BIOMEDICAL AND ENVIRONMENTAL SCIENCES **16**, 112-118 (2003)

Effects of Dietary Intervention on Hyperlipidemia in Eight Communities of Beijing, China[1]

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Objective To examine the effect of community-based dietary intervention on hyperlipidemia. **Methods** A total of 180 hyperlipidemia individuals with TG>2.26 mmol·L^{-1} (200 mg·dL^{-1}) and/or TC>5.72 mmol·L^{-1} (220 mg·dL^{-1}) were selected from 428 eligible subjects in eight communities of Beijing. They were randomly divided into intervention group (n=108) and control group (n=72). Dietary intervention was provided for the intervention group for 6 months. Information on dietary intakes, physical examinations and blood samples was collected. Serum lipids were assayed at baseline and endpoint of the study period. **Results** Respective decrease in dietary intake of total calories, fat, cholesterol and cooking oil by 13.62%, 24.75%, 24.40%, and 22.43%, in the intervention group was observed. The percentages of total calories from fat, carbohydrate and protein appeared to be desirable after study. Reduced body weight and BMI were also observed. There was a respective 5.61% and 7.06 % decrease in total serum cholesterol and low-density lipoprotein cholesterol in the intervention group, while no significant changes were found in the control group. **Conclusions** Community-based dietary intervention can effectively improve dietary patterns, control body weight, and decrease the levels of total serum cholesterol and low-density lipoprotein cholesterol.

Key words: Hyperlipidemia; Dietary intervention; Community

INTRODUCTION

It is well recognized that hyperlipidemia is one of the major risk factors of coronary heart diseases (CHD). Excessive fat intake and other dietary factors play important roles in hyperlipidemia. Data from various food consumption surveys[1-3] indicate that the fat content in Chinese diets has greatly increased since the 1990s, while the incidence of hyperlipidemia and CHD has also significantly risen. To better prevent CHD and other chronic health problems, dietary intervention has become an important tool in Western countries. In China, such research has been mostly limited to clinical studies, and the effect of oriental dietary interventions on hyperlipidemia remains unclear. Thus, we conducted a community-based comprehensive dietary intervention project, in order to promote the health in communities, families and individuals.

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[1]This work was supported by Danone Institute Grant for Nutrition Research and Education Projects, China, 2000.

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0895-3988/2003
CN 11-2816

METHODS

Study Design

The study was conducted in 8 community clinics in the Xicheng District of Beijing from March to September 2001. A total of 428 residents were eligible for the study according to the following criteria: the subjects >40 years of age, their total serum triglycerides (TG)>2.26 mmol·L^{-1} (200 mg·dL^{-1}) and/or total serum cholesterol (TC) >5.72 mmol·L^{-1} (220 mg·dL^{-1}). Among them, 180 subjects were randomly selected and divided into intervention group (n=108) and control group (n=72) based on the communities where they lived. None of the subjects was taking lipid-lowering medicines.

There was a 4-week baseline period preceding the 6-month dietary intervention for the study group. For both groups, information on dietary intake, physical examination and fasting blood samples was collected for each individual, and the assays of serum lipids were performed at the onset and endpoint of the study period. A three-day-record method was used in the dietary survey. The study was approved by the Ethic's Committee of Peking University. Informed consent was obtained from all participants.

Dietary Interventions

Based on the results of the dietary survey, each subject in the intervention group was provided with an individual diet improvement plan which focused on decreasing the consumption of cooking oil, and animal fat in order to reduce dietary cholesterol level, and also on controlling the intake of total calories and increasing the consumption of fruit, vegetable, milk and bean products. According to "The Guide to Prevention and Treatment for Dyslipidemia[4] (China, 1997)", the aim of dietary interventions was to provide a diet with more than 55% of energy from carbohydrate, approximately 15% from protein, and less than 30% from fat (less than 8% from saturated fat, 8%-10% from polyunsaturated fat, and 12%-14% from monounsaturated fat). At the same time, participants were told to fill out an "Individual Health Handbook" and to make self-assessments of their dietary patterns and lifestyles.

In the study communities, health education was provided. We published "Dietary Guideline for Chinese Residents", giving people a guideline for food selection. We also organized a contest on nutrition knowledge and provided peer education on hyperlipidemia.

Physical Examination and Serum Lipids Assay

Physical examination including height, weight, waist and hip circumference, systolic and diastolic blood pressure was conducted, before and after the intervention. Body Mass Index (BMI) and Waist-Hip Ratio (WHR) were calculated according to the following formulas:

$$\text{BMI} = \text{Weight (kg)} / \text{Height}^2\text{ (m)}$$
$$\text{WHR} = \text{Waist (cm)} / \text{Hip (cm)}$$

Blood samples were drawn after overnight fasting. Serum total cholesterol (TC) and HDL cholesterol were measured by the means of CHAD-POD[5]; TG was measured using the GPO-PAP method[6]; ApoA-I and ApoB were analyzed using the immuno-turbidimetric endpoint method[7]; glucose was determined using the glucose oxidase method[8]. LDL cholesterol value was calculated according to the Friedwald Formula[9].

