Association between dynamic obesity and mortality in patients with first-ever ischemic stroke: a hospital-based prospective study

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Abstract

Background and Purpose: Although obesity is an established risk factor for the occurrence of a primary stroke, the association between obesity with post-stroke mortality remains unclear. We evaluated the association of dynamic obesity status with mortality among first-ever stroke survivors in China. **Methods:** Data from 775 patients with first-ever ischaemic stroke from a longitudinal study, 754 patients were categorized 4 categories of BMI (underweight, normal weight, overweight and obese) and 2 categories of WC (normal WC and abdominal obesity) according to Chinese-specific criteria. Mortality information and obesity status were obtained through every 3 months via telephone follow-up, beginning in 2010 and continuing through 2016. Chi-square tests were used to compare different obesity status at admission and personal characteristics. Time-dependent Cox proportional hazards models were used to estimate the unadjusted and adjusted hazard ratios (HRs) for relationship between all-cause mortality and dynamic obesity status. **Results:** Of 754 analyzed patients, 60.87% were males, with a mean age of 61.45 years. After adjusting for possible confounders, there were significant inverse associations between BMI and WC with all-cause mortality: compared with normal BMI or WC counterparts, overweight and abdominal obesity patients significantly decrease risk of all-cause mortality (HR and 95% confidence interval (CI):0.521(0.303,0.897),0.545(0.352,0.845),respectively), whereas under-weight patients have the highest risk and obese have decreased risk of mortality, though significance was not obtained (1.241(0.691,2.226),0.486(0.192,1.231), respectively). **Conclusions:** Overweight and abdominal obesity was paradoxically associated with reduced risk of mortality among first-ever ischaemic stroke survivors in China. Body weight management recommendations ought to not be based on mere projection from primary prevention of stroke.

Background

Obesity is an established risk factors for primary stroke in general population[1]. Accordingly, for primary preventive purpose of stroke, there is general agreement to recommend striving for a normal weight[2]. However, the latest guidelines for secondary prevention refer that the beneficial effect of reducing weight is still uncertain[3]. Moreover, the association of obesity with mortality among stroke patients remains controversial. Some findings thought obesity worsen prognosis in stroke survivor[4, 5], while others think obesity confer better survival[2, 6]. Numerous findings indicated that in contrast to that of the general population, there exist an inverse relationship between obesity and mortality in stroke survivor , which is termed as obesity paradox[7]. Therefore, it is unclear if recommendations derived from primary prevention should be extended to secondary prevention of cardiovascular disease.

However, those studies that explored the association between obesity and stroke outcomes, exist some vital limited. Therefore, the results remains to be confirmed. It is well known, however, that the assumption that obesity status remained constant during follow-up was unreasonable, which may make obesity status misclassified and thus obtain biased results. Furthermore, it is noteworthy that mounting studies obtaining obesity paradox, failed to fully consider confounders associated with all-cause

mortality in post-stroke patients, e.g. the stroke severity has not been quantified and treatment of stroke was ignored[2, 5], which may contribute a false impression that obesity constitutes a survival advantage.

So whether the phenomena that obesity has been associated with better prognosis after stroke is true or just biased by imperfect confounder adjustment or research method? Should maintaining a normal weight still be advised if overweight or obesity carry a more favorable prognosis? To our best of knowledge, there are few studies simultaneously using BMI and WC to describe the obesity status in stroke patients from general and abdominal obesity aspects and few studies considering dynamic obesity status. Moreover, limited studies explored the relationship between obesity and post-stroke mortality among Chinese population, a subgroup with high prevalence rates of obesity and stroke[8, 9]. Therefore, our study attempts to explore the association between dynamic obesity status and mortality among first-ever ischaemic stroke survivors in China.

Methods

Study Population

The study was launched among first-ever ischaemic stroke survivors in the Department of Neurology, West China Hospital. A patient was diagnosed with stroke, according to the WHO criteria[10]. Stroke subtype (cerebral hemorrhage or infarction) is determined following computed tomography (CT) or magnetic resonance imaging (MRI). Patients with cardiovascular surgery, such as carotid endarterectomy, cardiac surgery or angiography, which may induce stroke, were excluded.

Written informed consents were obtained from all patients or their designated relatives. The study protocol was approved by the Ethics Committee of West China Hospital, Sichuan University, Chengdu, China.

