Efficacy of Dietary Modification Following the National Cholesterol Education Program (NCEP) Recommendation on Lipid Profiles among Hyperlipidemia Subjects

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Background: *Hyperlipidemia has adverse effects on atherosclerosis, causing it to develop into cardiovascular disease. The prevalence of hyperlipidemia has been increasing among those in the working-age group and may be caused by inappropriate dietary patterns. Dietary modification should form the basis of lipid management.*
Objective: Evaluate the effects of a dietary modification following the NCEP-ATP III recommendation on lipid profiles among hyperlipidemia subjects.
Material and Method: *The design was a quasi-experimental study, with a pre-test/post-test two-group design. Each group consisted of 31 hyperlipidemia subjects aged 30 to 59 years old with total cholesterol (TC) greater than or equal to 240 mg/dl or low-density lipoprotein cholesterol (LDL-C) greater than or equal to 130 mg/dl. The present study was conducted between January and June 2009. The research procedure included 6-week nutrition counseling and a 2-week follow-up for 12 weeks. Data were collected by self-reported questionnaire and a 3-day food record. Dietary and biological assessments were compared before and after the experiment. Statistical analysis was performed using means, standard deviations, independent and paired t-tests, Friedman test, Mann-Whitney U test, and Wilcoxon signed-rank test.*
Results: *The intervention group had a significant reduction of TC and LDL-C at the end of the experiment ($p<0.05$). Moreover, this group had a significantly higher percentage reduction of TC and LDL-C than the control group (8.5% vs. 3.0%, and 10.8% vs. 2.4%, respectively) ($p<0.05$). Distributions of monounsaturated fatty acids (MUFAs) in the intervention group were significantly higher than in the control group ($p<0.05$). Distribution of saturated fatty acids (SFAs):MUFAs:polyunsaturated fatty acids (PUFAs) were 12.0:13.4:6.3% in the intervention group and 12.3:9.2:5.6% in the control group. Neither group was able to reduce SFAs intake to <7% as recommended. Neither the recommended one-third of vegetable protein nor two-thirds of complex carbohydrate was achieved. Dietary fiber was less than 10 g/1,000 kcal. The cholesterol intake in the intervention group was less than in the control group (155.9 vs. 206.3 mg/d).*
Conclusion: *The dietary modification in the present study significantly lowered TC and LDL-C. However, compliance with the recommendation of high MUFAs intake was difficult to achieve. The dietary modification might be focused instead on lowering intake of SFAs, replacing animal protein with vegetable protein, and increasing complex carbohydrates, fruits, and vegetables to raise dietary fiber.*

Keywords: *Dietary modification, Lipid profiles, Hyperlipidemia subjects*

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Hyperlipidemia, an elevated total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C), is one of the most important risk factors of coronary heart disease (CHD) and all types of artherosclerotic vascular disease[1]. Surveys of health status in the working-age group demonstrated that the prevalence of hyperlipidemia was increasing dramatically average 15% in both rural and 25% in urban areas[2-6]. The link between the dietary pattern, hyperlipidemia, and coronary heart disease has been well established both by epidemiology studies and by controlled clinical trials[7]. Unfortunately, the relationship between elevated TC and LDL-C and dietary patterns in hyperlilipdemia subjects is not clear. However, the Fifth National Food and Nutrition Survey of Thailand 2003[6] reported inappropriate dietary patterns in the

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working-age group between the ages of 15 and 59 years, who consistently consumed high-fat animal products and fried their food in oil, and only 11% of whom regularly consumed brown rice. Furthermore, consumption of fruit and vegetables was lower than the recommended amounts in all age groups[6,8]. High prevalence of hyperlipidemia in these groups might be caused by inappropriate dietary patterns.

The recommendations of the National Cholesterol Education Program (NCEP) remain the most widely used guidelines for treatment of lipid abnormalities[9,10]. Later, Therapeutic Lifestyle Change (TLC) was developed based on American dietary patterns which typically contain high calories from fat (38-40% of total energy) in contrast to the typical Thai diet which derives only 24.0% of energy from fat[4,11]. The Fifth National Food and Nutrition Survey of Thailand 2003[6] reported that the energy distribution of populations in the central area was carbohydrate: protein:fat 55:15:30, the same as the Thai Recommended Dietary Intake[12]. Therefore, dietary recommendations for controlling blood lipids need to be developed and applied to hyperlipidemia subjects' diets. The purpose of the current study was to evaluate the effect of dietary modification on lipid profiles among hyperlipidemia subjects.

Material and Method

Subjects

The participants were men and women aged between 30 and 59 years who were working at Saha-Union Phrakanong and Bangchan Company and who met the following eligibility criteria: having blood lipids TC greater than or equal to 240 mg/dl and/or LDL-C levels greater than or equal to 130 mg/dl, and willing and able to participate in the whole 12-week program. Exclusion criteria included those who were taking medication for lipid-reduction or weight-reduction, beta-blockers, thiazide, diuretics, thyroid medications, and estrogen/progesterone replacement therapy; or those having a history of diabetes mellitus, liver disease, nephrotic syndrome, heart disease; or pregnant or lactating women. All participants gave signed inform consent as approved for ethical clearance by the Committee on Human Rights Related to Human Experimentation, Mahidol University.