Dietary Survey

All the 180 participants were asked to record their food consumption in the 3 d food formats. Salt spoons and oil vessels with accurate scales were used to quantify the intake of salt and cooking oil. All of the records were entered into the computer and the Individual Nutritional Software was used to calculate nutrient intakes.

Statistical Analysis

The results were showed as $\bar{x}\pm s$ for the mean values. Repeated-sample *t* tests were used for comparisons of the nutrient intake, serum lipid, physical examination indicators between baseline and endpoints of intervention in both groups. UNIANOVA was used to compare those variables between the intervention group and control group, both at baseline and endpoint of intervention. Two-sample *t* test was used to compare the difference of variables due to interventions between the two groups. Statistical analysis was carried out by SPSS 10.0 software (SPSS Inc.).

RESULTS

After 6-month intervention, 165 of the 180 subjects (Table 1) remained in the study and 15 withdraw because of having moved to other places. The representation of the 165-subject cohort was good because there was no significant difference in height, weight and serum lipid indicators between the 180-subject cohort and 165-subject at baseline level.

Table 1 showed the age and sex distribution of the participants. Of the 165 participants, 108 were women and 57 men. The average age was 58 years, with a range from 41 to 73 years. There were no significant differences between the two groups in regard to all parameters, which were higher in women of each group ($P<0.05$).

TABLE 1

Sex and Age Distribution of the Study Participants

Age (yr)	Intervention Group		Control Group		Summary
	Males	Females	Males	Females	
41-	2	4	1	3	10
51-	14	23	9	14	60
61-	17	38	14	25	94
71-	0	1	0	0	1
Total	33	66	24	42	165

The baseline energy and nutrient intakes showed no insignificant differences between the intervention group and control group. After intervention, the intake of energy, fat, total cholesterol and protein decreased significantly in the intervention group, while it remained unchanged in the control group (Table 2). The decrease in energy, fat, cholesterol and protein in the intervention group was greater than that in the control group ($P<0.05$). The intervention group had a greater decrease in the mean value of cooking oil consumption (from 42.85 g to 33.41 g by -22.43%) than the control group (from 38.19 g to 40.18 g by 5.20%) ($P< 0.01$).

TABLE 2

Changes in the Energy and Nutrients Intakes After Intervention

Energy and Nutrients	Intervention Group			Control Group		
	Baseline	End	Changes (%)	Baseline	End	Changes (%)
Energy (kJ)	8937±1879	7757±1569[a]	-13.20[b]	8343±1467	7954±1983	-4.66
Protein (g)	77.62±25.26	68.92±20.20[a]	-11.21[b]	70.92±21.93	70.05±21.71	-1.22
Fat (g)	80.82±25.47	60.82±19.45[a]	-24.75[b]	74.39±28.13	69.85±27.20	-6.10
Carbohydrate (g)	269.68±66.74	252.52±62.81	-6.36	256.69±72.67	245.42±60.42	-4.39
Dietary Fibre (g)	12.69±5.76	12.96±5.53	2.13	12.27±7.16	12.24±5.02	-0.24
Cholesterol (mg)	434.59±268.14	328.56±154.41[a]	-24.40[b]	376.31±250.73	344.98±163.58	-8.33
Vitamin A (μgRE)	655.73±371.22	624.13±376.41	-4.82	597.10±387.72	603.85±453.93	1.13
Vitamin B_1 (mg)	1.42±0.50	1.31±0.38	-7.75	1.32±0.41	1.31±0.40	-0.76
Vitamin B_2 (mg)	1.05±0.30	0.93±0.29	-7.62	0.95±0.36	0.89±0.27	-6.32
Vitamin E (mg)	26.62±8.45	24.17±6.93	-9.20	25.30±9.82	25.18±8.29	-0.47
Niacin (mg)	15.95±6.02	14.53±5.21	-8.90	14.92±5.12	15.02±4.95	0.67
Vitamin C (mg)	95.90±44.70	122.33±53.19[a]	27.56[b]	104.76±54.01	108.45±53.28	3.52
Calcium (mg)	507.61±212.91	534.93±183.55	5.38	482.24±203.19	458.68±186.43	-4.89
Sodium (mg)	3853±1012	3758±1231	-4.89	3745±1145	3704±1421	-1.09
Iron (mg)	22.90±16.54	19.89±7.16	-13.14	22.78±18.16	20.99±8.80	-7.86
Potassium (mg)	2098±652.34	1914±559.00	-8.77	1947±687.26	1856±544.00	-4.67
Cooking Oil (g)	42.85±20.68	33.41±15.23[a]	-22.43[b]	38.19±18.59	40.18±20.80	5.20

Note.[a]: Nutrient intake changes between baseline and treatment within each group $P<0.05$. [b]: Nutrient intake changes between two groups $P<0.05$.

