

Original Articles

Correlation Among Obesity Factors in Stroke in Korea

Woo-Sang Jung, Do-Ick Kwon, Jong-Myon Bae¹⁾, Sang-Kwan Moon, Young-Suk Kim, Ki-Ho Cho

Department of Cardiovascular & Neurologic Diseases (Stroke Center), College of Oriental Medicine, Kyung Hee University,
Department of Preventive Medicine, College of Medicine, Cheju National University¹⁾

To investigate the relative risk of obesity factors for stroke and their correlation, we assessed odds ratio of obesity factors for stroke by univariate and multivariate logistic regression analysis. Correlations among obese factors were estimated by Pearson's correlation test. Study subjects were selected stroke subjects within 1 month after onset and non-stroke referents in Kyung Hee Medical Center in Seoul. Body mass index, hypertension history, habits of drinking and smoking, waist/hip ratio, total cholesterol and triglyceride were checked once at baseline. In this study, there was no significant difference between referents and stroke subjects in general characteristics except waist/hip ratio and hypertension. By logistic regression, high waist/hip ratio (OR=7.05; 95% CI, 1.70-29.11) and hypertension (OR=12.90; 95% CI, 3.63-45.61) had significant odds ratio in females, as did hypertension (OR=3.36; 95% CI, 1.01-11.16) in males. Much more significant correlations among obesity factors were found in stroke subjects than referents. In conclusion, waist/hip ratio was an independent risk factor for stroke in females, and hypertension was a predictor of stroke in all genders. Interaction of obesity factors could be an important condition for stroke. (*Korean J of Oriental Med* 2003;24(4):6-10)

Key Words: obese factor, correlation, stroke

Introduction

As average life span has lengthened, the prevalence of stroke has been rising.

Stroke can be a cause of death or leave irreversible neurologic deficit, so the prevention of stroke is drawing more and more social concern.

There have been many suggested risk factors for stroke such as hypertension, atrial fibrillation, smoking, hyperlipidemia, carotid artery stenosis, diabetes mellitus

(DM), obesity, cardiovascular disease, atherosclerosis, etc.^{1,2)}. Among them, hypertension, hyperlipidemia, DM and atherosclerosis are common in the obese^{3,4)}.

Obesity is the excess accumulation state of fat and can be diagnosed when fat distribution is over 25% in men, 30% in women. Body mass index (BMI) and waist to hip (W/H) ratio are generally used in assessing obesity. Obesity seems to associate with stroke closely^{5,6)}, but this association still has not been explained perfectly. Therefore, we investigated obesity factors in stroke subjects and referents.

Received 16 April 2003; revised 18 September 2003; accepted 1 October 2003

Correspondence to: Woo Sang Jung, Department of Cardiovascular and Neurologic Diseases (Stroke Center) Kyung Hee Oriental Medical Center Hoegi-dong, Dongdaemun-gu Seoul, Korea; Tel: 82-2-958-9124, FAX: 82-2-958-9132, E-mail: WSJung@khmc.or.kr

Methods and Materials

1. Subjects

Three hundred fifty-eight males and two hundred

sixty-four females with stroke (within 1 month after onset) were drawn from in-patients at the Department of Circulatory Internal Medicine, Kyung Hee Oriental Medical Center, Seoul, Korea, from November 1, 1997 to June 30, 1999. Diagnosis was confirmed by brain CT or MRI.

Referents were composed of 21 males and 32 females among healthy subjects without any cardiovascular diseases from out-patients of the same hospital.

2. Methods

BMI, presence of drinking and smoking, and W/H ratio were recorded on admission. The diagnosis of hypertension was established on the basis of systolic blood pressure > 140 mmHg and/or diastolic pressure > 90 mmHg (average of three readings).

Patients with previous antihypertensive treatment were also regarded as having hypertension. Plasma total cholesterol (T-cholesterol) and triglyceride were determined by enzymatic colorimetric methods using commercially available kits (Wako Inc., Richmond, VA). Sample blood was drawn in the morning after an 8-hour fast. We compared the above variables of stroke subjects to healthy referents and calculated odds ratio. We also examined the correlation of each variable.

3. Statistics

We compared characteristics of stroke subjects and referents with independent *t*-test and chi-square test.

Relationships among risk factors were evaluated by Pearson's correlation test. We regarded *P*-value under 0.05 as significance. To assess odds ratio, univariate and multivariate models of logistic regression analysis were used.

Results

We analyzed our data according to the distinction of sex, because the normal ranges of W/H ratio and BMI differ by sex^{7,8)}.

1. Analysis in Males

1) Comparison of characteristics

Stroke subjects had significantly more hypertension and higher W/H ratio than referents. Alcoholic drinking was more common in stroke cases, but had no significance (Table 1).

2). Odds ratio of obesity factors

Univariate and multivariate logistic regression revealed that known hypertension was the only independent risk factor for stroke (Table 2).

3) Correlation analysis of obesity factors

BMI, T-cholesterol, triglyceride and W/H ratio correlated with one another in stroke cases, while no significant correlation was found in referents (Table 3).

2. Analysis in Females

1) Comparison of characteristics

Stroke subjects were more often hypertensive and

Table 1. Subjects' General Characteristics in Males

	Referents (n=21)	Cases (n=358)	<i>P</i> -value
Age	59.7 ± 9.6	59.9 ± 10.4	NS
Body Mass Index	23.1 ± 2.9	23.9 ± 2.9	NS
T-cholesterol	190.1 ± 27.4	183.1 ± 37.8	NS
Triglyceride	149.0 ± 65.9	177.9 ± 120.8	NS
Hypertension	6 (28.6%)	219 (61.2%)	0.003
Regular smoking	12 (57.1%)	260 (72.6%)	NS
Alcoholic drinking	12 (57.1%)	271 (75.7%)	NS
W/H ratio	0.92 ± 0.09	0.95 ± 0.05	0.012

*: Chi-square test for categorical variables and independent *t*-test for continuous variables.

