

Body Mass Index and Its Related Factors in the Elderly

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Abstract

Background: A cross-sectional study was conducted in May 1998 in Chung-Hsing Village, Taiwan to evaluate the relationship between body mass index (BMI) and its related factors in the elderly. **Methods:** Individuals aged 65 years and over were recruited as study subjects. A total of 1093 persons, out of 1774 registered residents, were contacted for face-to-face interview (61.6%). However, only 586 respondents completed the questionnaire and had blood tests. Analysis was based on these 586 subjects. **Results:** There were 66.0% men and 34.0% women. The mean age was 73.1 ± 5.3 years. The BMI was 24.13 ± 4.64 kg/m² and 24.07 ± 3.99 kg/m² for men and women, respectively ($P > 0.05$). In univariate analysis, high systolic pressure, high diastolic pressure, hypertriglyceridaemia, hyperglycaemia and hyperuricaemia were related to obesity. After controlling for the other covariates, the multivariate logistic regression analysis showed that significant related factors of obesity were hyperglycaemia and hyperuricaemia. **Conclusions:** Significant related factors of obesity in the elderly were hyperglycaemia and hyperuricaemia. A large-scale investigation will be suggested in the future to address causal-effect issues between obesity and hyperglycaemia or hyperuricaemia.

Ann Acad Med Singapore 2001; 30:397-400

Key words: Body mass index, Hyperglycaemia, Hyperuricaemia, Obesity

Introduction

Cardiovascular disease is one of the leading causes of mortality and morbidity in developed countries, especially among the elderly.¹ In Taiwan, cardiovascular disease is the third leading cause of death after neoplasm and cerebrovascular disease.² Obesity is one of the modifiable risk factors for cardiovascular disease.³ In western countries, 23% of elderly men and 35% of elderly women are obese [body mass index (BMI) ≥ 30 kg/m²].⁴ The population in Taiwan is over 21 million and the number of people aged 65 years and over has exceeded 7.0% since 1994.⁵ Until now, little is known about the effects of BMI and the associations between BMI and cardiovascular risk factors or sociodemographic factors in the elderly in Taiwan. As a result, recommendations on health promotion and disease prevention in the elderly remain uncertain.

A comprehensive health survey was conducted in the elderly living in Chung-Hsing Village, Taiwan, to evaluate the relationship between BMI and its related factors.

Materials and Methods

In May 1998, a cross-sectional study was conducted in Chung-Hsing Village located in central Taiwan. Individuals aged 65 years and over were recruited as study subjects. There was a total of 1774 subjects according to the official household registration records. A total of 1093 persons, out of the potential 1774 subjects, participated in this study. The response rate was 61.6%. However, only 586 respondents had blood tests and completed the questionnaire. Analysis in this study was based on these 586 subjects. Well-trained interviewers collected information about the subject's socioeconomic status, family structure, and educational level via face-to-face interview.

The subject's educational level was identified as junior high school or less, senior high school, professional training college, and undergraduate or graduate. If the subject had retired from work, that status was identified. If the subject still lived with a spouse, the marital status was defined as

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living together. If not, the marital status was defined as living alone.

Blood pressure was measured by a mercury sphygmomanometer in the sitting position. Weight and height were measured. Blood samples were obtained in the morning after a 12-hour overnight fast and blood samples were immediately sent to the Department of Clinical Laboratory, Chung-Hsing Hospital. A number of biochemical markers, such as total cholesterol, triglyceride, fasting glucose, creatinine, and uric acid were analysed by a biochemical autoanalyser (Chem1⁺, Technicon, USA).

Body mass index was measured as follows: weight (kg) divided by the square of height (m²). BMI ≥ 28 kg/m² was defined as obese, $25 \leq \text{BMI} < 28$ kg/m² as overweight, $20 \leq \text{BMI} < 25$ kg/m² as normal and BMI < 20 kg/m² as underweight.⁶ Hypercholesterolaemia was defined as total cholesterol ≥ 5.18 mmol/L and hypertriglyceridaemia was defined as triglyceride ≥ 2.26 mmol/L.⁷ Hyperglycaemia was defined as fasting glucose ≥ 6.05 mmol/L.⁸ Subjects were considered to have high blood pressure if the average of three readings exceeded 140 mmHg systolically and/or 90 mmHg diastolically.⁹ Renal function impairment was defined as creatinine ≥ 132.6 $\mu\text{mol/L}$.¹⁰ Hyperuricaemia was defined as serum uric acid ≥ 416.5 $\mu\text{mol/L}$ in men and ≥ 386.8 $\mu\text{mol/L}$ in women.¹¹

Statistical analyses were performed by the aid of a SAS package (Version 6.12, SAS Institute Inc., Cary, North Carolina, USA). The *t*-test, chi-square test and multivariate logistic regression were used for statistical analysis. *P* values < 0.05 were considered statistically significant.