The proportion of energy from macronutrients for the intervention group appeared to be more desirable compared with the baseline values. The proportion of energy from saturated and mono-unsaturated fat was reduced from 8.04% to 6.94% ($P<0.05$) and from 14.79% to 13.15% ($P<0.05$), respectively; the energy from carbohydrate increased from 50.8% to 55.3% ($P<0.05$). In the control group however, no significant difference was observed. The intervention group had a greater decrease ($P<0.05$) in percentage of energy from fat, and saturated fat and a greater increase ($P<0.05$) from carbohydrate compared with the control group (Table 3).

TABLE 3

Changes in the Percent of Energy From Macronutrients

Macronutrients	Intervention Group			Control Group		
	Baseline	End	Changes (%)	Baseline	End	Changes (%)
Fat (%)	34.5±8.6	30.4±8.1[a]	-4.1[b]	34.1±9.2	33.4±8.6	-0.7
Saturated Fat (%)	8.04±1.93	6.94±1.83[a]	-1.11[b]	7.48±2.05	7.47±2.25	-0.01
Monounsaturated Fat (%)	14.79±3.29	13.15±3.51[a]	-1.64	14.78±4.02	14.12±3.92	-0.66
Polyunsaturated Fat (%)	*11.03±3.02*	*10.09±3.11*	-0.94	*11.37±3.70*	*11.15±3.19*	-0.22
Carbohydrate (%)	50.8±12.6	55.3±10.2[a]	4.5[b]	51.5±13.2	52.1±11.2	0.6
Protein (%)	14.6±3.6	14.1± 4.1	-0.5	14.5±4.6	15.2±3.9	0.7

Note.[a]: Percentages from macronutrients changes between baseline and treatment within each group $P<0.05$.
[b]: Percentages from macronutrients changes between two groups $P<0.05$.

The baseline values of height, weight, blood pressure, BMI, and WHR were similar between the intervention group and control group (Table 4). After intervention, the intervention group had significant decreases in body weight and BMI than the control group ($P<0.05$). WHR was reduced in both groups. WHR was decreased slightly greater in the intervention group than in the control group. There was no significant difference in blood pressure either within or between the two groups.

TABLE 4

Changes in Physical Examination Indicators

Indicators	Intervention Group			Control Group		
	Baseline	End	Changes (%)	Baseline	End	Changes (%)
Weight (kg)	70.08±11.16	69.96±11.18	-0.17[b]	69.00±10.73	69.82±9.97	1.18
BMI	28.15± 4.07	27.96±4.02	-0.67[b]	27.20±3.63	27.88±3.64	2.5
WHR	0.89±0.06	0.86±0.05	-3.37	0.88±0.07	0.86±0.07	-2.27
Systolic Pressure (mmHg)	139.35±19.37	139.46±19.38	0.08	135.87±17.82	135.96±17.83	0.06
Diastolic Pressure (mmHg)	89.74±11.32	89.70±11.33	0.04	86.17±11.07	86.08±10.98	-0.1

Note.[b]: Physical examination indicator changes between two groups $P<0.05$.

Changes in serum lipids were listed in Table 5. Throughout the intervention, no significant change of serum lipids was found in the control group. In the intervention group, the level of TC and LDL cholesterol decreased by 0.29 $mmol{\cdot}L^{-1}$ (5.61%) and 0.25 $mmol{\cdot}L^{-1}$ (7.06%), respectively, with $P<0.05$. The decrease of TC and LDL cholesterol was greater in the intervention group than that in the control group ($P<0.05$). HDL cholesterol level fell significantly in the intervention group, but there was no difference between the two groups. As to other serum lipid indicators, no significant change was observed during the intervention period.

TABLE 5

Changes in Serum Lipid Indicators

Indicator	Intervention Group			Control Group		
	Baseline	End	Changes (%)	Baseline	End	Changes (%)
TG (mmol/L)	2.05±1.17	2.10±1.31	2.38	2.13±1.43	2.15±1.44	0.93
TC (mmol/L)	5.84±0.85	5.55±1.02[a]	-5.61[b]	5.91±0.86	5.92±0.86	0.17
HDL-C (mmol/L)	1.38±0.29	1.29±0.35[a]	-6.51	1.34±0.28	1.29±0.25	-3.73
LDL-C (mmol/L)	3.54±0.87	3.29±0.98[a]	-7.06[b]	3.63±0.83	3.62±0.86	-0.3
ApoA I (g/L)	1.26±0.07	1.29±0.10	3.78	1.26±0.07	1.28±0.10	1.59
ApoB (g/L)	0.91±0.13	0.92±0.16	1.01	0.93±0.11	0.90±0.12	-3.23
TC/HDL-C	4.38±0.96	4.52±1.21	3.20	4.60±1.16	4.76±1.25	3.48

Note.[a]: Serum lipid level changes between baseline and treatment within each group $P\leq0.05$. [b]: Serum lipid level changes between two groups $P<0.05$.

