
Female	0.82 (0.73–0.92)	1.00	1.35 (1.24–1.47)	1.73 (1.51–1.98)	
Age, yr					
>60	0.85 (0.77–0.94)	1.00	1.15 (1.05–1.26)	1.37 (1.16–1.61)	<0.0001
≤60	1.09 (0.97–1.23)	1.00	1.60 (1.49–1.72)	1.99 (1.74–2.27)	
Current smoker					
Yes	0.87 (0.77–0.97)	1.00	1.47 (1.35–1.61)	1.83 (1.53–2.19)	0.0001
No	0.87 (0.78–0.97)	1.00	1.41 (1.31–1.52)	1.69 (1.49–1.91)	
Ischemic stroke incidence					
Gender					
Male	0.75 (0.83–0.90)	1.00	1.66 (1.51–1.84)	1.71 (1.38–2.11)	0.005
Female	0.76 (0.63–0.93)	1.00	1.50 (1.34–1.69)	2.01 (1.69–2.38)	
Age, yr					
>60	0.70 (0.58–0.84)	1.00	1.31 (1.16–1.48)	1.55 (1.26–1.92)	0.004
≤60	1.00 (0.82–1.21)	1.00	1.76 (1.60–1.93)	2.14 (1.81–2.53)	
Current smoker					
Yes	0.75 (0.62–0.90)	1.00	1.63 (1.45–1.82)	2.06 (1.65–2.57)	0.005
No	0.77 (0.64–0.93)	1.00	1.58 (1.43–1.74)	1.82 (1.55–2.15)	
Hemorrhagic stroke incidence					
Gender					
Male	1.08 (0.92–1.26)	1.00	1.24 (1.08–1.43)	1.64 (1.21–2.21)	0.8
Female	0.91 (0.75–1.10)	1.00	1.10 (0.94–1.29	1.43 (1.11–1.85)	
Age, yr					

Stroke Incidence/Mortality	Body Mass Index				*p* Value for Interaction
	<18.5	**18.5–24.9**	**25.0–29.9**	**≥30.0**	
>60	1.07 (0.92–1.25)	1.00	0.92 (0.77–1.08)	1.17 (0.86–1.59)	0.0002
≤60	1.14 (0.94–1.39)	1.00	1.35 (1.18–1.54)	1.87 (1.45–2.40)	
Current smoker					
Yes	1.06 (0.89–1.25)	1.00	1.25 (1.06–1.48)	1.60 (1.12–2.29)	0.7
No	0.95 (0.80–1.13)	1.00	1.13 (0.99–1.29)	1.50 (1.19–1.89)	
Stroke mortality					
Gender					
Male	0.99 (0.87–1.12)	1.00	1.20 (1.07–1.35)	1.61 (1.28–2.04)	0.08
Female	0.89 (0.77–1.02)	1.00	1.08 (0.95–1.23)	1.38 (1.11–1.70)	
Age, yr					
>60	0.96 (0.86–1.08)	1.00	0.91 (0.80–1.02)	1.14 (0.92–1.42)	0.004
≤60	1.29 (1.09–1.52)	1.00	1.40 (1.24–1.59)	1.86 (1.47–2.34)	
Current smoker					
Yes	0.92 (0.80–1.50)	1.00	1.17 (1.02–1.35)	1.74 (1.33–2.29)	0.09
No	0.96 (0.84–1.09)	1.00	1.13 (1.01–1.26)	1.36 (1.12–1.65)	

[a] Where appropriate, adjusted for age, sex, cigarette smoking, alcohol consumption, physical inactivity, education, residence in Northern China, and residence in an urban area.