YALE JOURNAL OF BIOLOGY AND MEDICINE 74 (2001), pp. 89-94.

ORIGINAL CONTRIBUTION

Hypertension and Its Related Factors in Taiwanese Elderly People

Shih-Wei Lai[a], Tsai-Chung Li[b], Cheng-Chieh Lin[a,d], Chee-Keong Tan[a], Kim-Choy Ng[c], Ming-May Lai[a], and Chiu-Shong Liu[a]

[a]Department of Community Medicine, China Medical College Hospital, Taichung, Taiwan; [b]Institute of Chinese Medicine, China Medical College, Taichung City, Taiwan; and *[c]Department of Emergency, China Medical College Hospital, Taichung City, Taiwan*

Background: Our study used data collected in Chung-Hsing Village in May 1998 to evaluate the prevalence of hypertension and its correlates in Taiwanese elderly people.

Methods: All of individuals aged 65 and over were recruited as study subjects. A total of 1093 persons, out of 1774 registered residents, were contacted by face-to-face interview. The response rate was 61.6 percent. However, only 586 respondents had blood tests and completed questionnaires. Analysis in this study was based on these 586 subjects. In order to study the significant correlates of hypertension, the t-test, chi-square analysis, and multivariate logistic regression were used.

Results: Our results showed that 66 percent were men and 34 percent were women. The mean age was 73.1 ± 5.3 years. The proportions of hypertension were 53.09 percent in men and 56.06 percent in women ($p > 0.05$). After controlling the other covariates, the multivariate logistic regression analysis showed that the significant related factors of hypertension were obesity (OR = 1.88, 95 percent CI = 1.06-3.34, $p < 0.05$) and renal function impairment (OR = 1.69, 95 percent CI = 1.02-2.80, $p < 0.05$).

Conclusions: The prevalence of hypertension was high in elderly people. Hypertension is significantly associated with obesity and renal function impairment in elderly people.

INTRODUCTION

Hypertension was identified as one risk factor for cardiovascular disease [1]. Patients treated with antihypertensive drugs could have a 38 percent decrease in cardiovascular mortality [2]. In Taiwan, cardiovascular disease is the third leading cause of death after neoplasm and cerebrovascular disease. Hypertension is the ninth leading cause of death [3]. Early detection and early intervention of hypertension seem to be the keypoint to the

[d] *To whom all correspondence should be addressed:* Cheng-Chieh Lin, Department of Community Medicine, China Medical College Hospital, No 2, Yuh-Der Road, Taichung City, 404, Taiwan. Tel.: 886-4-206-2121, Ext. 2292. Fax: 886-4-203-3986; E-mail: shihweil@ms2.hinet.net.
Received: April 10, 2000; Returned for revision: December 5, 2000; Accepted: January 20, 2001

reduction of morbidity and mortality of cerebrovascular disease and cardiovascular disease [4]. In NHANES study, the prevalence of hypertension was over 40 percent of people aged 65 to 74 years [5]. In Liau's report, the prevalence of hypertension in the aged people in Taiwan were 33.2 percent in men and 40.9 percent in women [6]. In Aronow's report, systolic or diastolic hypertension was a risk factor for new coronary events in elderly people [7]. The population aged ≥ 65 years has exceeded 7 percent in Taiwan since 1994, and a continued increase in numbers of elderly people is detected [8]. Up to now, there is little information about the association between hypertension and the cardiovascular risk factors or the sociodemographic factors in Taiwanese elderly people. As a result, health promotion and disease prevention recommendations in elderly people remain uncertain. Thus, it is time to pay attention to the health status of elderly people in this country.

For early detection of hypertension and early identification of its related factors, under conduction of comprehensive health survey studies in elderly people living in Chung-Hsing Village in Taiwan, the prevalence of hypertension and its related factors were investigated.

SUBJECTS AND METHODS

In May 1998, a cross-sectional study was conducted in Chung-Hsing Village in Taiwan. All individuals aged 65 and over were candidates for study, totally 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 percent. However, only 586 respondents had blood tests and completed questionnaires. Analysis in this study was based on these 586 subjects. Information about the subject's socioeconomic status, family structure, and educational level was collected using a structured questionnaire by well-trained interviewers in face-to-face interviews.

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 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 fasting. A number of biochemical markers, such as total cholesterol, triglyceride, fasting glucose, creatinine, and uric acid were analyzed by a biochemical autoanalyser (Chem1$^+$, Technicon, USA) at the Department of Clinical Laboratory of Chung-Hsing Hospital within four hours of collection.