Study Design

A semi-structured questionnaire was used to conduct face-to-face interview at the hospital by professionally trained, qualified and experienced interviewers. Combined the questionnaire with medical records, demographic characteristics, lifestyle, vascular risk factors and stroke severity were considered to examine the influences on post-stroke mortality. Demographic characteristics included gender, age (<45, 45~64 and >65 years), civil status (with spouse, without spouse), occupation (farmer, non-agricultural laborer, retired, unemployed), education attainment (≤ 6 , 7 to 9 and ≥ 10 years), household income (<3057.4, 3057.4~6114.8, >6114.8\$ per year), number of resident population in their family (<3, 3~4, >4 persons). Lifestyle aforementioned includes smoking status (never smoking, smoking cessation, current smoking, passive smoking), drinking status (never or current drinking), pre-stroke exercise time (<210, 210~420 and >420 minutes per week). Vascular risk factors, included family history of stroke, hypertension, diabetes mellitus (DM), hyperlipidemia, heart disease and peripheral vascular diseases. Diagnosis of aforementioned co-morbidities is made following their current standards[11, 12].

Measure of obesity

Because most patients were unable to stand on admission, it is difficult to directly measure height, weight and WC. At baseline, participants were asked to report their weight, height and WC by answering the following questions: "What is your weight now?" in kg and to the nearest 0.1 kg, "What is your height and waist circumference?" in cm and to the nearest 0.1 cm. Body weight status was measured by BMI calculated from height and weight (weight in kilograms divided by height in meters squared). These subjects were divided into four subgroups according to the Chinese criteria: underweight (BMI<18.5 kg/m²), normal weight (BMI 18.5 to <24 kg/m²), overweight (BMI 24 to <28 kg/m²) and obese (BMI≥28 kg/m²)[13]. WC ≥85 cm in men and WC ≥80 cm in women were used to indicate abdominal obesity according to the Chinese-specific WC cutoff points of modify International Diabetes Federation criteria[14, 15].

Outcomes and Follow-up

Follow-up was routinely conducted via telephone interviews every 3 months by trained and qualified investigators after hospital discharge. The follow-up survey included the information on the severity of the stroke, body weight, WC, anti-thrombotic medication adherence and health outcome. Because most patients are in acute phase in baseline survey and stroke severity changes quickly, mRS scores in baseline survey may not accurately reflect the stroke severity[16], hence the mRS score at the first time of follow-up was deemed to indicate stroke severity instead. mRS score <2 was defined as mild disability, while mRS score ≥3 was defined as severe/moderate disability[17]. Patient strictly according with the doctor's advice to take, change or quit anti-thrombotic medication during the follow-up period is termed as adherence, and vice versa. The endpoint of the study is all-cause mortality, which was got from patients' relatives when follow-up. Survival time was from baseline survey to death from any cause, withdraw or end of follow up. Follow up continued until the patients dropped out of the study, died or could no longer be contacted.

Statistical Analysis

Descriptive statistics on baseline individual characteristics were stratified by baseline obesity status assessed by BMI and WC with Chi-square test or Fisher exact test. We used change in obesity status updated every 3 months as a time-varying exposure, and time-dependent Cox proportional hazard regression model[18, 19] was used to estimate the hazard ratio (HR) for all-cause mortality in the followed-up. Statistical tests were two-sided and *P* value of <0.05 were considered statistically significant. All statistical analyses were performed using the SAS 9.3 (SAS Institute Inc., Cary, NC, USA).

Results

During January 2010 and June 2016, there were 775 subjects enrolled. After excluding 21 patients (2.7%) with repeated recruited and missing data, a total of 754 patients were included in our analysis. The mean age of those was 61.45 years (range, 17–89 years) and 60.88% were male. Analyzed patients were

followed-up for a mean period of 54.86 months (range, 0–75 months). Overall, baseline demographic and clinical characteristics are shown in Table 1.

At admission, 33.69% of patients were categorized as overweight, 10.08% as obese, 45.62% as abdominal obesity, and the survival curve was significantly different among different subgroups in Figure 1 and 2. Univariate analysis results are shown in Table 2.