Table 2. Univariate and Multivariate Logistic Regression in Males

Variables	Range	Referents	Cases	cOR*	95% CI	aOR**	95% CI
W/H ratio	< 0.89	5	42	1.00		1.00	
	≥ 0.89	16	316	2.35	0.82-6.75	1.89	0.65-5.55
Hypertension	Yes	6	219	3.94	1.49-10.39	3.70	1.39-9.84
	No	15	139	1.00		1.00	

*cOR: Crude odds ratio **aOR: Adjusted odds ratio for W/H ratio, hypertension

Table 3. Bivariate Correlations in Males

	BMI	T-cholesterol	Triglyceride
T-cholesterol			
Referents	-0.118		
Cases	0.129*		
Triglyceride			
Referents	0.393	0.274	
Cases	0.184**	0.390**	
W/H ratio			
Referents	0.355	0.329	0.269
Cases	0.465**	0.129*	0.150**

*: Correlation is significant at the 0.05 level

**: Correlation is significant at the 0.01 level

had higher W/H ratio than referents (Table 4).

2) Odds ratio of obesity factors

In univariate and multivariate models, there were two independent risk factors - hypertension and W/H ratio (Table 5).

3) Correlation analysis of obesity factors

There were little relationship in referents, but stroke cases showed much more correlations of BMI, T-cholesterol, triglyceride and W/H ratio with one another (Table 6).

Discussion

Obesity is known to be associated with stroke risk factors. Hypertension and obesity are two conditions closely linked; obesity-associated hypertension is characterized by an endothelial dysfunction that may contribute to the higher stroke risk^{9,10}. Although the precise mechanisms of obesity hypertension are not fully understood, considerable evidence suggests that excess renal sodium reabsorption and a hypertensive

shift of pressure natriuresis play a major role¹¹. Obesity activates the sympathetic nervous and renin-angiotensin systems, and causes insulin resistance and hyperinsulinemia, all of which have been postulated to increase tubular reabsorption and raise blood pressure¹²⁻¹⁴.

It has been frequently noted that obesity has a stronger relationship to hypertension than to the risk of stroke, because potential risk of obesity for stroke could be obscured by a history of cigarette smoking and other things associated with deteriorating health¹⁵. Thus, the pathophysiological mechanisms underlying this association of obesity and stroke are still poorly understood.

This study examined obesity factors as possible independent risk factors for stroke and correlation of factors in a case-control study. We used BMI and W/H ratio for evaluating obesity.

BMI did not differ between stroke cases and referents, which corresponds to previous reports saying that BMI is not an independent risk factor for stroke¹⁵⁻¹⁷.

However, there are not a few reports arguing the opposite^{6,18}. While there was no difference of W/H ratio between stroke cases and referents in males, W/H ratio of female cases was higher than referents. This could be an independent risk factor for stroke in logistic regression analysis. The same results have been reported previously^{6,16,19}. Hypertension, already proven to be a strong risk factor, was the only independent risk factor in both sexes.

Much more significant correlations were found in stroke cases than in referents.

Table 4. Subjects' General Characteristics in Females

	Referents (n=32)	Cases (n=264)	P-value
Age	59.4±7.5	63.0±10.0	NS
Body Mass Index	24.7±2.9	24.1±3.3	NS
T-cholesterol	200.9±37.5	202.9±39.6	NS
Triglyceride	144.4±83.1	176.8±111.8	NS
Hypertension	6 (18.8%)	182(68.9%)	<0.001
Regular smoking	1 (3.1%)	27(10.2%)	NS
Alcoholic drinking	3 (9.4%)	36(13.6%)	NS
W/H ratio	0.90±0.05	0.94±0.06	<0.001

*: Chi-square test for categorical variables and independent *t*-test for continuous variables.

Table 5. Univariate and Multivariate Logistic Regression in Females

Variables	Range	Referents	Cases	cOR*	95% CI	aOR**	95% CI
W/H ratio	< 0.88	13	31	1.00	1.00		
	≥ 0.88	19	233	5.14	2.31-11.43	4.28	1.81-10.15
Hypertension	Yes	6	182	9.62	3.81-24.26	8.72	3.41-22.34
	No	26	82	1.00	1.00		

*cOR: Crude odds ratio **aOR: Adjusted odds ratio for W/H ratio, hypertension

Table 6. Bivariate Correlations in Females

	BMI	T-cholesterol	Triglyceride
T-cholesterol			
Referents	0.252		
Cases	0.234**		
Triglyceride			
Referents	-0.045	0.401*	
Cases	0.126*	0.168**	
W/H ratio			
Referents	0.214	0.243	0.241
Cases	0.402**	0.161**	0.081

*: Correlation is significant at the 0.05 level

***: Correlation is significant at the 0.01 level

In male, all of BMI, total-cholesterol, triglyceride and W/H ratio correlated with one another significantly. The same results were found in females, except triglyceride did not correlate with W/H ratio significantly. Referents in all sexes did not have significant correlations among obesity factors. The mechanisms behind these associations should be further explored but may present that the interactions of obesity factors could be an important condition for stroke, and obesity factors might collaborate with one another on stroke occurrence.

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