Body mass index (BMI) was measured as follows: weight (kg) ÷ height $(m)^2$. BMI ≥ 28 was defined as obesity, 25 ≤ BMI < 28 as overweight, 20 ≤ BMI < 25 as normal and BMI < 20 as underweight [9]. Hypercholesterolemia was defined as total cholesterol ≥ 5.18 mmol/l and hypertriglyceridemia was defined as triglyceride ≥ 2.26 mmol/l [10]. Hyperglycemia was defined as fasting glucose ≥ 6.05 mmol/l [11]. Subjects were considered to have hypertension if the average of three readings exceeded 140 mmHg systolically and/or 90 mmHg diastolically or current therapy with antihypertensive drugs [12]. Hyperuricemia was defined as serum uric acid ≥ 416.5 μmol/l in men and ≥ 386.8 μmol/l in women [13]. Renal function impairment was defined as creatinine ≥ 132.6 μmol/l [14].

The statistical analysis was performed by the aid of a SAS package (Version 6.12, SAS Institute Inc., Cary, North Carolina).

The methods of statistical analysis were t-test, chi-square analysis, and multivariate logistic regression. Statistical significance was defined as p value less than 0.05.

RESULTS

Among 1093 subjects, 65.7 percent were men and 34.3 percent were women. The mean age was 73.5 ± 5.6 years. Our current study disclosed that 66 percent were men and 34 percent were women out of 586 subjects. 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 the respondent and the non-respondent. No significant difference was observed. Therefore, the potential non-response bias could be minimized. For those elderly people included in this current study, the mean systolic pressure was 131.29 ± 19.14 mmHg in men and 135.30 ± 24.98 mmHg in women ($p > 0.05$). The mean diastolic pressure was 79.39 ± 11.74 mmHg in men and 80.48 ± 12.76 mmHg in women ($p > 0.05$).

The results of chi-square analysis for hypertension among the cardiovascular risk factors and the sociodemographic factors were shown in Table 1. The proportions of hypertension were 53.09 percent in men and 56.06 percent in women ($p > 0.05$). The significant related factors of hypertension were obesity, hypertriglyceridemia, hyperglycemia, hyperuricemia, and renal function impairment.

The results of multivariate logistic regression for hypertension were shown in Table 2. After controlling the other covariates, the significant related factors of hypertension were obesity (odds ratio [OR] = 1.88, 95 percent confidence interval [CI] = 1.06-3.34, $p < 0.05$) and renal function impairment (OR = 1.69, 95 percent CI = 1.02-2.80, $p < 0.05$). That is, people with obesity were more likely to have hypertension than people with normal weight. People with renal function impairment were more likely to have hypertension than people with normal renal function. No significant association was found between hypertension and hypercholesterolemia, hypertriglyceridemia, hyperglycemia, or hyperuricemia.

DISCUSSION

Most of people living in Chung-Hsing Village moved to Taiwan from Mainland China after the civil war during their military service. Because most of them were male, the proportion of male in this sample was higher than that of female.

In the Western adult, their probability of being hypertensive (blood pressure greater than 140/90 mmHg) exceeded 50 percent when they reached age 70 [15], this finding was similar to our study. Therefore, the prevalence of hypertension was high in elderly people.

In previous reports, the prevalence of hypertension increased with age [15, 16]. However, no significant association was found between hypertension and age in our study. The real reason for the rise in blood pressure with age was not well established. It needed further evaluation. Our study revealed no significant difference of the prevalence of hypertension between gender in the univariate analysis, this finding was similar to Chou's study [17].

Hypertension, diabetes mellitus, obesity, hypercholesterolemia, hypertriglyceridemia, low serum HDL (high density lipoprotein) cholesterol, cigarette smoking, physical inactivity, increased age, prior cardiovascular disease, and left ventricular hypertrophy are risk factors for cardiovascular disease [1]. The greater the number of the cardiovascular risk factors, the higher the incidence of new cardiovascular events [1]. Clustering of hypertension, obesity, hyperglycemia, hyperlipidemia, and hyperuricemia was disclosed

Table 1. Correlates of hypertension in elderly people by chi-square analysis.