Results of multivariable-adjusted time-dependent Cox proportional hazards regression analysis on BMI and WC subgroups are shown in table 3 and 4. When adjusted only for age, overweight remained associated with decreased mortality (*HR*: 0.491, 95% *CI*: 0.293, 0.824); in univariate analysis, severity of stroke was strongly associated with post-stroke mortality and after we adjusted it, results alter slightly. Similarly, after simultaneous adjustment for all socio-demographic and other factors in table 2, an inverse relationship between BMI and all-cause mortality was constantly observed in overweight (*HR*: 0.521; 95% *CI*: 0.303–0.897). Particularly, underweight counterparts had the worst survival all the time in any of adjusted model, but significances still were not obtained. Notably, for obese subjects, the statistical significance was lost after adjusted for any of listed confounders. After simultaneous adjustment for all aforementioned factors, the significant association between mortality and obesity still wasn't observed (*HR*: 0.487; 95% *CI*: 0.192–1.235).

Furthermore, with respect to threshold categories for WC, the inverse association was constantly observed, in any considered model. Simultaneous adjustment for all characteristics, mortality risk were significantly lower in the abdominal obesity patients compared with normal WC (*HR*: 0.572; 95% *CI*: 0.370–0.883).

Discussion

The main finding of present study is that patients hospitalized for ischaemic stroke who are overweight and obese have better survival when compared with normal weight participants. In contrast, underweight patients show the worst mortality. It's noteworthy, that the inverse associations of body weight and outcome measures remained after adjustment for confounder. Furthermore, the inverse association between abdominal obesity and mortality was constantly observed.

The results of this study are in line with studies showing that overweight group significantly decrease risk of mortality[20, 21]. When omitting different covariate from our models, risk of mortality among overweight participants was still lower. Similarly, Vemmos et al[21]. revealed that overweight significantly confer better survival rates compared to those with normal BMI. Contrastively, inconsistent with our finding, Dehlendorff et al.[22] have suggested overweight was not associated with decreased risk of all-cause mortality. The possible reason is that both ischaemic stroke and hemorrhagic stroke survivors were included in Dehlendorff's, while our study only included the former. Another possible explanation for distinct result is that our participants were followed-up for a mean period of 54.86 months and endpoint is all-cause mortality, which differs from Dehlendorff's assessed deaths caused by the index stroke at 1 week and 1 month.

Furthermore, our findings revealed that obesity confer decreased risk of mortality without statistical significance, which is consistent with other findings[23, 24]. A Chinese follow-up study[25], have found obesity (27.5-32.4 kg/m²) isn't associate with increased risk, which is similar to the South Korea result of Ryu et al[24]. However, a TEMPiS study[6] revealed lowest mortality risk was observe in obese and very obese patients when compared with normal BMI counterparts. The discrepancy of the findings may be due to several reasons. Firstly, the TEMPiS study was a non-randomized intervention study comparing acute stroke treatment and without specialized stroke care in hospitals, differently ours was hospital-based longitudinal study without any intervention. Secondly, the TEMPiS study included individuals with hemorrhagic stroke, whereas our study included only first-ever ischaemic stroke subjects. So, the relationship between obesity and all-cause mortality still remain to be validated.

A remarkable finding in our study was that abdominal obesity also associated with better prognosis in stroke patients, which was in accordance with results from previous studies[26]. Though currently subjects were divided into normal WC and abdominal obesity according to all sex-specific WC criteria, which couldn't distinguish mild, moderate and extreme abdominal obesity. However, Gomes et al.[26] used quartiles of WC to categorize different levels of abdominal obesity, found 4th quartile WC confer significant better survival, while 3rd and 2nd decreased risk of mortality without significance, when compared with 1st quartile WC.

The obesity paradox should not be directly interpreted as the fatter the better. Although the obesity paradox has been confirmed in various chronic diseases, such as cancer, hypertension and DM[27-29]. There are some proposed explanations for the paradox. Firstly, obese patients may tend to present earlier/more aggressive treatment, varying the natural history of their disease, which may have benefited from lead-time bias[23]. Meanwhile, obese counterparts were encouraged to change unhealthy lifestyle [2] and thereby acquired a better prognosis, but this requires additional research. Additionally, underweight may be the result of another underlying disease, unintentional weight loss, reduced mental and physical health or severe comorbidities that lead to worse prognosis[30, 31].

