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Effect of High Carbohydrate Intakes on the Obesity Index, Blood Pressure, and Blood Lipid Levels in Patients with Cardiovascular Disease*

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ABSTRACT

This study was designed to investigate the effect of the ratio of energy from carbohydrate to total calories on dietary intake, obesity index, blood pressure, and blood lipid content in cardiovascular disease patients over 35 years old. A total of 552(227 male, 325 female) subjects were divided into three groups according to carbohydrate/total energy ratio : carbohydrate ratios below 25 percent were in the low carbohydrate group(<61.1%), between 25 and 75 percent carbohydrate were medium(≥61.1 – <74.7%), and higher than 75 percent were in the high carbohydrate group(≥74.7%). The anthropometric data, nutrient intake, serum lipid levels, and blood pressure of each group were compared with one another. For men and women with high carbohydrate intakes, inadequate nutritional intake was observed. Abdominal fat accumulation and blood TC level for men in the high carbohydrate group were higher than in medium or low carbohydrate groups. Therefore, it seems that high carbohydrate intake may produce adverse effects on abdominal fat accumulation and blood lipid patterns. Blood pressure, however, was significantly higher for women in low and high carbohydrate groups than in medium carbohydrate group. These results suggest that extremely high and low carbohydrate intake may raise the risk of cardiovascular disease and that it is necessary to consume nutritionally balanced meals. This can be done by controlling the ratio of dietary carbohydrate at a medium level in order to prevent and/or to reduce the risk. (*Korean J Nutrition* 30(4) : 451~457, 1997)

KEY WORDS : carbohydrate ratio · cardiovascular disease · blood pressure · obesity index · blood lipids.

Introduction

Disease patterns in Korea have changed in recent years. According to national annual death report statistics, infectious diseases, diseases of the digestive system, and tuberculosis were the major causes of the death until 1970[1-3]. Today, cardiovascular disease(CVD) has become the main cause of death in Korea, representing 29.9% of all deaths in 1990[4].

The risk factors for cardiovascular disease are known to be high blood pressure, obesity, heredity, and dietary consumption pattern[5-7]. Many research studies have shown that high lipid intake increases cardiovascular disease[8-9]. However, in the cases of Koreans and Japanese, high dietary carbohydrate ratios are known to be related to cardiovascular disease[10-12]. In Korea, it was observed that blood lipid concentrations tend to increase more with high dietary carbohydrate

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ratios than with high lipid ratios.

Therefore, the present study was performed to investigate whether or not dietary carbohydrate ratios are related to various risk factors in cardiovascular patients.

Subjects and Methods

The subjects in this study were 552 outpatients with cardiovascular disease who were given medical treatment. They were selected from three general hospitals in Seoul. Of these, 227 patients were male and 325 were female. The average age of the patients was 58.2(Table 1).

The data for anthropometric measurement, dietary intake, obesity index, blood lipid levels, and blood pressure in 552(227 male, 325 female) patients was obtained between June 1991 to August 1992.

The diets were examined by 24-hour recall method and the amount of nutrient intake was calculated by the food composition table[13]. Then the subjects were divided into three groups according to dietary carbohydrate ratio : low carbohydrate group below 25 percent, medium between 25 and 75 percent, and high carbohydrate group over 75 percent(Table 1).

There were 78 male and 60 female subjects in the low carbohydrate group, 115 men and 162 women in the medium carbohydrate group, and 34 men and 103 women in the high carbohydrate group. The ratios of energy nutrients in the low carbohydrate group were 54% carbohydrate, 25% fat, and 21% protein. Those in the medium carbohydrate group were 69% carbohydrate, 16% fat, and 15% protein. The diet for the high carbohydrate group was 80% carbohydrate, 9% fat, and 12% protein, respectively(Table 1).

The anthropometric data, serum lipid levels, and blood pressure of each group was compared with one another. In the blood lipids and blood pressure data, past values were obtained when the subject had first visited the hospital. Present data was the values measured on the day when the patients were interviewed.

