Original Article

The association of weight status with cognitive impairment in the elderly population of a Shanghai suburb

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Objective: A population-based survey was conducted to analyze the association of under-weight, blood pressure, glucose and lipid metabolism with cognitive impairment in people, 60 years and over, living in 2 towns of Shanghai. Methods: Face-to-face interviews were carried out to collect relevant information with questionnaires. Anthropometric indices of height, weight, waist circumference (WC) and hip circumference were measured. Multivariable logistic regression analyses were performed to evaluate the association of weight status with cognitive impairment. Results: Cognitive impairment were diagnosed in 198 (7.0%) of the 2 809 participants. Compared to the normal BMI category, the under-weight category was significantly associated with the risk of cognitive impairment (OR= 2.47, 95%CI: 1.46-5.23). Subjects with a high WC were 1.5 times (OR= 1.42, 95%CI: 1.10-2.67) more likely and subjects with a high WHR were 1.7 times (OR= 1.68, 95%CI: 1.05-2.84) more likely to be associated with cognitive impairment than the subjects in the reference group. This study demonstrates a significant interaction between hypertension, lipid disorder and WC or WHR on the risk of cognitive impairment in a rural population in Shanghai. Conclusions: Central obesity was significantly associated with the risk of cognitive impairment. A low BMI may be a risk factor for cognitive impairment. A significant interaction between hypertension, lipid disorder and WC or WHR on the risk of cognitive impairment in Shanghai rural population was found.

Key Words: cognitive impairment, waist circumference, waist-to-hip ratio, BMI

INTRODUCTION

Dementia prevalence and its burden on families are increasing. Cognitive impairment is an important part of the diagnostic criteria for dementia, it may indicate the initiation of dementia. The prevention of cognitive impairment through the identification and management of risk factors is important to public health because of the increasing elderly population. We have observed that the prevalence of cognitive impairment was 7.05% in elderly Chinese people of agricultural and rural Shanghai China.[1] Despite therapeutic advances, the current treatments for cognitive impairment and dementia have shown limited success.[2]

Weight status, commonly measured by BMI, waist circumference (WC) and waist-to-hip ratio (WHR), is a powerful risk factor for cardiovascular disease.[3] It is not clear whether weight status predisposes patients to cognitive impairment and dementia independently of other risk factors. Cross-sectional studies have shown that older individuals with dementia have lower BMIs than those without dementia.[4-6] However, the results from other longitudinal studies relating the BMIs of older people to cognitive function are conflicting. For example, Whitmer *et al* [7] reported that increased BMI was associated with cognitive impairment, but Rosengren *et al* [8] found a U-shaped association between BMI and cognitive impairment. Another study suggested that high BMI was a pro-

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tective factor for cognitive function, but high WC was a risk factor for cognitive impairment.[9] However, at the time of these studies, the cut-off point for BMI and WC in China was different from the international standard criteria. The WHO Regional Office for the Western Pacific Region proposed a new guideline in 2000 in which lower cut-off values for BMI and WC were recommended for classifying Asian subjects as overweight or obese.[10] Indeed, data supporting a role for fat tissue distribution in predicting cognitive decline in older Chinese patients are lacking, especially from subjects in rural areas. In this article, we analyzed the associations between obesity and the risks of cognitive impairment in participants aged 60 and older from Shanghai suburbs.

MATERIALS AND METHODS

Subjects

Data are from a population-based cohort study conducted in 2005 investigating the common mechanisms of dementia and diabetes. Participants were residents of a Shanghai suburb and were aged 60 years or older. The investigation with a face-to-face interview was carried out by specifically trained research assistants with questionnaires, and a number of physical and neurological examinations were also performed. The questionnaires included items regarding demographic information, general medical history, family medical history, and factors putatively associated with cognitive impairments like smoking, drinking alcohol or tea, history of head injury or vascular disease, family history of Alzheimers disease (AD), aluminum exposure and family incomes. Prior to the survey, we explained the consent process, study procedures and purpose to the participants. Informed consent was obtained from each subject, and for participants who were illiterate or severely demented, the consent was signed by their legal guardian accompanying them to the visits.[1] A total of 2,809 individuals were enrolled in this study. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Ethics Committee of Ruijin Hospital affiliated to School of Medicine, Shanghai Jiao Tong University.