Variate	Total number	Hypertension number (%)	p value
Gender:			
Men	388	206 (53.09)	0.552
Women	198	111 (56.06)	
Age (years):			
65-69	167	88 (52.69)	0.696
70-74	190	109 (57.37)	
75-79	152	78 (51.32)	
≥ 80	73	40 (54.79)	
Body mass index ≥ 28 (kg/m^2):			
No	501	258 (51.50)	**0.020**
Yes	70	47 (67.14)	
Total cholesterol ≥ 5.18 (mmol/l):			
No	298	163 (54.70)	0.866
Yes	287	154 (53.66)	
Triglyceride ≥ 2.26 (mmol/l):			
No	456	235 (51.54)	**0.022**
Yes	126	80 (63.49)	
Fasting glucose ≥ 6.05 (mmol/l):			
No	466	238 (51.07)	**0.006**
Yes	119	78 (65.55)	
Uric acid (men ≥ 416.5; women ≥ 386.8 μmol/l):			
No	283	137 (48.41)	**0.010**
Yes	300	178 (59.33)	
Creatinine ≥ 132.6 (μmol/l):			
No	410	208 (50.73)	**0.016**
Yes	176	109 (61.93)	
Education level:			
Junior high school or less	165	85 (51.52)	0.944
Senior high school	152	77 (50.66)	
Professional training college	72	38 (52.78)	
Undergraduate or graduate	133	72 (54.14)	
Retirement status:			
Non-retired	151	87 (57.62)	0.361
Retired	435	230 (52.87)	
Marital status:			
Living together	426	222 (52.11)	0.156
Living alone	159	94 (59.12)	

in numerous studies [13, 18-23]. However, only obesity was associated with hypertension in multivariate logistic regression analysis in our study. This may be due to environmental and racial differences, but the real cause needs further investigation.

In our study, renal function impairment was also associated with hypertension in multivariate logistic regression analysis. Recent reports indicated that renal function damage could cause hypertension [24]. This could be explained by the mechanism that renal function impairment might lead to hemodynamic abnormality, which resulted in increased peripheral resistance and caused hypertension [15]. In the other hand, elevated blood pressure might cause renal damage [25,

Table 2. Results of multivariate logistic regression for hypertension in elderly people.

Variate	EP (SE)	OR	95% CI
Intercept	-0.18 (0.21)		
Body mass index (kg/m^2, normal as reference obesity:			
Obesity	0.63 (0.29)	1.88	**1.06-3.34**[a]
Total cholesterol (< 5.18 mmol/l as reference):			
≥ 5.18	-0.40 (0.23)	0.67	0.42-1.06
Triglyceride (<2.26 mmol/l as reference):			
≥ 2.26	0.42 (0.28)	1.52	0.87-2.65
Fasting glucose (< 6.05 mmol/l as reference):			
≥ 6.05	0.34 (0.30)	1.40	0.79-3.34
Uric acid (men < 416.5; women < 386.8 μmol/l as reference):			
≥ 416.5 (women ≥ 386.8 μmol/l)	0.14 (0.24)	1.15	0.72-1.84
Creatinine (< 132.6 μmol/l as reference):			
≥ 132.6	0.52 (0.26)	1.69	**1.02-2.80**[a]

[a] $p < 0.05$
CI, Confidence interval
EP, Estimated parameter
SE, Standard error
OR, Odds ratio

26]. The kidney was one of the target organs affected by hypertension [27]. The available evidence suggested that the control of blood pressure was critical to the preservation of renal function [28]. However, further studies are needed on the mechanisms of renal function impairment in hypertension and on how to preserve renal function in hypertension.

In conclusion, the prevalence of hypertension was high in elderly people. Hypertension is significantly associated with obesity and renal function impairment in elderly people.

REFERENCES

1. Aronow, W.S. Cardiac risk factors: still important in the elderly. Geriatrics 45:71-74, 79-80, 1990.
2. Amery, A., Birkenhager, W., Brixko, P., Bulpitt, C., Clement, D., Deruyttere, M., De Schaepdryver, A., Dollery, C., Fagard, R., and Forette, F. Mortality and morbidity results from the European working party on high blood pressure in the elderly trial. Lancet 1:1349-1354, 1985.
3. Department of Health, Taiwan: General health statistics. 1999.
4. Tseng, W.P. Outcome of untreated hypertensives in an agricultural population, A 15-year follow-up study. J. Formosan. Med. Assoc. 79:556-563, 1980.
5. Drizd, T., Dannenberg, A.L., and Engel, A. Blood pressure levels in persons 18-74 years of age in 1976-80, and trends in blood pressure from 1960 to 1980 in the United States. Vital Health Stat. 11 234:1-68, 1986.
6. Liau, C.S., Tseng, Y.Z., and Lee, T.K. Prevalence of cardiovascular diseases in elderly Chinese in Taiwan. Int. J. Cardiol. 67:177-181, 1998.
7. Aronow, W.S., Herzig, A.H., Etienne, F., D'Alba, P., and Ronquillo, J. 41-month follow-up of risk factors correlated with new coronary events in 708 elderly patients. J. Am. Geriatr. Soc. 37:501-506, 1989.
8. National Health Administration, Taiwan: Health statistics. I. Vital statistics. 1971-1996.
9. Huang, P.C., Yu, S.L., Lin, Y.M., and Chu, C.L. Body weight of Chinese adults by sex, age and body height and criterion of obesity based on body mass index. J. Chin. Nutr. Soc. 17:157-172, 1992.
10. National Cholesterol Education Program: Report of the expert panel on detection, evaluation, and treatment of high blood cholesterol in adults. JAMA 269:3015-3023, 1993.