Several strengths and limitations should be acknowledged and discussed. Our strength is that we have considered association not only general obesity but also abdominal obesity with mortality in a long-term Chinese cohort. Furthermore, in our study, important confounding factors, such as stroke severity and anti-thrombotic medication adherence, have been comprehensively considered, but often absent in previous studies[2, 5]. Importantly, the dynamic change of weight and WC in the period of follow-up has been considered by recording temporary BMI and WC in every follow-up, which may constitute believable conclusion.

Our study does have some limitations. Firstly, weight, height and WC were indicated by self-report of patients other than tool measuring, which may be biased[32]. However, previous studies have suggested that self-reported weight, height and WC have satisfactorily accurate for the assessment of the obesity status and have near-perfect correlations and agreement with measured anthropometric values[33, 34]. Furthermore, BMI failed to distinguish between individuals with different types of fat distribution[35] and

WC unable to distinguish persons with different height[36]. However, directly and accurately quantified methods are impractical and time-consuming[37]. Therefore, self-reported data should be generally acceptable.

Moreover, index bias may exist in our study, because though in our study all possible confounding were considered, essentially no uncontrolled confounding of both the obesity and mortality is impossible[38]. Even though unmeasured confounder inevitable, index bias only may be a partial explanation of the obesity paradox, which can't deny obesity paradox does exists in stroke survivors[39]. Finally, our participants were recruited only from West China Hospital of Sichuan University, which might limit the generalized ability of these findings.

Conclusions

Overweight and abdominal obesity was paradoxically associated with reduced risk of mortality among AIS survivors in China. Consequently, we certifies body weight management recommendations in AIS survivors ought to not be based on mere projection from primary prevention of stroke. Further studies are required to devise such a weight management strategies for optimal prognosis in secondary prevention among stroke survivors.

Abbreviations

AIS: acute ischemic stroke; BMI: Body Mass Index; WC: Waist circumference

Declarations

Ethics approval and consent to participate

Written informed consents were obtained from all patients or their designated relatives. The study protocol was approved by the Ethics Committee of West China Hospital, Sichuan University, Chengdu, China.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

JW and JL was involved in design of the study, data collection, interpretation of the data and writing and revising the manuscript. CZ and MZ took part in design of the study, funding obtained, data collection, interpretation of the data and revising the manuscript. ML and LH were involved in data collection. XD

and PZ took part in data analysis and revising the manuscript. All authors read and approved the final manuscript.

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Tables

Table 1. Epidemiologic characteristics, co-morbidities, and stroke severity by BMI and WC subgroup (at admission)

Characteristics	Total	BMI Category				<i>P</i> <i>value</i>	WC Category		<i>P</i> <i>value</i>
		Underweight	Normal	Overweight	Obese		Normal	Abdominal	
		(N,%)	weight	(N,%)	(N,%)		WC	obesity	
		(N,%)	(N,%)	(N,%)	(N,%)		(N,%)	(N,%)	
Number of participant (N,%)	754	49(6.50)	375(49.73)	254(33.69)	76(10.08)		344(45.62)	410(54.38)	
Gender									
Male	459	27(5.88)	234(50.98)	154(33.55)	44(9.59)	0.719	218(47.49)	241(52.51)	0.198
Female	295	22(7.46)	141(47.80)	100(33.90)	32(10.85)		126(42.71)	169(57.29)	
Age-group(year)*									
<45	84	4(4.76)	43(51.19)	24(28.57)	13(15.48)	0.207	43(51.19)	41(48.81)	0.446
45~	337	19(5.64)	158(46.88)	125(37.09)	35(10.39)		156(46.29)	181(53.71)	
65~	332	26(7.83)	174(52.41)	104(31.33)	28(8.43)		145(43.67)	187(56.33)	
Civil status									
Without spouse	96	12(12.50)	51(53.13)	22(22.92)	11(11.46)	0.016	43(44.79)	53(55.21)	0.861
With spouse	658	37(5.62)	324(49.24)	232(35.26)	65(9.88)		301(45.74)	357(54.26)	
Education attainment(year)*									
≤6	285	26(9.12)	142(49.82)	89(31.23)	28(9.82)	0.364	138(48.42)	147(51.58)	0.282
7 to 9	190	7(3.68)	95(50.00)	69(36.32)	19(10.00)		88(46.32)	102(53.68)	
≥10	275	16(5.82)	135(49.09)	96(34.91)	28(10.18)		115(41.82)	160(58.18)	
Occupation*									
Farmer	189	16(8.47)	101(53.44)	59(31.22)	13(6.88)	0.326	98(51.85)	91(48.15)	0.047
Non-agricultural laborer	203	10(4.93)	101(49.75)	66(32.51)	26(13.30)		100(49.26)	103(50.74)	
Retired	312	17(5.45)	151(48.40)	112(35.90)	32(12.81)		126(40.38)	186(59.62)	
Unemployed	49	6(12.24)	22(44.90)	17(34.69)	4(8.16)		20(40.82)	29(59.18)	