Measurements

The Chinese version of the Mini-Mental State Examination (C-MMSE) was used to screen subjects with cognitive impairments. Participants were considered to have a cognitive impairment if they scored below the following cut-off points according to their level of education:[1] 17/18 for those without formal education, 20/21 for those with 1-6 years of education (primary school) and 24/25 for participants with >6 years of education (middle school or higher). The sensitivity and specificity of the cut-off scores of the CMMSE were reported to be 85.2% and 92.7% in a study of dementia in Shanghai.[1]

Hypertension was defined as an average systolic blood pressure (SBP)≥140 mmHg and/or an average diastolic blood pressure (DBP)≥90 mmHg. Subjects who were receiving regular antihypertensive treatments were considered to have hypertension.[11]

BMI was calculated by dividing weight in kilograms by height in meters-squared (kg/m^2).

Body weight was measured to the nearest 0.1 kg while the participant was standing and not wearing shoes using a balance scale, and height was measured to the nearest 0.5 cm. WC was measured at the level of the iliac crest at minimal inspiration to the closest 0.1 cm as the subjects stood with their weight evenly distributed and their feet 25-30 cm apart. For hip circumference, the measurements were taken around the pelvis at the point of maximal protrusion of the buttocks to the closest 0.1 cm. Each of these measurements was taken by at least two health care workers. One took the measurements, and the other recorded the readings.

The classification of weight status followed the WHO guidelines for the Asian Pacific population:[10] underweight, BMI<18.5; normal, BMI 18.5-22.9; overweight, BMI 23.0-24.9; obese I, BMI 25.0-29.9; and obese II, BMI≥ 30.0 kg/m^2. Waist-to-hip ratio (WHR) was defined as the waist measurement divided by the hip measurement. Central obesity was defined as a WC≥90 cm for men and a WC≥80 cm for women. As for the WHR, central obesity was defined a WHR≥0.90 for men and a WHR≥0.85 for women, peripheral obesity was defined as a WHR<0.90 for men and a WHR<0.85 for women.

Blood pressure was measured using a mercury manometer after the subjects had been seated for 10 min. Measurements were taken in triplicate from the same arm, with at least 30 seconds between readings. Each patient's SBP and DBP were calculated as the mean of the three measurements.

Lipid abnormalities were standard: total cholesterol ≥5.72 mmol/L or triglyceride ≥1.69 mmol/L or LDL≥ 3.64 mmol/L or HDL<0.91 mmol/L

Statistical methods

Baseline descriptive statistics for the participants were computed for BMI category and WC. Continuous variables were expressed as mean values (SD). Categorical variables were expressed as numbers and percentages. Logistic regression analysis was conducted to determine the odds ratios (OR) with 95% confidence intervals (CI) for cognitive impairment. The reference group for BMI was the 18.5-23.0 kg/m^2 category. For WC, the reference group was <90 cm for men and <80 cm for women, and for WHR, it was <0.90 for men and <0.85 for women. The variables that were adjusted in the logistic regression analysis were age, sex, education level, smoking, alcohol consumption and physical activity, blood pressure, history of diabetes (past diagnosis of diabetes mellitus) and lipid abnormalities. These variables are risk factors associated with CI and are also associated with body fat..BMI, WC and WHR were treated as categorical variables. All statistical analyses were performed using SPSS 19.0 (SPSS for Windows). All *p*-values were based on two-sided tests with a significance level of 0.05.

RESULTS

Our study included 2,809 subjects with a mean age of 70.6 years (SD=6.6), and a range from 60 to 92 years. There were 1,010 (36.0%) men and 1,799 (64.0%) women, and 198 were screened for cognitive impairment. Baseline demographic, anthropometric, and health-related characteristics, as well as cognitive screening test scores,

