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Obesity, Biochemical Indices and Nutrient Intakes in Hypertensive Type Ⅱ Diabetes Mellitus

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Abstract

This study was conducted to find obesity, biochemical indices and nutrient intakes in type Ⅱ diabetes mellitus with hypertension in Gwangju area. Subjects were divided into two groups based on the status of hypertension. Duration of 139 normotensive type Ⅱ diabetes mellitus was 49.8±80.2 months while that of hypertensive type Ⅱ diabetes was 79.7±95.5 months. Anthropometric measurement revealed that subjects in both groups were in overweight determined by BMI, though there was no significant difference between two groups. Contrastingly, obesity rate and subscapular fat distribution were a good predictor to identify hypertensive group due to the significant differences between two groups, regardless of sex. Hypertensive type Ⅱ diabetes mellitus is significantly associated with more elevated cholesterol and fasting blood glucose level. Triglyceride level in the hypertensive female was prominent. Significant gender differences were shown in energy, carbohydrate, protein, Ca, Zn, vitamin B_6 and cholesterol intakes. Nutrient intakes of female normotensive group were higher than those of female hypertensive group except for riboflavin. However, different pattern on nutrient intakes in male was noted. Thus, sex is a great determinant to influence nutrient intakes in subject. Effective nutrition education program targeting type Ⅱ diabetes mellitus, especially hypertensive type Ⅱ diabetes mellitus should be developed and implemented to control blood glucose and lipidemia. It might be suggested to consider the importance different approaches of nutrition education program to both genders.

Key words: obesity, biochemical indices, nutrient intakes, hypertensive type Ⅱ diabetes mellitus

INTRODUCTION

Diabetes mellitus is a chronic disorder due to an absolute deficiency of insulin or ineffective insulin. It afflicts 151 million person in the world and is emerging as a major health problem throughout the world (1). In Korea, the prevalence of diabetes has increased dramatically these days with the economic growth and westernization of lifestyle and it ranks fifth among the leading causes of death (2). It is likely that the number of diabetics will increase substantially and may exceed 7.2 million by 2030 (3).

The predominant type of diabetes is type Ⅱ diabetes mellitus. It accounts for 85 to 90% of diabetics (4). This type usually develops in the middle-aged and overweight individual. Environmental factors contributing to development of type Ⅱ diabetes mellitus are obesity, especially body fat in abdominal fat, lack of physical activity, high fat, low fiber diets and aging (5-8).

Due to exposure of the tissues to high glucose concentration, people with diabetes often result in the chronic complications of diabetes, such as vascular, renal and neuropathic disease leading to premature disability and death (8-13). In Korea the prevalence of hypertension is twice in diabetes compared to normal population (14). Since hypertension is the major risk factors for coronary heart disease in type Ⅱ diabetes mellitus, special attention should be given to hypertensive type Ⅱ diabetes mellitus.

Despite the importance of dietary intake and nutritional factors of hypertensive type Ⅱ diabetes mellitus, the research to assess this area has not been extensively done and little is known about the current situation on nutrition related factors of hypertensive type Ⅱ diabetes mellitus. This study was done to find obesity, biochemical indices and nutrient intakes in hypertensive type Ⅱ diabetes mellitus compared to normotensive type Ⅱ diabetes mellitus. Findings from this study will help to identify characteristics of nutrition related problems of hypertensive type Ⅱ diabetes mellitus, which may contribute to limit the development of complication of hypertension in the diabetic patients.

MATERIALS AND METHODS

Subjects

Subjects were 139 diabetics (diabetic: FBG≥140 mg/dL) who were hospitalized in Gwangju. Subjects

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were asked to fill out the structured survey forms on demographic information, data on food habits and health related factors with the help of trained interviewers. Subjects were divided into two groups based on the status of hypertension, due to the critical public health concern of complication in type Ⅱ diabetes mellitus (15).

Anthropometric and blood pressure measurements

Investigators measured the height, weight and body fat by bioelectrical impedence analyzer (TBF-501, Tanita, Japan). Waist circumference was measured at the most narrow area below the rib cage and above the umbilicus using an inelastic and flexible tape. Measurements of the triceps and subscapular skinfold site were done using digital calipers (SKINDEX, USA). Blood pressure was measured twice after 2 minutes of rest by automatic blood pressure analyzer (FT-500R/L, Jawon Medical, Korea).