Characteristics	Total	BMI Category				<i>P</i> <i>value</i>	WC Category		<i>P</i> <i>value</i>
		Underweight	Normal	Overweight	Obese		Normal	Abdominal	
		(N,%)	weight	(N,%)	(N,%)		WC	obesity	
		(N,%)	(N,%)	(N,%)	(N,%)				
Household income									
(dollars/year)*									
< 3057.4	252	22(8.73)	129(51.19)	83(32.94)	18(7.14)	0.451	129(51.19)	123(48.81)	0.058
3057.4 to 6114.8	245	13(5.31)	121(49.39)	84(34.29)	27(11.02)		110(44.90)	135(55.10)	
> 6114.8	237	14(5.91)	113(47.68)	83(35.02)	27(11.39)		96(40.51)	141(59.49)	
Number of resident									
population									
< 3	359	27(7.52)	182(50.70)	118(32.87)	32(8.91)	0.780	158(44.01)	201(55.99)	0.690
3 to 4	249	13(5.22)	118(47.39)	89(35.74)	29(11.65)		118(47.39)	131(52.61)	
> 4	146	9(6.16)	75(51.37)	47(32.19)	15(10.27)		68(46.58)	78(53.42)	
Smoking status									
Non-smoking	334	23(6.89)	161(48.20)	108(32.34)	42(12.57)	0.139	144(43.11)	190(56.89)	0.403
Passive smoking	117	7(5.98)	54(46.15)	49(41.88)	7(5.98)		51(43.59)	66(56.41)	
Smoking	244	15(6.15)	125(51.23)	85(34.84)	19(7.79)		122(50.00)	122(50.00)	
cessation									
Current smoking	59	4(6.78)	35(59.32)	12(20.34)	8(13.56)		27(45.76)	32(54.24)	
Drinking status									
Non-drinking	490	34(6.94)	242(49.39)	170(34.69)	44(8.98)	0.466	209(42.65)	281(57.35)	0.026 [‡]
Current drinking	264	15(5.68)	133(50.38)	84(31.82)	32(12.12)		135(51.14)	129(48.86)	
Pre-stroke exercise									
time within a week									
(minutes)									
<210	491	30(6.11)	255(51.93)	156(31.77)	49(9.99)	0.001	229(46.64)	262(53.36)	0.194
210 ~	82	14(17.07)	34(41.46)	26(31.71)	8(9.76)		42(51.22)	40(48.78)	

Characteristics	Total	BMI Category				<i>P</i> <i>value</i>	WC Category		<i>P</i> <i>value</i>
		Underweight	Normal	Overweight	Obese		Normal	Abdominal	
		(N,%)	weight	(N,%)	(N,%)		WC	obesity	
		(N,%)	(N,%)				(N,%)	(N,%)	
420 ~	181	5(2.76)	85(46.96)	72(39.78)	19(10.50)		73(40.33)	108(59.67)	
Stroke severity									
Mild disability	486	22(4.53)	240(49.38)	170(34.98)	54(11.11)	0.016	225(46.30)	261(53.70)	0.617
Severe/Moderate disability	268	27(10.07)	135(50.37)	84(31.34)	22(8.21)		119(44.40)	149(55.60)	
Family history of stroke									
No	606	39(6.44)	312(51.49)	200(33.00)	55(9.08)	0.143	290(47.85)	316(52.15)	0.013
Yes	148	10(6.76)	63(42.57)	54(36.49)	21(14.19)		54(36.49)	94(63.51)	
Hypertension									
No	284	25(8.80)	157(55.28)	86(30.28)	16(5.63)	0.001	155(54.58)	129(45.42)	<0.001
Yes	470	24(5.11)	218(46.38)	168(35.74)	60(12.77)		189(40.21)	281(59.79)	
Diabetes mellitus									
No	552	42(7.61)	294(53.26)	166(30.07)	50(9.06)	<.0001	280(50.72)	272(49.28)	<.0001
Yes	202	7(3.47)	81(40.10)	88(43.56)	26(12.87)		64(31.68)	138(68.32)	
Hyperlipidemia*									
No	486	41(8.44)	269(55.35)	140(28.81)	36(7.41)	<.0001	248(51.03)	238(48.97)	<.0001
Yes	266	8(3.01)	104(39.10)	114(42.86)	40(15.04)		94(35.34)	172(64.66)	
Heart disease									
No	587	36(6.13)	288(49.06)	204(34.75)	59(10.05)	0.641	275(46.85)	312(53.15)	0.205
Yes	167	13(7.78)	87(52.10)	50(29.94)	17(10.18)		69(41.32)	98(58.68)	
Peripheral vascular diseases*									
No	732	47(6.42)	365(49.86)	246(33.61)	74(10.11)	0.768	336(45.90)	396(54.10)	0.479