DISCUSSION

Along with the economic development, the dietary intake of fat and total energy in Chinese population has been increasing, even though the traditional plant-based Chinese diet remains for the majority of the population. Data from the national nutrition surveys[1-3]

(Institute of Nutrition and Food Hygiene, 1992) indicate that the percentage of energy from fat has increased from 18.4% to 22.0%; cooking oil intake increased from 1982 to1992. Our current study showed that the percentage of energy from fat and cooking oil intake of Beijing residents was 34.5% and 43 g per day, respectively, in 2001. Another study[10] of 15 395 Chinese residents aged 35 to 59 found that the prevalence of hypercholesterolemia (TC $\geqslant$200 mg·dL^{-1} and/or LDL-C $\geqslant$130 mg·dL^{-1}) increased from 17.6% in 1982 to 24.0% in 1992, and to 33.1% in 1998 for men, and 19.2%, 27.1% and 31.7% for women, respectively. Dietary intervention to reduce the risk of CHD has been widely used in Europe and North America. In a meta-analysis of dietary trials[11,12], Gordon found that dietary lowering serum cholesterol produces as much CHD risk reduction as drugs, commensurate with their respective degree of cholesterol lowering. However, nutrition knowledge of Chinese population is relatively scarce, and it is more difficult to help people understand what is a balanced diet, and how to calculate nutrients intake and the necessity for some dietary restrictions. Therefore, in order to make it easily understood and assure strict compliance, dietary intervention in Chinese population must be focused on several key points. After careful analysis, we decided to focus on "decreasing the consumption of cooking oil, animal oil and foods rich in cholesterol", which are the main source of fat for Beijing residents. In addition, we designed salt spoons and oil vessels to measure their consumption. As for the form of intervention, a multi-level health education program was applied, in order to promote healthy life styles for the communities, families and individuals, respectively.

Baseline data shows that the participants in this study had high intake of dietary fat (providing 34.3% total energy) and cholesterol (434.59 mg per day). Meantime, the cooking oil consumption was 41 g per day, which is significantly higher than 25 g per day recommended by Chinese Nutritional Society[13]. Regarding ATP II[14], the Chinese Expert Panel on Dyslipidemia (1997) recommended obtaining more than 55% of energy from carbohydrates, approximately 15% from protein, less than 30% from fat (less than 8% from saturated fat, 8%-10% from polyunsaturated fat, and 12%-14% from monounsaturated fat) and the intake of cholesterol less than 300 mg per day[4]. As a result of dietary intervention, the intake of total calories, fat, cholesterol and oil was decreased by 13.62%, 24.75%, 24.40%, and 22.43%, respectively, in the intervention group. The percentage of total calories from fat, carbohydrate and protein was desirable. Total serum cholesterol and low- density lipoprotein cholesterol were reduced by 0.29 mmol·L^{-1} (5.61%) and 0.25 mmol·L^{-1} (7.06%), respectively, in the intervention group. The decreased values of TC and LDL-C were consistent with the results of David's study[15] (0.31 mmol·L^{-1} in TC, 0.24 mmol·L^{-1} in LDL-C, in Americans) and Wang Wenhua's study[16] (0.27 mmol·L^{-1} in TC, 0.26 mmol·L^{-1} in LDL-C, in Chinese). Brinton[17] found that a low-fat diet could decrease HDL-C levels by decreasing HDL apolipoprotein transport rates, which may explain why HDL-C levels decreased in our study. The influence of reduced HDL-C on health may need further study. The level of TG was not significantly different during the intervention, which should be further studied. What should be emphasized is that in comparison with the control group, our study avoided confusion from seasonal variation, thus improving the reliability of results. In summary, community-based dietary intervention can effectively improve dietary patterns, control body weight, and decrease levels of total serum and low-density lipoprotein cholesterol. It may serve as a possible strategy for hyperlipidemic intervention in Chinese urban communities.

ACKNOWLEDGEMENT

We thank to Aiping BAI for excellent technical assistance, to Dr. Yanfang WANG for editorial improvements in the manuscript.

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(*Received July* 28, 2002 *Accepted January* 19, 2003)