Biochemical analyses

Venous blood samples were obtained during fasting and analyzed by an automatic blood analyzer ADVTA 120, USA) for levels of fasting blood glucose, cholesterol, triglyceride. Concentrations of calcium, sodium and potassium were analyzed by an automatic analyzer SPOTCHEM^{TM} EL, SE-1520, Japan).

Nutrient intakes

Dietary data were obtained by 24-hour dietary recall. With the aid of food model and pictures, the trained interviewers filled out the information on food consumption. Nutrient intake analysis was done with the CAN 2.0 program (16) and compared with Dietary Reference Intakes for Koreans (17).

Statistical analysis

All statistical analyses were performed using SPSS 12.0 programs. In order to establish pairwise comparison between experimental and control groups, ANOVA was used. Furthermore, Scheffe's multiple range test was conducted to support the obtained results. X^2-test were employed to find the effects of gender on objective variables. A probability value of 0.05 was chosen as the level of significance.

RESULTS AND DISCUSSION

General characteristics

General characteristics of 139 diabetics are presented in Table 1. Sample consisted of 68 men and 71 women. Hypertensive type Ⅱ diabetes mellitus are 42.9% of type Ⅱ diabetes mellitus in male and 57.1% of type Ⅱ diabetes mellitus in female. Among them 30% were 60～69 years and 28.6% were 50～59 years. Mean ages of normotensive type Ⅱ diabetes mellitus in male and female are 59.5, 65.1 years respectively while those of hypertensive type Ⅱ diabetes mellitus in male and female are 57.9 and 62.2 years respectively. This finding indicated that age itself is one of risk factors in type Ⅱ diabetes mellitus, which is agreeable to other findings (18-20). Family history was not one of the strongest risk factors for development of hypertension to half of the subjects in the study. Duration of normal type Ⅱ diabetes mellitus is 49.8±80.2 months while that of hypertensive diabetics is 79.7±95.5 months. Thus, hypertensive diabetics has longer duration of disease than normotensive diabetics.

Obesity and biochemical indices

The mean systolic blood pressure and diastolic blood pressure for both groups are given in Table 2. Mean systolic blood pressures (SBP) of male and female in

Table 1. General characteristics of subjects by blood pressure and gender N (%)

		Blood pressure[1)]				X^2
		Normal		Hypertension		
		Male	Female	Male	Female	
Age (yr.)	<50	11 (29.0)	2 (6.2)	5 (17.2)	5 (12.5)	17.776*
	50～59	16 (42.1)	6 (18.8)	6 (20.7)	12 (30.0)	
	60～69	4 (10.5)	12 (37.5)	8 (27.6)	10 (25.0)	
	≥70	7 (18.4)	12 (37.5)	10 (34.5)	13 (32.5)	
Duration of diabetes	<1	8 (21.1)	7 (21.9)	4 (13.8)	8 (20.0)	16.974
	1～5	9 (23.7)	4 (12.5)	5 (17.2)	11 (27.5)	
	5～10	9 (23.7)	4 (12.5)	5 (17.2)	3 (7.5)	
	10～15	3 (7.9)	9 (28.1)	3 (10.3)	11 (27.5)	
	≥15	9 (23.7)	8 (25.0)	12 (41.4)	7 (17.5)	
Family history	Never	34 (89.5)	22 (68.8)	15 (51.7)	24 (60.0)	16.501
	Father	2 (5.3)	3 (9.4)	7 (24.1)	6 (15.0)	
	Mother	1 (2.6)	1 (3.1)	3 (10.3)	2 (5.0)	
	Brother/sister	1 (2.6)	6 (18.8)	4 (13.8)	8 (20.0)	

[1)]Normal: SBP<140 mmHg, DBP<90 mmHg, Hypertension: SBP≥140 mmHg, DBP≥90 mmHg. *p<0.05