Table 1. Characteristics of subjects classified by BMI and waist circumference

Characteristics	BMI, kg/m^2						Waist circumference, cm	
	<18.5	18.5 to <23.0	23.0 to <25.0	25.0 to <30.0	≥30.0	Total		
Men							<90	≥90
Number of subjects	35	339	206	343	86	1010	703	307
Age, years	75.0 (6.9)	71.8 (6.1)	70.8 (6.3)	70.0 (6.2)	69.3 (6.0)	70.6 (6.6)	71.2 (6.3)	69.8 (6.4)
Body weight, kg	42.4 (3.7)	51.0 (5.1)	58.1 (5.1)	65.6 (6.4)	77.1 (8.7)	59.3 (10.3)	54.9 (7.6)	69.1 (8.7)
Height, cm	155 (4.7)	155 (6.3)	155 (6.8)	155 (6.8)	154 (12.4)	155 (7.0)	155 (6.3)	157 (8.2)
Waist, cm	72.4 (6.8)	77.7 (5.9)	84.5 (5.9)	90.7 (6.3)	99.9 (9.4)	85.1 (9.7)	80.1 (6.2)	96.5 (5.8)
Hip, cm	85.4 (3.4)	90.9 (6.4)	95.3 (4.4)	100 (4.9)	108 (7.5)	96.1 (7.7)	92.8 (6.0)	103 (6.0)
Systolic blood pressure, mmHg	123 (17.9)	126 (17.1)	130 (17.6)	135 (16.0)	137 (16.0)	131 (18.0)	129 (18.4)	135 (16.8)
Diastolic blood pressure, mmHg	73.6 (9.4)	75.4 (9.4)	78.2 (9.3)	80.3 (9.2)	81.1 (7.6)	78.1 (9.5)	77.0 (9.6)	80.8 (8.7)
Educated for ≥1 year, n (%)	17 (48.6)	144 (42.5)	97 (47.1)	188 (54.8)	45 (52.3)	491 (48.6)	321 (45.7)	170 (55.4)
Smoking, n (%)	17 (48.6)	205 (60.5)	123 (59.7)	21 (6.1)	45 (52.3)	583 (57.7)	418 (59.5)	165 (53.7)
Alcohol consumption, n (%)	8 (22.9)	145 (42.8)	96 46.6)	161 (46.9)	35 (40.7)	445 (44.1)	311 (44.2)	134 (43.6)
Physical activity ≥60 min/day, n (%)	7 (20)	114 (33.8)	75 (36.4)	119 (34.7)	31 (36.0)	346 (34.3)	240 (34.1)	106 (34.5)
C-MMSE score	24.1 (4.8)	25.7 (3.6)	25.8 (4.0)	26.3 (3.5)	26.7 (3.2)	25.9 (3.6)	26.2 (3.7)	25.8 (3.4)
Women							<80	≥80
Number of subjects	56	487	359	699	198	1799	581	1218
Age, years	75.1 (5.9)	71.8 (6.5)	70.7 (6.7)	69.4 (6.7)	69.1 (6.5)	70.4 (6.7)	70.9 (6.6)	70.3 (6.8)
Body weight, kg	36.3 (3.6)	44.8 (6.0)	50.1 (4.4)	57.5 (5.6)	67.0 (7.7)	53.0 (9.3)	45.9 (6.5)	56.3 (8.5)
Height, cm	144 (6.4)	145 (6.0)	144 (6.2)	145 (5.9)	143 (13.8)	145(7.3)	144 (7.2)	145 (7.3)
Waist, cm	71.5 (8.2)	76.3 (6.3)	82.6 (5.7)	88.8 (6.9)	96.7 (9.2)	84.9 (9.7)	74.1 (4.8)	89.6 (7.1)
Hip, cm	84.8 (3.2)	90.9 (6.4)	94.7 (5.0)	100 (6.2)	108 (8.1)	97.0 (8.4)	90.6 (7.2)	99.8 (7.3)
Systolic blood pressure, mmHg	123 (18.0)	128 (17.5)	131 (16.8)	133 (16.8)	135 (18.8)	131 (17.4)	144 (7.2)	145 (7.3)
Diastolic blood pressure, mmHg	72.0 (9.4)	75.9 (19.0)	77.9 (9.5)	78.6 (8.6)	80.4 (9.2)	77.7 (9.1)	76.1 (9.4)	78.5 (8.9)
Educated for ≥1 year, n (%)	9 (16.1)	64 (13.1)	54 (15.0)	128 (18.3)	35 (17.7)	290 (16.1)	88 (15.1)	202 (16.6)
Smoking, n (%)	0 (0.0)	8 (1.6)	0 (0.0)	11 (1.6)	4 (2.0)	23 (0.1)	6 (1.0)	23 (1.9)
Alcohol consumption, n (%)	1 (1.8)	11 (2.3)	9 (2.5)	7 (1.0)	8 (4.0)	36 (2.0)	13 (2.2)	23 (1.9)
Physical activity ≥60 min/day, n (%)	10 (17.9)	119 (24.4)	96 (26.7)	197 (28.2)	52 (26.3)	474 (26.3)	144 (24.8)	330 (27.1)
C-MMSE score	20.6 (4.6)	23.0 (4.1)	23.5 (4.1)	24.0 (4.2)	23.8(4.3)	23.5 (4.2)	23.5 (3.9)	22.3 (4.4)