11. The expert committee on the diagnosis and classification of diabetes mellitus: report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care 23:4-19, 2000.
12. Subcommittee of WHO/ISH Mild Hypertension Liaison Committee: Summary of 1993 World Health Organisation International Society Hypertension guidelines for the management of mild hypertension. Br. Med. J. 307:1541-1546, 1993.
13. Saggiani, F., Pilati, S., Targher, G., Branzi, P., Muggeo, M., and Bonora, E. Serum uric acid and related factors in 500 hospitalized subjects. Metabolism 45:1557-1561, 1996.
14. Chou, C.T. and Lai, J.S. The epidemiology of hyperuricemia and gout in Taiwan aborigines. Br. J. Rheumatol. 37:258-262, 1998.
15. McNeil, J.J. and Silagy, C.A. Hypertension in the elderly: epidemiology and pathophysiology. Cardiovasc. Drugs Ther. 4(suppl. 6):1197-1201, 1991.
16. Omar, M.A., Seedat, M.A., Dyer, R.B., and Motala, A.A. Diabetes and hypertension in South African Indians. A community study. S. Afr. Med. J. 73:635-637, 1988.
17. Chou, P., Chen, C.H., Chiu, C.F., and Chang, M.S. Community-based epidemiological study on hypertension in Pu-Li, Taiwan. Am. J. Hypertens. 5:608-615, 1992.
18. Chen, T.J. and Yu, B.T. Report on survey of serum glucose, cholesterol, uric acid and creatinine vales in adults of Taipei city. J. Nephrol. ROC 9:109-118, 1995.
19. Rodriguez, B.L., Curb, J.D., Burchfiel, C.M., Huang, B., Sharp, D.S., Lu, G.Y., Fujimoto, W., and Yano, K. Impaired glucose tolerance, diabetes, and cardiovascular disease risk factor profiles in the elderly: the Honolulu Heart Program. Diabet. Care 19:587-590, 1996.
20. Woo, J., Swaminathan, R., Cockram, C., Lau, E., and Chan, A. Association between serum uric acid and some cardiovascular risk factors in a Chinese population. Postgrad. Med. J. 70:486-491, 1994.
21. Agamah, E.S., Srinivasan, S.R., Webber, L.S., and Berenson, G.S. Serum uric acid and its relation to cardiovascular disease risk factors in children and young adults from a biracial community: the Bogalusa heart study. J. Lab. Clin. Med. 118:241-249, 1991.
22. Lin, C.C., Li, T.C., Lai, S.W., Ng, K.C., Wang, K.C., and Liu, C.S. Hypertriglyceridemia and the related factors in middle-aged adults in Taiwan. Mid. Taiwan J. Med. 6:1-6, 2001.
23. Ng, K.C., Lin, C.C., Lai, S.W., Li, T.C., Li, C.I., Lai, M.M., Chen, W.K., and Liu, C.S. Obesity and the related factors in middle-aged adults in Chung-Hsing Village in Taiwan. Mid. Taiwan J. Med. 6:35-39, 2001.
24. Ruilope, L.M., Campo, C., and Rodicio, J.L. Relationship between blood pressure and renal function. J. Hypertens. Suppl. 12: 55-9, 1994.
25. Perneger, T.V. and Whelton, P.K. The epidemiology of hypertension-related renal disease. Curr. Opin. Nephrol. Hypertens. 2:395-403, 1993.
26. Rosansky, S.J., Hoover, D.R., King, L., and Gibson, J. The association of blood pressure levels and change in renal function in hypertensive and nonhypertensive subjects. Arch. Intern. Med. 150:2073-2076, 1990.
27. Klahr, S. The kidney in hypertension: villain and victim. N. Engl. J. Med. 320:731-733, 1989.
28. Bakris, G.L. Hypertension in diabetic patients. An overview of interventional studies to preserve renal function. Am. J. Hypertens. 6:140-147, 1993.