Table 2. Association of obesity indices by blood pressure and gender Mean±SD

	Blood pressure				F
	Normal		Hypertension		
	Male	Female	Male	Female	
SBP (mmHg)[1)]	117.5±11.8[a]	118.4±10.8[a]	150.3±12.7[b]	148.5±16.4[b]	64.652***
DBP (mmHg)[2)]	74.3±8.4[a]	75.2±8.5[a]	91.6±7.5[b]	90.1±7.2[b]	47.891***
TSF (mm)[3)]	13.9±6.7[a]	19.1±4.7[b]	13.3±5.4[a]	21.5±7.4[b]	14.085***
SSF (mm)[4)]	16.1±5.3[a]	18.2±4.0[b]	16.2±6.6[a]	23.7±8.6[b]	11.242***
Body fat (%)	20.3±6.5[a]	28.3±7.3[b]	19.7±8.4[a]	32.7±8.8[b]	23.228***
Obesity rate (%)[5)]	105.2±14.1[a]	110.4±15.4[ab]	106.4±16.2[a]	118.2±17.7[b]	4.745**
BMI (kg/m^2)[6)]	23.3±3.1	23.2±3.3	23.4±3.5	24.8±3.7	2.121

[a,b]Different superscripts are significantly different in the same row at **$p<0.01$, ***$p<0.001$ by Scheffe's multiple range test.
[1)]SBP: Systolic blood pressure. [2)]DBP: Diastolic blood pressure.
[3)]TSF: Triceps skinfold thickness. [4)]SSF: Subscapular skinfold thickness.
[5)]Obesity rate: {(Actual weight (kg) − Standard weight (kg) / Standard weight (kg)}, Standard weight (kg) = {Height (cm) − 100}×0.9
[6)]BMI: Body mass index = weight (kg) / height (m)^2

normal type Ⅱ diabetes mellitus were 117.5±11.8 and 118.4±10.8 mmHg respectively while SBP in male and female in hypertensive group were 150.3±12.7, 148.5±16.4 mmHg respectively. Mean diastolic blood pressure of male and female in normal type Ⅱ diabetes mellitus were 74.3±8.4, 75.2±8.5 mmHg respectively while DBP of male and female in hypertension group were 91.6±7.5, 90.1±7.2 mmHg.

Obesity is one of the major factors closely associated with liability both to diabetes and hypertension. It is known obesity aggravates insulin resistance as body fat increases and body tissues become less able to respond to insulin (4). In this study obesity is a contributor to development and maintenance of the diabetic state which is consistent with other findings (7,20). There are different parameters to measure obesity. Body mass index (BMI) has been known to be highly correlated with estimates of body fatness. Due to its convenience and reliability, BMI is the most widely used height-weight index (21,22). In this study mean BMI of subjects is over 23 in both hypertensive type Ⅱ diabetes mellitus and normotensive type Ⅱ diabetes mellitus. This result is agreeable to Moon's finding that incidence of diabetes and hypertension in Korea has been closely associated with over 23 of BMI (23). With BMI, both groups are overweight regardless of sex. Even though the hypertensive group tended to have more weight than normotensive group by BMI, there was no significant difference between two groups. When obesity rate was used, there was significant difference between two groups. Thus, there was a big discrepancy depending on what parameters to measure obesity in the study.

Results of triceps skinfold thickness and body fat determined by biochemical impedence analyser showed significantly higher in normotensive male type Ⅱ diabetes mellitus and in hypertensive female type Ⅱ diabetes mellitus group compared to their matched counterparts. Thus, there was a gender difference in fat distribution in subjects. However, when we measured subscapular fat, the higher subscapular fat was observed in the hypertensive groups regardless of sex. This may indicate the measurements of obesity rate and subscapular fat distribution among many different obesity indices were more reliable to identify hypertensive groups. This result is consistent regardless of sex.

Table 3 shows biochemical indices of subjects by blood pressure and gender. The higher fasting blood glucose and cholesterol level were observed in the hypertensive group. In this study tissue exposure to higher glucose concentrations over time resulted in chronic complications of diabetes which is agreeable to other findings (10,11). These differences were significant in both sexes. However, HbAIC was not statistically significantly different between two groups in spite of higher concentration in the hypertensive group. Furthermore, concentrations of Na^+, K^+, Cl^- were not different in groups.

Gender difference was shown in the triglyceride level. Interestingly triglyceride level in the hypertensive female was prominent. It was reported that high carbohydrate consumption in Koreans was associated with hypertriglyceridemia (24). This result was contradictory to ours, since carbohydrate consumption in female was not noted in the study. Different response in triglyceride level by gender should be further investigated.