Values are presented as mean (SD), except when otherwise noted.

groups by BMI and waist circumference categories, are shown in Table 1. In this population, the prevalence rate of obesity, according to BMI (≥25.0 kg/m^2), was 47.2% for the whole group, 42.5% for men and 50.0% for women. For both men and women, the mean values of SBP and DBP increased with BMI and WC. Age and height decreased with increasing BMI. There was a decrease in mean age and height with increasing waist circumference. More than 30.4% of men and 67.7% of women fell above the cut-off points of 90 cm for men and 80 cm for women. No significant differences (p=0.365 for BMI and p=0.257 for WC) in BMI and WC were observed between men and women, although body weight, height and hip circumference were significantly higher (all p-value <0.01) in men than women. The percentage of smokers and alcohol consumers, the number of physically active people (≥60 min/day) and the number of people with at least 1 year of education were all higher in men than in women. The mean C-MMSE score was significantly (p=0.001) higher in men than women (mean score: 25.9, SD: 3.6 for men and mean score: 23.5, SD: 4.2 for women). For subjects with a BMI of <18.5 kg/m^2, the C-MMSE score was the lowest, and it was significantly different (p=0.001) from the other categories. The C-MMSE scores were higher in the groups with a WC<90 cm for men and a WC<80 cm for women.

Table 2 presents the unadjusted association of cognitive impairment with age, gender, cigarette smoking, alcohol drinking, physical activity, BMI, WC and WHR. Higher age, female sex, without formal education, high blood pressure, lipid disorder, BMIs of <18.5 kg/m^2, higher WC and WHR groups were each associated with increased cognitive impairment. Cigarette smoking, alcohol drinking, and physical activity were each negatively related to cognitive impairment, but it was not associated with the history of DM.

These associations were further evaluated by multivariable analysis. The multivariable-adjusted associations between cognitive impairment and environmental risks were presented in Table 3. The association between lipid disorder, BMIs of <18.5 kg/m^2, higher WC, WHR groups and cognitive impairment still differed remarkably with

Table 2. Crude association of cognitive impairment with environmental risks and BMI,WC,WHR

Variable	No	Odds ratio (95% confidence interval)	p-value
Age group, years			
60-69	1229	1.0	
70-79	1229	2.75 (1.90-3.98)	<0.001
80 and above	281	6.12 (3.93-9.53)	<0.001
Gender			
Men	1010	1.0	
Women	1799	2.19 (1.54-3.11)	<0.001
BMI, kg/m^2			
<18.5	91	2.32 (1.25-4.56)	<0.001
18.5 to <23.0	826	1.0	-
23.0 to <25.0	565	1.13 (0.618-1.88)	0.116
25.0 to <30.0	1042	1.25 (0.701-2.24)	0.054
≥30.0	285	0.973 (0.493-1.58)	0.088
WC, cm			
<80/90	1284	1.0	
≥80/90	1525	1.42 (1.11-2.60)	<0.001
WHR			
<0.85/0.90	1160	1.0	
≥0.85/0.90	1544	1.68 (1.04-2.78)	<0.001
Cigarette smoking			
No	2179	1.0	
Yes	606	0.461 (0.291-0.712)	0.002
Alcohol drinking			
No	2304	1.0	
Yes	481	0.323 (0.181-0.572)	<0.001
Educational level			
Formal education	780	1.0	
Without formal education	2010	2.25 (1.00-4.76)	<0.001
Physical activity, min/day			
<30	1486	1.0	
≥30	1276	0.631 (0.301-0.783)	<0.001
Blood pressure, mmHg			
<140/90	1721	1.0	
≥140/90	1088	1.26 (1.11-1.65)	0.048
Lipid disorder			
No	2646	1.0	
Yes	163	3.57 (2.32-5.51)	<0.001
History of diabetes			
No	2731	1.0	
Yes	78	1.12 (0.645-1.94)	0.108

WC = waist circumference; WHR = waist-to-hip ratio.