Statistical analysis was done by using the Statistical Analysis System(SAS). Data was expressed as the mean ±standard deviation, and analyzed statistically by Duncan's multiple-range test and multiple regression.

Results

1. General features of subjects

Mean age of male subjects was 57.4 years and that of the female subjects was 58.7 years(Table 1). There was no significant difference in age among the three groups.

Table 2 shows general characteristics of all subjects. The majority of the men were college and high school graduates, and most of the women were high school and elementary school graduates. The majority of the male patients were engaged in sales jobs, office work, and administrative positions, in that order. 82.2% of the women were housewives. The average monthly family income of the majority ranged between 510,000 - 2,000,000 Won, a middle income level according to the Korean statistics for 1991[14]. Subjects who exercise regularly were 62.1% of the men and 37.5% of the women.

Table 1. The ratio of energy nutrients to total energy intake in low, medium, and high carbohydrate groups

Group		Low CHO[1)]	Medium CHO[2)]	High CHO[3)]	Total
Ratio of CHO to total energy (%)		<61.1	≥61.1 - <74.7	≥74.7	
Number of Subjects	Men	78	115	34	227
	Women	60	162	103	325
	Total	138	277	137	552
Average rate of energy nutrient(%)	Carbohydrate	53.8± 6.2^{c}	68.5±3.8^{b}	79.6±3.4^{a}	67.0±10.1
	Fat	25.4± 5.4^{a}	16.1±3.6^{b}	8.5±2.7^{c}	16.9± 7.1
	Protein	20.8± 5.3^{a}	15.4±3.1^{b}	11.9±2.1^{c}	16.1± 4.8
Age(yr)	Men	56.3±10.8*^{a}	57.9±9.7^{a}	59.2±9.8^{a}	57.4±10.2
	Women	59.2± 8.9^{a}	59.2±8.4^{a}	57.7±8.7^{a}	58.7± 8.6
	Total	57.7±10.2^{a}	58.5±9.0^{a}	58.0±8.9^{a}	58.2± 9.3

*Mean±SD : Values with different superscripts in the same row are significantly different at $p<0.05$ by Duncan's multiple test.

1) <25th percentile of the rate of CHO energy to total energy of the total subjects

2) ≥25th percentile - <75 percentile

3) ≤75th percentile

Table 2. General characteristics of subjects

Variables	Men (n=227)	Women (n=325)
Age(yr)		
30 - 39	14(6.2)	4(1.2)
40 - 49	30(13.2)	44(13.6)
50 - 59	81(35.7)	125(38.5)
60 - 69	78 (34.4)	122(37.5)
70≤	24(10.6)	30(9.2)
No response	0(0)	0(0)
Total	227(100.0)	325(100.0)
Education(year)		
No school	2(0.9)	20(6.2)
Primary school	22(9.7)	111(34.2)
Middle/high school	92(40.5)	156(48.0)
College	98(43.2)	31(9.5)
Graduate school	12(5.3)	3(0.9)
No response	1(0.4)	4(1.2)
Total	227(100.0)	325(100.0)
Occupation		
Simple laborer	10(4.4)	4(1.2)
Service worker	18(7.9)	14(4.3)
Salesman	48(21.1)	21(6.5)
Office worker	44(19.4)	4(1.2)
Public officer	36(15.9)	3(0.9)
Professional	17(7.5)	11(3.4)
Other(Housewife, Student)	43(18.9)	267(82.2)
No response	11(4.9)	1(0.3)
Total	227(100.0)	325(100.0)
Family income(10,000won)		
≤50	23(10.1)	40(12.3)
51 - 100	46(20.3)	103(31.7)
101 - 150	46 (20.3)	65(20.0)
151 - 200	36(15.9)	48(14.8)
201 - 300	25(11.0)	32(9.8)
300≤	43(18.9)	19(5.9)
No response	8(3.5)	18(5.5)
Total	227(100.0)	325(100.0)
Exercise		
Almost no exercise	84(37.0)	197(60.6)
Light(Walking..)	80(35.2)	95(29.2)
Moderate(Jogging, Biking, Mountain-climbing, Swimming, Tennis..)	61(26.9)	27(8.3)
No response	2(0.9)	6(1.9)
Total	227(100.0)	325(100.0)

2. Anthropometric data

The relationship between carbohydrate ratios and anthropometric measurements is shown in Table 3-1 and Table 3-2.