Characteristics	Total	BMI Category				<i>P</i> <i>value</i>	WC Category		<i>P</i> <i>value</i>
		Underweight	Normal	Overweight	Obese		Normal	Abdominal	
		(N,%)	weight (N,%)	(N,%)	(N,%)		WC (N,%)	obesity (N,%)	
Yes	21	2(9.52)	9(42.86)	8(38.10)	2(9.52)		8(38.10)	13(61.90)	
Anti-thrombotic									
drug medication									
adherence									
Adherence	306	18(5.88)	156(50.98)	99(32.35)	33(10.78)	0.804	138(45.10)	168(54.90)	0.811
Non-adherence	448	31(6.92)	219(48.88)	155(34.60)	43(9.60)		206(45.98)	242(54.02)	

CI, confidence interval; *HR*, hazard ratio; *P* by c2 test or Fisher exact test

*For some socio-demographic characteristics the sample size did not add up to 754 due to missing value

Table 2. Relationship between BMI, WC and aforementioned factors with all-cause mortality in unadjusted analysis

Parameter	HR	95%CI	P value
BMI criteria			
Normal weight (18.5 to <23.9)	1.000 (reference)		
Underweight (<18.5)	1.554	(0.895,2.700)	0.118
Overweight (24.9 to <27.9)	0.456	(0.272,0.764)	0.003
Obese (≥ 28.0 kg/m ²)	0.370	(0.148,0.921)	0.033
WC criteria			
Normal WC(male and WC ≤ 85 cm or female WC ≤ 80 cm)	1.000 (reference)		
Abdominal obesity(male and WC >85 cm or female WC >80 cm)	0.527	(0.352,0.790)	0.002
Gender			
Male	1.000 (reference)		
Female	1.125	(0.756,1.674)	0.561
Age-group (year)*			
<45	1.000 (reference)		
45~	2.403	(0.734,7.860)	0.147
65~	5.501	(1.729,17.498)	0.004
Marital status			
Without spouse	1.000 (reference)		
With spouse	0.455	(0.287,0.719)	0.001
Education attainment (year)*			
≤ 6	1.000 (reference)		
7 to 9	0.446	(0.258,0.770)	0.004
≥ 10	0.554	(0.352,0.871)	0.011
Occupation*			
Farmer	1.000 (reference)		
Non-agricultural laborer	0.265	(0.126,0.555)	<0.001
Retired	0.970	(0.626,1.505)	0.894
Unemployed	0.678	(0.283,1.621)	0.382

Parameter	HR	95%CI	P value
House hold income (dollars/year)*			
< 3057.4	1.000 (reference)		
3057.4 to 6114.8	1.006	(0.638,1.587)	0.980
> 6114.8	0.824	(0.497,1.366)	0.452
Number of resident population			
< 3	1.000 (reference)		
3 to 4	0.716	(0.45,1.138)	0.157
> 4	0.886	(0.53,1.482)	0.646
Smoking status			
Non-smoking	1.000 (reference)		
Passive smoking	0.593	(0.324,1.085)	0.090
Smoking cessation	0.600	(0.377,0.955)	0.031
Current smoking	0.617	(0.247,1.542)	0.302
Drinking status			
Non-drinking	1.000 (reference)		
Current drinking	0.603	(0.386,0.943)	0.027
Pre-stroke exercise time within one week (minutes)			
<210	1.000 (reference)		
210 ~	1.030	(0.546,1.944)	0.928
420 ~	0.750	(0.442,1.273)	0.286
Stroke severity			
Mild disability	1.000 (reference)		
Severe/Moderate disability	4.155	(2.767,6.239)	<0.001
Family history of stroke			
No	1.000 (reference)		
Yes	0.708	(0.415,1.209)	0.206
Hypertension			