Table 3. Multivariable-adjusted associations between cognitive impairment and environmental risks

Variable	No	Odds Ratio (95% confidence interval)	*p*-value
BMI, kg/m^2			
<18.5	91	2.47 (1.46-5.23)	<0.001
18.5 to <23.0	826	1.0	-
23.0 to <25.0	565	1.03 (0.768-1.65)	0.105
25.0 to <30.0	1042	1.38 (0.636-2.46)	0.089
≥30.0	285	0.846 (0.651-1.33)	0.065
WC, cm			
<80/90	1284	1.0	
≥80/90	1525	1.42 (1.10-2.67)	<0.001
WHR			
<0.85/0.90	1160	1.0	
≥0.85/0.90	1544	1.68 (1.05-2.84)	<0.001
Blood pressure, mmHg			
<140/90	1721	1.0	
≥140/90	1088	1.16 (0.813-1.65)	0.051
Lipid disorder			
No	2646	1.0	
Yes	163	3.57 (2.32-5.51)	<0.001

WC = waist circumference; WHR = waist-to-hip ratio.
Multiple linear regression models with adjustment for age group (60-69, 70-79, ≥80 years), gender, education level (formal education, without formal education), smoking (no, yes), alcohol drinking (no, yes), physical activity (<30, ≥30 min/day)

Table 4. Interaction analysis between blood pressure and BMI, waist circumference, waist-to-hip ratio to cognitive impairment

Variable	Blood pressure (mmHg)	n	Cognitive impairment		
			OR	95% confidence interval	*p*-value
BMI, kg/m^2					
<18.5	<140/90	69	1.0		
	≥140/90	22	0.743	0.548-1.01	0.055
18.5 to <23.0	<140/90	615	1.0		
	≥140/90	211	1.62	0.832-3.36	0.062
23.0 to <25.0	<140/90	378	1.0		
	≥140/90	187	1.21	0.937-1.64	0.049
25.0 to <30.0	<140/90	644	1.0		
	≥140/90	398	2.22	1.01-4.52	0.018
≥30.0	<140/90	158	1.0		
	≥140/90	127	0.826	0.525-1.51	0.198
WC, cm					
< 80/90	<140/90	914	1.0		
	≥140/90	370	1.47	1.03-1.75	0.041
≥80/90	<140/90	950	1.0		
	≥140/90	575	2.11	1.14-4.33	0.036
WHR					
<0.85/0.90	<140/90	847	1.0		
	≥140/90	313	2.51	1.21-5.20	0.021
≥0.85/0.90	<140/90	958	1.0		
	≥140/90	586	1.5	1.01-2.24	0.006

Multiple linear regression models with adjustment for age group (60-69, 70-79, ≥80 years), gender, education level (formal education, without formal education), smoking (no, yes), alcohol drinking (no, yes), physical activity (<30, ≥30 min/day)

adjustment for age group, gender, education level, smoking, alcohol drinking, physical activity. But it was not significant in the high blood pressure.

The Interaction analysis between blood pressure and BMI, WC, WHR to cognitive impairment is presented in Table 4. Blood pressure was significantly associated with increased prevalence of cognitive impairment in the 23-25 kg/m^2 and 25-30 kg/m^2 BMI groups after controlling for confounders, but was not significant in the other groups. Consistently, we found a similar pattern when the association was stratified by higher and lower WC and WHR. A test of interaction between the blood pressure and WC (p=0.024), or WHR (p =0.016) was statistically significant from log likelihood ratio test. No interaction between blood pressure and BMI to cognitive impairment (p=0.362) was found.

The interaction analysis between lipid disorder and body mass index, waist circumference, waist-to-hip ratio to cognitive impairment is presented in Table 5. Lipid disorder was significantly associated with increased prevalence of cognitive impairment in the higher BMI groups, higher WC and WHR groups, but was not significant in the groups of BMIs of <18.5 kg/m^2, and BMIs of 18.5-23.0 kg/m^2. A test of interaction between lipid disorder

Table 5. Interaction analysis between blood pressure and BMI, waist circumference, waist-to-hip ratio to cognitive impairment