It was observed that men in the high carbohydrate group was shorter and had a significantly higher waist/hip ratio than men in the low or medium carbohydrate groups. It was shown that men in high carbohydrate group tended to have more fat accumulation around the waist.

No parameters were shown to be significantly different among the groups of women in this study.

3. Nutrient intake

Significant differences in nutrient intakes were observed among different carbohydrate groups(Table 4-1, Table 4-2).

In both men and women, the high carbohydrate groups consumed less protein, fat, Ca, P, Fe, thiamin, riboflavin and niacin($p<0.05$) than the medium and low carbohydrate groups did. Of these nutrients, protein, Ca, thiamin, and riboflavin were below the RDA [15] for their age group.

Multiple regression analysis showed that the most significant explanatory variables for carbohydrate ratio were fat, carbohydrate, and protein in that order(Table 4-3, Table 4-4).

4. Blood lipids

Blood lipid levels for men and women are summarized in Table 5-1 and Table 5-2. In men, the total serum cholesterol level at first diagnosis was significantly higher in the high carbohydrate group than in the low carbohydrate group. No parameters were shown to be significantly different among the groups of women.

5. Blood pressure

Blood pressures for men were not significantly different among the three groups(Table 6-1). However, significant differences in blood pressure among the different carbohydrate groups were observed in women. The past and present diastolic blood pressures for the medium carbohydrate group were significantly lower than the values for the low or high carbohydrate groups(Table 6-2). The present systolic blood pressure was also lowest in the medium carbohydrate group. It could be summarized that in women, medium carbohydrate groups tended to have lower blood pressures than the high or low carbohydrate groups.

Table 3-1. Anthropometric data for men

Anthropometric data		Low CHO[1](n=78)	Medium CHO(n=115)	High CHO(n=34)	Total(n=227)
Height	(cm)	168.51±5.42[a5]	168.36±5.20[a]	165.88± 5.19[b]	168.03±5.33
Weight	(Kg)	69.90±9.34	69.65±7.43	69.36± 9.47	69.69±8.41
Past weight	(Kg)	71.05±9.71	69.90±8.17	68.12±10.58	70.04±9.13
Past BMI[2][3]	(Kg/m^2)	24.88±2.92	24.66±2.66	24.79± 3.61	24.75±2.90
Present BMI	(Kg/m^2)	24.68±2.71	24.48±2.20	25.20± 3.20	24.66±2.55
Skinfold thickenss(Tricep)	(mm)	12.66±4.45	13.31±4.24	12.96± 4.47	13.03±4.34
Waist circumference	(cm)	88.81±8.37	89.11±6.81	89.29± 9.89	89.04±7.85
Hip circumference	(cm)	96.15±6.08	96.44±5.03	95.35± 5.21	96.17±5.43
WHR[4]		0.92±0.05[b]	0.92±0.05[ab]	0.94± 0.06[a]	0.92±0.05

Table 3-2. Anthropometric data for women

Anthropometric data		Low CHO[1](n=60)	Medium CHO(n=162)	High CHO(n=103)	Total(n=325)
Height	(cm)	153.08±5.34[5]	155.96±4.90	155.78±5.37	155.92±5.12
Weight	(Kg)	59.72±9.20	60.22±8.04	60.85±8.29	60.33±8.32
Past weight	(Kg)	59.37±9.71	60.22±8.28	59.99±8.10	59.99±8.48
Past BMI[2][3]	(Kg/m^2)	24.43±3.48	24.73±3.09	24.54±3.55	24.61±3.31
Present BMI	(Kg/m^2)	24.29±3.74	24.68±2.94	25.05±3.26	24.73±3.20
Skinfold thickness(Tricep)	(mm)	24.73±7.85	24.73±6.67	25.55±7.21	24.99±7.06
Waist circumference	(cm)	81.83±9.38	82.99±7.58	82.84±7.79	82.73±7.99
Hip circumference	(cm)	95.77±7.94	95.92±6.48	96.14±5.60	95.96±6.50
WHR[4]		0.85±0.06	0.87±0.06	0.86±0.06	0.86±0.06