Nutrient intakes

Nutrient intakes by blood pressure and gender were compared and shown in Table 4. Significant gender differences by %RI and %EER were shown in energy, carbohydrate, protein, calcium, zinc, vitamin B_6 and cholesterol intakes. In female, nutrient intakes of normotensive

Table 3. Biochemical indices of subjects by blood pressure and gender Mean±SD

	Blood pressure				F
	Normal		Hypertension		
	Male	Female	Male	Female	
FBG[1] (mg/dL)	190.2±31.1[a]	89.3±36.5[a]	259.2±63.2[b]	252.9±65.4[b]	17.967***
Cholesterol (mg/dL)	151.8±41.3[a]	172.6±36.6[a]	167.0±46.2[a]	200.5±46.4[b]	7.550***
Triglyceride (mg/dL)	147.0±142.4	147.1±84.8	132.8±62.9	192.5±126.0	1.609
Sodium (mEq/L)	140.3±4.4	141.2±4.3	140.5±3.2	141.3±3.9	0.423
Potassium (mEq/L)	4.3±0.6	4.2±0.7	4.3±0.9	4.3±0.7	1.375
Chloride (mEq/L)	103.1±18.5	109.1±19.0	107.4±4.6	106.0±5.0	1.058
HbAlc[2] (%)	7.8±2.7	7.8±2.2	8.4±1.8	7.9±1.8	0.203

[a,b]Different superscripts are significantly different in the same row at **p<0.01, ***p<0.001 by Scheffe's multiple range test. [1]FBG: Fasting blood glucose. [2]HbAlc: Glycoylated hemoglobin.

group were higher than those of hypertensive group except for riboflavin. Contrastingly nutrient intakes of male hypertensive group were higher than those of normotensive group except for vitamin B_6. Thus, there was a gender difference in nutrient intakes in both groups. Evidently higher consumption of most nutrients in hypertensive male diabetics and normotensive female diabetics were noted. In the study we did not find out the reason for different food consumption pattern in different genders. In the future study more research will be done to elucidate the role of gender in food consumption pattern in diabetics.

Ratios of carbohydrate, protein and fat in energy by blood pressure and gender are shown in Table 5. Energy ratios of carbohydrate : protein : fat were 60.5:17.8:21.7 in male and 59.8:18.5:21.7 in female normotensive subjects. On the other hand, energy ratios of carbohydrate : protein : fat were 59.3:18.7:21.9 in male and 59.5: 18.7:21.8 in female hypertensive groups.

There were no significant differences in terms of en-

Table 4. Nutrient intakes by blood pressure and gender Mean±SD

	Blood pressure				F
	Normal		Hypertension		
	Male	Female	Male	Female	
Energy (kcal)	1902.4±114.5[a]	1697.5±179.4[b]	1870.7±194.5[a]	1645.6±259.4[b]	10.368***
	(92.0)[1]	(99.3)	(96.2)	(95.1)	(1.943)
Protein (g)	85.5±8.2	79.3±10.9	87.8±9.0	78.6±17.2	2.991*
	(90.1)[2a]	(175.5)[b]	(97.7)[a]	(173.1)[b]	(117.057)***
Fat (g)	46.4±9.5	41.5±10.0	45.9±9.1	40.6±10.0	2.338
Cholesterol (mg)	315.4±109.4[ab]	288.7±79.4[ab]	364.1±119.5[a]	272.9±109.7[b]	2.941*
Carbohydrate (g)	290.0±26.4[a]	256.5±32.0[b]	278.9±35.4[a]	245.5±38.3[b]	9.745***
Calcium (mg)	824.7±139.5	735.2±173.4	862.7±170.9	761.4±243.9	1.978
	(115.9)[a]	(173.1)[b]	(128.9)[a]	(167.1)[b]	(25.752)***
Iron (mg)	16.9±3.6	16.4±3.6	16.9±2.9	15.6±4.2	0.680
	(171.1)	(169.2)	(174.6)	(163.6)	(0.456)
Sodium (mg)	5718.1±981.8	5540.9±1118.3	5875.9±926.2	5523.5±1103.2	0.743
Potassium (mg)	3527.6±499.2[ab]	3255.9±639.8[ab]	3630.0±571.0[a]	3226.2±606.8[b]	3.643*
Zinc (mg)	11.1±3.0	12.4±7.9	12.9±6.6	10.3±4.3	1.403
	(128.4)[ab]	(117.8)[ab]	(153.3)[b]	(82.9)[a]	(3.508)*
Vitamin A (R.E)	1159.7±445.6	1138.3±538.8	1114.9±222.5	1076.5±461.4	0.175
	(179.5)	(191.2)	(185.4)	(181.4)	(0.150)
Thiamin (mg)	1.3±0.1[ab]	1.2±0.2[ab]	1.3±0.2[a]	1.1±0.3[b]	3.374*
	(103.8)	(108.9)	(115.6)	(104.5)	(2.491)
Riboflavin (mg)	1.4±0.2	1.3±0.2	1.5±0.2	1.3±0.4	2.741*
	(96.0)	(105.7)	(102.5)	(107.7)	(2.116)
Vitamin B_6 (mg)	2.5±0.4[a]	2.1±0.4[b]	2.5±0.5[a]	2.2±0.5[ab]	6.728***
	(166.9)[a]	(95.1)[b]	(164.9)[a]	(96.0)[b]	(63.513)***
Niacin (mg)	18.3±2.5	17.5±3.6	19.0±2.2	17.2±4.7	1.099
Vitamin C (mg)	127.8±44.8	137.2±56.2	129.4±52.5	112.2±51.4	1.158
	(124.8)	(133.0)	(128.6)	(115.4)	(0.924)