Variable	Lipid disorder	n	Cognitive impairment		
			OR	95% confidence interval	*p*-value
BMI, kg/m^2					
<18.5	No	79	1.0		
	Yes	12	0.703	0.354-1.54	0.379
18.5 to <23.0	No	806	1.0		
	Yes	20	1.43	0.805-2.67	0.752
23.0 to <25.0	No	537	1.0		
	Yes	28	3.93	1.65-7.32	0.007
25.0 to <30.0	No	1003	1.0		
	Yes	39	8.10	1.44-14.98	<0.001
≥30.0	No	221	1.0		
	Yes	64	4.80	1.28-8.45	<0.001
WC, cm					
<80/90	No	1222	1.0		
	Yes	62	0.827	0.437-1.43	0.069
≥80/90	No	1424	1.0		
	Yes	101	4.85	1.20-8.46	<0.001
WHR					
<0.85/0.90	No	1101	1.0		
	Yes	59	1.61	0.957-3.00	0.088
≥0.85/0.90	No	1545	1.0		
	Yes	104	7.71	1.24-14.6	<0.001

Multiple linear regression models with adjustment for age group (60-69, 70-79, ≥80 years), gender, education level (formal education, without formal education), smoking (no, yes), alcohol drinking (no, yes), physical activity (<30, ≥30 min/day), and hypertension (no, yes)

and BMI (p=0.041), WC (p=0.001), or WHR (p =0.004) was statistically significant from the log likelihood ratio test.

DISCUSSION

In this cross-sectional study of an older population, the BMI category of <18.5 kg/m^2 was positively associated with an increased prevalence of cognitive impairment. In contrast, a higher WC and WHR were associated with an increased prevalence of cognitive impairment. These results suggest that the effects of generalized obesity and central obesity on the prevalence of cognitive impairment may be different.

Whether total obesity, as measured by BMI, increases the risk of dementia, Alzheimer's disease, and cognitive impairment is unclear.[4-8] Cross-sectional studies have shown that older individuals with dementia have lower BMIs than those without CI.[4-6] Results from other cross-sectional and longitudinal studies relating BMI to cognitive function in older patients are conflicting. According to the studies of Kivipelto *et al*[12] and Nourhashemi *et al*[13], a low BMI does not significantly increase the risk of cognitive impairment after adjusting for comorbid factors. In Whitmer *et al*'s study, a high BMI significantly increased the risk of cognitive impairment.[7] However, in Rosengren *et al*'s study, the association between BMI and cognitive impairment was U-shaped.[8] Our results show that being underweight (BMI≤18.5 kg/m^2) is a risk factor for cognitive impairment, and total obesity has an insignificant effect on cognitive impairment. However, the adjustments for confounding variables were different in all of the studies, and this can influence the results. In our study, the adjusted variables included age, gender, education level, smoking, alcohol consumption, and physical activity because all of these factors influence fat accumulation.

The distribution of body fat in the abdominal region, referred to as central obesity and measured by WC and WHR, is an independent and more potent risk factor for type 2 diabetes, insulin resistance, coronary heart disease, stroke, and mortality than total body obesity. Currently, it is unclear whether central obesity predisposes patients to cognitive impairment independently of other risk factors, and few studies have examined the potential link between central obesity and the risk of cognitive impairment. In Whitmer *et al*'s population-based study of middle-aged adults who were followed for an average of 36 years,[7] central obesity was associated with an increased risk of dementia that was independent of demographics, diabetes, cardiovascular comorbidities, and BMI. Our findings, showing that the relative risk for cognitive development increased with increasing WCs and WHRs, are consistent with these results.

Mechanisms relating BMI, independent from central obesity, to cognitive impairment or dementia are unclear. A low BMI may be due to weight that is lost as a precursor to dementia.[14] A higher BMI can be the result of more lean body mass as well as more fat mass. It is possible that higher lean body mass may be involved in reducing the risk of dementia in the older population. In a large, cross-sectional study of older women, participants in the highest quartile of fat-free soft tissue mass had a decreased risk of cognitive impairment compared to the lowest quartile group.[15] Increased BMI may also result from increased accumulation of fat in regions other than the abdominal area. More fat mass in the legs of older individuals has been associated with improved glucose metabolism,[16] which could potentially have implications for reducing the risk of developing cognitive impairment.

A recent publication reported an increased risk of dementia associated with sagittal fat.[17] It may also be possible that muscle loss and central fat gain may act synergistically to increase the risk of cognitive impairment in older populations.