1) Low CHO ; Low carbohydrate group Medium CHO ; Medium carbohydrate group High CHO ; High carbohydrate group
2) Past means initial value at the first diagnosis. 3) BMI ; Body Mass Index 4) WHR ; Waist Hip Ratio
5) Mean±SD
Values with different superscripts in the same row are significantly different at $p<0.05$ by Duncan's multiple test.

Discussion

The subjects in this study had lower caloric intakes than normal adults for their age[16-19], especially in the high carbohydrate group. Similar results were observed from several previous studies that the patients with cardiovascular diseases had lower intakes of all energy nutrients except alcohol than normal adults[18].

Men who consumed more than 74.7% of their total energy from carbohydrate were observed to have more fat accumulation, especially around the waist. This phenomenon was quite interesting, since the total energy intake for the men in the high carbohydrate group was significantly lower than the ones for medium and/or low carbohydrate groups. The high carbohydrate groups in both sexes consumed less fat, protein, and many other nutrients than the medium and low carbohydrate groups did. Therefore, it may be speculated that the abdominal fat accumulation in the high carbohydrate group could be attributed to their poor nutritional intake.

Blood lipid patterns for men in the high carbohydrate group were shown to have higher total cholesterol level. This may be related to a high waist/hip ratio[20][21]. This result is somewhat similar to previous studies showing that high carbohydrate intake induced hypertriglyceridemia[10-12][22-25]. Although high carbohydrate intake was not related directly to serum triglyceride level in this study, the blood lipid pattern could cause cardiovascular diseases. These results indicate that extremely high carbohydrate intake may induce an undesirable effect on blood lipid patterns and can be as bad as high lipid intake.

Women in both high and low carbohydrate groups had higher blood pressures than those in the medium

Table 4-1. Average nutrient intake for men

Nutrient		Low CHO[1](n=78)	Medium CHO(n=115)	High CHO(n=34)	Total(n=227)
Total energy	(Kcal)	2183 ± 562.50[a2]	1869 ± 410.82[b]	1690 ± 683.14[b]	1950.30±541.56
Food energy[3]	(Kcal)	2092 ± 534.84[a]	1809 ± 404.15[b]	1658 ± 661.09[b]	1883.73±518.79
Protein	(g)	109 ± 41.30[a]	74 ± 22.29[b]	53 ± 25.59[c]	83.12± 36.48
Fat	(g)	60 ± 24.61[a]	33 ± 10.90[b]	18 ± 10.11[c]	40.29± 22.77
Carbohydrate	(g)	278 ± 65.41[b]	306 ± 70.39[ab]	324 ± 121.62[a]	298.98± 79.96
Fiber	(g)	7.30 ± 2.92	7.93 ± 3.51	7.78 ± 4.36	7.69± 3.46
Ca	(mg)	645 ± 477.89[a]	561 ± 259.73[ab]	452 ± 189.51[b]	573.63±348.02
P	(mg)	1262 ± 451.28[a]	938 ± 357.13[b]	654 ± 454.22[c]	1006.59±455.48
Fe	(mg)	21 ± 7.56[a]	17 ± 7.68[b]	14 ± 7.51[c]	17.86± 7.92
Retinol	(RE)	662 ± 617.89	580 ± 550.59	565 ± 579.90	605.59±577.74
Thiamin	(mg)	1.45 ± 0.62[a]	1.20 ± 0.48[b]	1.07 ± 0.57[b]	1.27± 0.56
Rivoflabin	(mg)	1.67 ± 0.66[a]	1.28 ± 0.57[b]	0.99 ± 0.40[c]	1.37± 0.63
Niacin	(mg)	27 ± 13.29[a]	19 ± 7.94[b]	16 ± 10.85[b]	21.19± 11.23
Ascorbic acid	(mg)	96 ± 57.99[b]	100 ± 78.51[b]	129 ± 66.29[a]	102.95± 70.89
Alcohol	(g)	13.00 ± 28.05	8.59 ± 22.51	4.62 ± 25.22	9.51± 24.99