Study design

The design was a quasi-experimental study with a two-group pre-test/post-test design. The sample size was calculated by the compared mean formula based on variance of total cholesterol from a previous study[13]. Thirty-one participants were eligible to enter into the intervention and the control groups. General data collection and dietary assessment were carried out at the initiation, immediately after the 6-week intervention, and at the 12-week follow-up. Participants in the intervention group received the diet control guideline while participants in the control group received general dietary leaflets and each group received a handout of a food exchange list to be used in their 3-day food record. Both groups received the same process of counselling during the experiment period. The total study period was 6 months from January 2009 to June 2009.

Dietary assessments

Dietary Modification refers to nutrient composition to be applied based on NCEP and Thai RDI recommendations. The modified diet in the intervention group recommended nutrient composition as follows: total fat 30% of total energy, saturated fatty acids (SAFs) <7%, monounsaturated fatty acids (MUFAs) up to 15%, polyunsaturated fatty acids (PUFAs) up to 10% of total energy from fat; carbohydrate 55-60% of total energy, 2/3 from complex carbohydrate; protein 15% of total energy, 1/3 from vegetable protein; cholesterol intake less than 200 mg/day; fiber 10 g/1,000 kcal, and total calories designed to maintain a desirable body weight. The main sources of MUFAs were especially recommended to this group. General leaflets on nutrition information were offered to the control group including information about food for cholesterol control, and the correct methods of choosing fat and oil.

The participants in both groups were instructed to maintain three-day food records. They were required to record all food and drink that they consumed for three consecutive-day periods (2 weekdays and 1 weekend day). The time, duration, and the method of food preparation were advised for food record. Compliance was monitored by weekly review of three-day food records. The participants were requested to record their food intake throughout the first 6-week period. The diets were coded and entered into a computer using the Nutri-survey Program and the compositions of the individual food item of the meal were summarized. The components of saturated, monounsaturated, and polyunsaturated fatty acids were calculated using the database from the document Fatty Acids Composition and Cholesterol in Thai Foods, published by the Nutrition Department, Ministry of Public Health[14].

Blood lipids collection

Trained and certified clinic staff collected blood samples and height measurements data from all participants at the baseline date and week-12 visits. A single blood sample of 5 ml was collected after a 12-hour overnight fast. The 5 ml blood sample was drawn into an 8 ml red-top tube packed in an ice box and taken to the Office of Public Health and Environmental Technology Services (OPHETS) for preparation of serum. All blood samples drawn at the baseline date and 12 weeks after implementation were tested at the laboratory of the OPHETS.

Data analysis

SPSS for Windows version 17.0 (SPSS Inc., Chicago, Illinois, USA) was used for statistical analysis. Chi-square or Fisher's Exact test analyses were conducted to determine the statistical significance of group differences. A paired sample t-test was conducted to compare the mean score within groups. An independent t-test was conducted to compare the mean score between groups. Friedman test (non-parametics testing algorithm) was conducted to analyze mean differences of dietary data among three periods of food analysis. Mann-Whitney U tests and Wilcoxon signed-rank tests were conducted to compare the mean differences of dietary data. Statistical significance is defined as a p-value less than 0.05.

Results

Ninety-four participants were initially interested in taking part in the present study. Forty-eight people from Saha-Union Phrakanong were assigned to be the intervention group and 46 people from Saha-Union Bangchan were nominated as the control group. After blood lipids screening, 39 people in the intervention group and 36 people in the control group who met the eligibility criteria were included in the present study. During the first visit, five participants in the intervention group and two in the control group declined to participate stating as reasons workload and illness. At the follow-up week, three participants in each group dropped out. Therefore, only 31 cases in each group, continued to participate in the present study.

The description profile of the background characteristics are shown in Table 1. Although the education level (the number with graduate/postgraduate degrees) of the participants in the intervention group was higher than that of the participants in the control group, it was not significantly different ($p>0.05$). The baseline socio-demographic data were not significantly different either. Table 2 shows changes over time (mean, mean difference, and percent change) in fasting blood lipid, plasma TC, LDL-C, HDL-C, and triglycerides. The results demonstrated that mean LDL-C at baseline in the intervention group was higher than in the control group, and the difference between the groups was significant ($p<0.05$). In contrast, triglyceride in the control group was higher than in the intervention group and represented a significant difference between the groups ($p<0.05$). There was no significant difference between the intervention and the control groups in term of TC and HDL-C.