Particularly in older individuals, WC is a more accurate indicator of abdominal visceral fat levels than BMI, percent body fat, or WHR.[18] Waist circumference also correlates well with the gold standards, computed tomography and magnetic resonance imaging (MRI) of the abdomen.[19] Although somewhat abandoned during the last five or seven years as a measure of fat distribution, the WHR is still a useful measure for the evaluation of obesity. Some experts believe the hip measurement provides additional information about gluteofemoral muscle mass and bone structure. In West's study,[9] WC was a more accurate indicator of cognitive impairment than BMI, and our results are consistent with that finding. In our study, when WC or WHR increased, the ORs for cognitive impairment increased. This demonstrates that the accumulation of abdominal fat, but not total body fat, may confer an increased risk of cognitive impairment in the elderly population.

The relationship between weight status and cognitive impairment may work through a number of other potential risk factors, such as blood pressure, glucose and blood lipids. Both diabetes and hypertension worsen brain perfusion and are major risk factors for cerebrovascular disease, stroke and dementia.[20] Many studies have shown a positive correlation between elevated blood glucose and cognitive dysfunction. Cherbuin's study shows that high plasma glucose levels within the normal range (<6.1 mmol/L) were associated with greater atrophy of structures relevant to aging and neurodegenerative processes, the hippocampus and amygdala.[21] The metabolic syndrome (MetS), a clustering of risk factors for type 2 diabetes mellitus and cardiovascular disease including lipid disorders, has been associated with cognitive dysfunction and brain abnormalities. Insulin resistance-associated impairment in cerebrovascular reactivity is an important mechanism underlying brain deficits seen in MetS, according to the Adult Treatment Panel III definition, MetS is defined as the presence of dyslipidemia, obesity, glucose intolerance, and hypertension [22] In our study, there were interaction between obesity, as measured by WC or WHR, with hypertension and lipid disorder to cognitive impairment. But in this study, the number of people that had a history of diabetes was limited. This may be because our study population is farmers on the outskirts of Shanghai, and are mainly engaged in manual work, there is a certain difference on diet habit of these individuals compared to those living in urban areas. We also did not collect the participant's blood glucose, which could be done in subsequent studie.

In summary, the association between BMI and cognitive impairment is complex. Among older individuals, BMI may underestimate adiposity because lean body mass is replaced by fat during the aging process.[23] The association between increased adiposity and dementia may be weaker among the older participants because they may have more body fat in spite of their low body weight. This also implies that the association between BMI and dementia may be assessed more accurately during midlife than in the older age.[7] Waist circumference and WHR may be more accurate indicators of abdominal fat levels than BMI. Ascertaining obesity as an independent risk factor or protective factor for cognitive impairment requires careful adjustment for confounding variables, an adequate number of cognitive impairment cases and a distinction between the different types of obesity. Long-term, well-designed studies are still needed to examine the mechanisms underlying the relationship between weight status and cognitive impairment.

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AUTHOR DISCLOSURES

There were no conflicts of interests.

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Original Article

The association of weight status with cognitive impairment in the elderly population of a Shanghai suburb

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上海郊区老年人群体重与认知功能障碍的关系

目的：研究上海郊区 2 个镇的老年人群低体重、血压、血糖、血脂与认知功能障碍之间的关系。方法：由经过培训的调查人员采用认知功能障碍调查问卷，对研究对象进行面对面的询问，收集相关资料。並進行对身体的测量，包括身高、体重、腰围及臀围。通过非条件多因素逻辑回归分析研究体重、血压、血糖、血脂与认知功能障碍的关系。结果：2,809 人的研究对象中，有 198 (7.0%)人被诊断为认知功能障碍。在调整了可能的混杂因素后，与正常体重指数(BMI)人群相比，低体重与认知功能障碍之间存在相关关系(OR= 2.47，95%CI: 1.46-5.23)；与正常腰围组相比，高腰围与认知功能障碍之间存在相关关系(OR= 1.42，95%CI: 1.10-2.67)；与正常腰臀比(WHR)组相比，高腰臀比与认知功能障碍之间亦存在相关关系(OR= 1.68，95%CI: 1.05-2.84)。本研究结果表明，高血压、血脂异常可能通过与腰围、腰臀比之间的交互作用对认知功能障碍的发生产生影响。结论：中心型肥胖与认知功能障碍之间存在相关关系。低体重可能是认知功能障碍的危险因素。高血压、血脂异常与腰围、腰臀比之间存在交互作用。

關鍵字：认知功能障碍、腰围、腰臀比、体重指数