[1]%EER (Estimated Energy Requirement). [2]%RI (Recommended Intake). [a,b]Different superscripts are significantly different in the same row at *p<0.05, **p<0.01, ***p<0.001 by Scheffe's multiple range test.

Table 5. Ratio of carbohydrate, protein and fat in energy by blood pressure and gender Mean

	Blood pressure				F
	Normal		Hypertension		
	Male	Female	Male	Female	
Protein (%)	17.8[1)]	18.5	18.7	18.7	1.248
Fat (%)	21.7	21.7	21.9	21.8	0.012
Carbohydrate (%)	60.5	59.8	59.3	59.5	0.203

[1)]Percentage of total intake.

Table 6. Dietary source of food by blood pressure and gender Mean

		Blood pressure				F
		Normal		Hypertension		
		Male	Female	Male	Female	
Protein (%)	Plant source	47.7[1)]	47.6	43.8	48.5	1.050
	Animal source	52.3	52.4	56.2	51.5	
Fat (%)	Plant source	43.1	47.3	39.7	46.8	1.382
	Animal source	56.9	52.7	60.3	53.2	
Calcium (%)	Plant source	46.1	50.7	44.7	50.1	1.175
	Animal source	53.9	49.3	55.3	49.9	
Iron (%)	Plant source	71.3	69.8	67.5	69.7	0.532
	Animal source	28.7	30.2	32.5	30.3	

[1)]Percentage of total intake.

ergy ratios between normotensive and hypertensive type Ⅱ diabetes mellitus. However, subjects in the study tended to consume more carbohydrate and less protein when compared to the recommended level as an ideal ratio of energy contributing nutrients for Koreans (17). This ratio of energy is similar to the recommended level for diabetics in Korea (24).

Table 6 presents dietary sources of food. Compared to males, female subjects consumed more plant food than animal one as their dietary source except for iron in each group. It is clear that there are gender differences in food preference and consumption. Similar results were reported in other studies (25,26). Different approaches to nutrition education in both genders might be considered.

In this study diabetic subjects were overweight determined by BMI regardless of hypertension status in type Ⅱ diabetes mellitus. However, hypertensive type Ⅱ diabetes mellitus showed more severe in obesity than normotensive type Ⅱ diabetes mellitus. This may indicate that obesity rate and subscapular fat distribution were more sensitive to distinguish hypertensive type Ⅱ diabetes mellitus from normotensive type Ⅱ diabetes mellitus. Though BMI has been extensively used as a diagnostic tool to determine obesity because of its convenience, more research on reliable and sensitive method to determine obesity for the patients might be further suggested. In addition to obesity, hypertensive group has more elevated fasting blood glucose and cholesterol level than normotensive one.

Even though risk factors of type Ⅱ diabetes mellitus are interrelated, obesity, especially fat distribution, glycemic and blood lipid control were much more poorer in the hypertensive type Ⅱ diabetes mellitus compared to normotensive type Ⅱ diabetes mellitus, in the study. Thus it is suggested that correction of obesity and glycemic control should be strongly emphasized and educated to type Ⅱ diabetes mellitus especially to the hypertensive type Ⅱ diabetes mellitus.

In the study, sex is a great determinant to influence nutrient intakes and triglyceride level in the blood. Different approach to nutrition education by gender should be developed and implemented.

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