Parameter	<i>HR</i>	<i>95%CI</i>	<i>P value</i>
No	1.000 (reference)		
Yes	0.890	(0.595,1.330)	0.569
Diabetes mellitus			
No	1.000 (reference)		
Yes	1.158	(0.752,1.785)	0.505
Hyperlipidemia*			
No	1.000 (reference)		
Yes	0.683	(0.445,1.049)	0.081
Heart disease			
No	1.000 (reference)		
Yes	1.387	(0.896,2.147)	0.142
Peripheral vascular diseases*			
No	1.000 (reference)		
Yes	0.965	(0.306,3.043)	0.951
Anti-thrombotic drug medication adherence			
Adherence	1.000 (reference)		
Non-adherence	0.766	(0.512,1.147)	0.196

*For some socio-demographic characteristics the sample size did not add up to 754 due to missing values

Table 3. Effects of adjustment for personal characteristics and various indices of health on the association between all-cause mortality and BMI criteria

All patients	Underweight		Overweight		Obese	
<i>P</i> and <i>HR</i> (95% <i>CI</i>) of all-cause mortality as normal BMI as reference, adjusted for:	<i>P</i>	<i>HR</i> (95% <i>CI</i>)	<i>P</i>	<i>HR</i> (95% <i>CI</i>)	<i>P</i>	<i>HR</i> (95% <i>CI</i>)
Age only	0.120	1.549(0.892,2.692)	0.007	0.491(0.293,0.824)	0.068	0.427(0.171,1.067)
Age and mRS	0.382	1.281(0.735,2.233)	0.010	0.506(0.302,0.850)	0.073	0.433(0.174,1.082)
Age, mRS and personal characteristics*	0.586	1.173(0.661,2.078)	0.011	0.507(0.299,0.858)	0.131	0.489(0.194,1.236)
Age, mRS, personal characteristics* and comorbidities†	0.650	1.144(0.640,2.044)	0.019	0.523(0.304,0.898)	0.129	0.487(0.192,1.233)
Age, mRS, personal characteristics*, comorbidities† and anti-thrombotic medication adherence	0.632	1.153(0.644,2.062)	0.019	0.523(0.305,0.897)	0.130	0.487(0.192,1.235)

*personal characteristics include gender, civil status, occupation, education attainment, annual household income, number of resident population in their family, smoking status, drinking status, pre-stroke exercise time.

†Comorbidity included hypertension, diabetes mellitus, hyperlipidemia, heart disease, peripheral vascular diseases

Table 4. Effects of adjustment for personal characteristics and various indices of health on the association between all-cause mortality and WC criteria

All patients	Abdominal obesity	
<i>P</i> and <i>HR</i> (95% <i>CI</i>) of all-cause mortality as normal WC as reference, adjusted for:	<i>P</i>	<i>HR</i> (95% <i>CI</i>)
Age only	0.003	0.539(0.359,0.807)
Age and mRS	0.002	0.528(0.352,0.793)
Age, personal characteristics* and mRS	0.005	0.547(0.360,0.832)
Age, personal characteristics*, mRS and comorbidities†	0.011	0.569(0.368,0.880)
Age, personal characteristics*, mRS, comorbidities† and anti-thrombotic medication adherence	0.012	0.572(0.370,0.883)

*personal characteristics include gender, civil status, occupation, education attainment, annual household income, number of resident population in their family, smoking status, drinking status, pre-stroke exercise time

†Comorbidity included hypertension, diabetes mellitus, hyperlipidemia, heart disease, peripheral vascular diseases.

Figures

Figure 1

Survival curves after stroke according to groups of BMI (univariate analysis)

Figure 2

Survival curves after stroke according to groups of WC (univariate analysis)