Results

Out of 1093 subjects, 65.7% were men and 34.3% were women. The mean age was 73.5 ± 5.6 years. Out of 586

respondents, 66.0% were men and 34.0% were women. The mean age was 73.1 ± 5.3 years. We performed chi-square analysis and *t*-test to examine the gender and age distributions between these two samples. No significant difference was observed. Therefore, the potential non-response bias could be minimised. For those elderly people included in the current study, the BMI was 24.13 ± 4.64 kg/m² and 24.07 ± 3.99 kg/m² in men and women, respectively ($P > 0.05$).

Table I shows the mean BMI values and the proportion of obesity for both genders in the different age groups. Men and women were similar in BMI for each age group ($P > 0.05$). The proportion of obesity was 12.66% in men and 11.70% in women. The proportion of obesity for each age group in men or women was not statistically significant ($P > 0.05$).

The results of chi-square analysis for BMI among the cardiovascular risk factors and the sociodemographic factors are shown in Table II. The significant related factors of BMI were high systolic pressure, high diastolic pressure, hypertriglyceridaemia, hyperglycaemia and hyperuricaemia.

The results of multivariate logistic regression for obesity are shown in Table III. After controlling for the other covariates, the significant related factors of obesity were hyperglycaemia (odds ratio 1.98, 95% confidence interval 1.03–3.82, $P < 0.05$) and hyperuricaemia (odds ratio 1.91, 95% confidence interval 1.08–3.37, $P < 0.05$). That is, people with hyperglycaemia were more likely to be obese than people with normal fasting glucose. People with hyperuricaemia were more likely to be obese than people with normal serum uric acid. No significant association was found between obesity and hypertension or hypertriglyceridaemia.

TABLE I: BODY MASS INDEX BY GENDER AND AGE IN THE ELDERLY

Age (y)	BMI (kg/m ²)*	Underweight n (%)	Normal n (%)	Overweight n (%)	Obesity n (%)	<i>P</i>
Men						
65-69	24.70 ± 4.16	10 (10.42)	43 (44.79)	31 (32.29)	12 (12.50)	0.336
70-74	24.21 ± 5.83	16 (12.50)	69 (53.91)	27 (21.09)	16 (12.50)	
75-79	23.52 ± 3.66	19 (17.12)	55 (49.55)	26 (23.42)	11 (9.91)	
≥80	24.20 ± 3.81	8 (18.18)	17 (38.64)	10 (22.73)	9 (20.45)	
Subtotal	24.13 ± 4.64	53 (13.98)	184 (48.55)	94 (24.80)	48 (12.66)	
Women						
65-69	24.13 ± 3.81	8 (11.59)	35 (50.72)	15 (21.74)	11 (15.94)	0.758
70-74	24.35 ± 4.73	9 (14.75)	27 (44.26)	19 (31.15)	6 (9.84)	
75-79	24.14 ± 3.31	4 (11.43)	14 (40.00)	14 (40.00)	3 (8.57)	
≥80	23.15 ± 3.52	4 (17.39)	10 (43.48)	7 (30.43)	2 (8.70)	
Subtotal	24.07 ± 3.99	25 (13.00)	86 (45.74)	55 (29.26)	22 (11.70)	