Table 4-2. Average nutrient intake for women

Nutrient		Low CHO[1](n=60)	Medium CHO(n=162)	High CHO(n=103)	Total(n=325)
Total energy	(Kcal)	1790 ± 512.73[a2]	1570 ± 432.71[b]	1360 ± 459.48[c]	1544.05±478.42
Food energy[3]	(Kcal)	1784 ± 515.55[a]	1568 ± 432.12[b]	1357 ± 446.50[c]	1540.99±475.48
Protein	(g)	95 ± 35.15[a]	60 ± 20.37[b]	41 ± 14.68[c]	60.33± 29.06
Fat	(g)	51 ± 20.26[a]	29 ± 11.64[b]	14 ± 7.41[c]	28.51± 17.89
Carbohydrate	(g)	236 ± 71.54[b]	269 ± 72.84[a]	270 ± 87.88[a]	263.47± 78.52
Fiber	(g)	6.73 ± 2.40	7.44 ± 3.53	6.58 ± 3.54	7.04± 3.37
Ca	(mg)	545 ± 250.74[a]	468 ± 203.97[b]	366 ± 191.60[c]	450.13±218.51
P	(mg)	1106 ± 384.54[a]	839 ± 395.72[b]	521 ± 279.63[c]	787.38±414.85
Fe	(mg)	18 ± 8.79[a]	15 ± 7.26[b]	12 ± 5.24[c]	14.54± 7.36
Retinol	(RE)	606 ± 438.85	509 ± 493.48	488 ± 566.09	520.65±508.65
Thiamin	(mg)	1.33 ± 0.73[a]	1.10 ± 0.49[b]	0.89 ± 0.46[c]	1.08± 0.55
Rivoflabin	(mg)	1.54 ± 1.22[a]	1.08 ± 0.41[b]	0.81 ± 0.39[c]	1.08± 0.68
Niacin	(mg)	24 ± 12.11[a]	17 ± 7.00[b]	12 ± 5.54[c]	16.33± 8.89
Ascorbic acid	(mg)	94 ± 52.23	98 ± 60.55	95 ± 70.38	96.20± 62.29
Alcohol	(g)	0.87 ± 4.22	0.28 ± 2.24	0.44 ± 4.43	0.44± 3.46

1) Low CHO : Low carbohydrate group <25th percentile of the rate of CHO to total energy of the total subjects
Medium CHO : Medium carbohydrate group ≥25th percentile – <75th percentile
High CHO : High carbohydrate group ≥ 75th percentile

2) Mean±SD
Values with different superscripts in the same row are significantly different at $p<0.05$ by Duncan's multiple test.

3) Food Energy=Total energy-alcohol energy

Table 4-3. Stepwise multiple regression for carbohydrate ratio and nutrient intake of cardiovascular disease patients(men)

Step	Variables	β	Cumulative R^2	p>F
1	Fat	-0.2443	0.5996	0.0001
2	Carbohydrate	0.0625	0.7805	0.0001
3	Protein	-0.1001	0.9053	0.0001
4	Phosphate	-0.0028	0.9090	0.0029
5	Vitamin C	0.0069	0.9110	0.0260
6	Alcohol	-0.0015	0.9125	0.0558

Table 4-4. Stepwise multiple regression for carbohydrate ratio and nutrient intake of cardiovascular disease patients(women)

Step	Variables	β	Cumulative R^2	p>F
1	Fat	-0.3491	0.6100	0.0001
2	Carbohydrate	0.0772	0.8014	0.0001
3	Protein	-0.1644	0.8849	0.0001
4	Vitamin B_2	1.4188	0.8876	0.0037
5	Calcium	-0.0030	0.9008	0.0016
6	Alcohol	-0.0145	0.9030	0.0076
7	Fiber	-0.1941	0.9054	0.0046