*: Not significant

TABLE II: COMPARISONS OF CLINICAL CHARACTERISTICS OF BMI IN THE ELDERLY BY CHI-SQUARE ANALYSIS

Variable	Underweight n (%)	Normal n (%)	Overweight n (%)	Obesity n (%)	P value
Systolic pressure ≥ 140 (mm Hg)					
No	66 (17.37)	182 (47.89)	94 (24.74)	38 (10.00)	0.002
Yes	13 (6.99)	87 (46.77)	56 (30.11)	30 (16.13)	
Diastolic pressure ≥ 90 (mm Hg)					
No	70 (15.63)	220 (49.11)	108 (24.11)	50 (11.16)	0.010
Yes	9 (7.63)	49 (41.53)	42 (35.59)	18 (15.25)	
Total cholesterol ≥ 5.18 (mmol/L)					
No	44 (15.28)	130 (45.14)	79 (27.43)	35 (12.15)	0.607
Yes	35 (12.41)	141 (50.00)	71 (25.18)	35 (12.41)	
Triglyceride ≥ 2.26 (mmol/L)					
No	72 (16.22)	214 (48.20)	111 (25.00)	47 (10.59)	0.002
Yes	6 (4.88)	56 (45.53)	39 (31.71)	22 (17.89)	
Fasting glucose ≥ 6.05 (mmol/L)					
No	70 (15.49)	225 (49.78)	106 (23.45)	51 (11.28)	0.002
Yes	9 (7.63)	46 (38.98)	44 (37.29)	19 (16.10)	
Creatinine ≥ 132.6 ($\mu\text{mol/L}$)					
No	57 (14.47)	182 (46.19)	104 (26.40)	51 (12.94)	0.776
Yes	22 (12.79)	87 (50.58)	44 (25.58)	19 (11.05)	
Uric acid (men ≥ 416.5 , women ≥ 386.8 $\mu\text{mol/L}$)					
No	46 (16.73)	139 (50.55)	64 (23.27)	26 (9.45)	0.024
Yes	33 (11.26)	131 (44.71)	85 (29.01)	44 (15.02)	
Educational level					
Junior high school or less	19 (11.88)	80 (50.00)	42 (26.25)	19 (11.88)	0.640
Senior high school	26 (17.45)	62 (41.61)	38 (25.50)	23 (15.44)	
Professional training college	11 (15.71)	36 (51.43)	17 (24.29)	6 (8.57)	
Undergraduate or graduate	14 (10.77)	67 (51.54)	34 (26.15)	15 (11.54)	
Retirement status					
Non-retired	20 (13.70)	65 (44.52)	45 (30.82)	16 (10.96)	0.562
Retired	59 (13.88)	206 (48.47)	106 (24.94)	54 (12.71)	
Marital status					
Living together	57 (13.70)	200 (48.08)	110 (26.44)	49 (11.78)	0.968
Living alone	22 (14.29)	71 (46.10)	41 (26.62)	20 (12.99)	

Discussion

In our study, the proportion of obesity was 12.66% in men and 11.70% in women. There was no significant difference between obesity and gender. Because few reports about the effects of obesity are demonstrated in the Taiwanese elderly, we cannot discuss further their difference. Thus, our report provides the background data for further studies about the epidemiology of obesity in the Taiwanese elderly. However, to our mind, in Taiwan, as with other developed countries, obesity has become a major critical health problem. Therefore, it is important to measure body weight periodically in the elderly, whether men or women. Also, early intervention for obesity can be performed.

In Himes's report, obesity in the elderly is associated with an increased prevalence of arthritis, diabetes mellitus and hypertension.¹² In Ferraro and Booth's report,¹³ obesity is associated with more days hospitalised or ill in bed, and an increase in functional limitations. Obesity usually occurs in conjunction with other metabolic disorders, such as

TABLE III: MULTIVARIATE LOGISTIC REGRESSION OF OBESITY IN THE ELDERLY

Variable	EP (SE)	OR	95% CI
Intercept	-2.14 (0.27)		
Systolic pressure (<140 mmHg as reference)			
≥ 140	0.26 (0.31)	1.30	0.71-2.37
Diastolic pressure (<90 mmHg as reference)			
≥ 90	0.35 (0.35)	1.42	0.72-2.80
Triglyceride (<2.26 mmol/L as reference)			
≥ 2.26	0.25 (0.33)	1.28	0.68-2.42
Fasting glucose (<6.05 mmol/L as reference)			
≥ 6.05	0.68 (0.33)	1.98	1.03-3.82*
Uric acid (men <416.5 , women <386.8 $\mu\text{mol/L}$ as reference)			
≥ 416.5 (women ≥ 386.8)	0.65 (0.29)	1.91	1.08-3.37*

CI: confidence interval; EP: estimated parameter; OR: odds ratio;
SE: standard error

* $P < 0.05$

insulin resistance, hyperinsulinaemia, glucose intolerance, hypertension, left ventricular hypertrophy, dyslipidaemia, hyperuricaemia, and hypercoagulability.¹⁴⁻¹⁷ Clustering of these disorders has been called metabolic syndrome.¹⁵ In our present study, only hyperglycaemia and hyperuricaemia are significantly associated with obesity. Abdominal obesity seems to induce insulin resistance leading to hyperglycaemia and hyperinsulinemia which increases the appetite, further promoting obesity.^{14-15,18} In our previous report, BMI was also significantly related to serum uric acid.¹⁹ Thus, there is a close relationship between hyperuricaemia and obesity. As this is a cross-sectional survey, which cannot address any causal-effect issues between obesity and hyperglycaemia or hyperuricaemia, the real mechanism needs further study. Many factors, such as dietary habits, lack of exercise, sedentary life styles, elevated alcohol consumption, history of systemic illness, and history of medication use, all of which might predispose the subjects to obesity, were not analysed in detail. There is still a need for further large-scale investigation to see whether these factors affect study results.

In conclusion, the significant related factors of obesity in the elderly were hyperglycaemia and hyperuricaemia. Because of the study's inherent limitation, we cannot address any causal-effect relationship between obesity and hyperglycaemia or hyperuricaemia. A large-scale investigation will be suggested in future.

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