After intervention (week 12), in both groups, had managed to decrease TC from the baseline level, but did not achieve the desirable value. However, there was an 8.5% reduction in TC within the intervention groups, and these values were significantly different ($p<0.05$). There was also a significant difference between the intervention and the control group ($p = 0.032$). Before intervention, LDL-C in the intervention group was greater than in the control group and the values were significantly different ($p = 0.015$). At the end of the present study, participants in the intervention group had managed to reduce LDL-C from the baseline, but they were still in the high-risk group according to the recommendations. There was a significant difference within the group values ($p<0.05$), representing a 10.8% reduction. There was also a significant difference between the groups ($p = 0.020$). Although HDL-C in the intervention group was greater than in the control group before intervention, it was not significantly different. At the end of the present study, participants in the intervention group had reduced HDL-C from the baseline, and within this group there was a significant difference ($p<0.05$), which was a 4.7% reduction, and there was a significant difference between the groups ($p = 0.007$).

Dietary intake is shown in Table 3. The results show that both male and female participants in the intervention and the control group received total energy intake lower than Thai RDI recommendations. The energy received from carbohydrates (CHO) by both groups was lower than the recommendation whereas energy from protein (P) and fat (F) were

Table 1. Number and percentage of socio-demographic, family history, and health risk behavioural characteristics at baseline

Variables	Intervention group (n = 31)	Control group (n = 31)
Sex		
Male	8 (25.8)	12 (38.7)
Female	23 (74.2)	19 (61.3)
Age group (years)		
30-39	9 (29.0)	3 (9.7)
40-49	10 (32.3)	16 (51.6)
50-59	12 (38.7)	12 (38.7)
Means ± SD; min-max	45.7±8.3; 32-58	47.4±6.8; 36-59
Education level		
High school	5 (16.1)	7 (22.6)
Junior degree	5 (16.1)	11 (35.5)
Bachelor/higher degree	21 (67.7)	13 (41.9)
Religion		
Buddhist	29 (93.5)	26 (83.8)
Islam	2 (6.5)	5 (16.2)
Monthly income (Baht)		
<25,000-49,999	20 (64.5)	25 (80.6)
50,000->75,000	11 (35.5)	6 (19.4)
Family history		
Heart attack		
Yes	1 (3.2)	2 (6.5)
No	30 (96.8)	29 (93.5)
Smoking		
Non-smoking	22 (71.0)	17 (54.8)
Secondary smoke/stopped smoking	9 (29.0)	14 (45.2)
Alcohol drinking		
Never	21 (67.7)	16 (51.6)
Sometimes	10 (32.3)	15 (48.4)
Exercise		
Never	6 (19.4)	5 (16.1)
Sometimes (<3 time/week)	15 (48.4)	14 (45.2)
Always (≥3 time/week)	10 (32.3)	12 (38.7)
Menstruation		
Yes	13 (41.9)	9 (52.7)
Menopause	10 (32.3)	10 (47.3)

Values are represented as n (%)

higher than the recommended levels (CHO:P:F = 50.3%:17.3%:32.3% vs. 52.6%:17.3%:30.1%). In addition, distribution of SFAs in both groups was higher than the recommendation (12.9% vs. 15.0%). After implementation (week 12), the control group consumed less total energy from fat than the intervention group ($p = 0.009$). The consumption of MUFAs in the intervention group represented 13.4% of total energy from fat, which did not meet the recommendation. However, they were significantly higher than those of the control group at all time periods. Neither group managed to limit their consumption of SFAs to less than 7% as recommended. Cholesterol intake in the intervention group was down from baseline, both in week 6 and week 12, but there was no significant difference whereas in the control group it had dropped below the recommended level at week 6 but had returned to just above the recommended level by week 12. There were no within-group or between-group significant differences with regard to dietary fiber and the level of consumption did not reach the recommended levels.

Table 2. Comparison of fasting blood lipid at baseline and week 12

Variables	Group	Baseline (mean ± SD)	Week 12 (mean ± SD)	% change (mean ± SD)	p-value
TC (mg/dl)	1	268.9±27.4	245.4±33.1	-8.5±10.6*	0.001
	2	258.2±31.8	249.4±31.6	-3.0±8.8*,a	0.040
p-value		0.157	0.632	0.032	
LDL-C (mg/dl)	1	182.6±27.3	161.2±25.3	-10.8±14.3*	0.001
	2	165.5±25.8a	161.8±32.5	-2.4±13.3a	0.316
p-value		0.015	0.989	0.020	
HDL-C (mg/dl)	1	63.3±16.3	59.8±15.2	-4.7±11.9#,b	0.005
	2	59.5±17.9	59.9±15.5	2.3±10.8	0.281
p-value		0.468	0.806	0.007	
Triglycerides (mg/dl)	1	115.9±70.2	121.8±71.7	10.6±34.9	0.272
	2	162.8±78.8b	138.8±64.8	-9.7±25.6#,b	0.019
p-value		0.008	0.125	0.022	

Values are represented as mean ± SD
1 = intervention group (n = 31); 2 = control group (n = 31)
* Significant difference by paired t-test
a Significant difference by independent t-test
Significant difference by Wilcoxon signed ranks test
b Significant difference by Mann-Whitney U test

Discussion

The link between dietary pattern and blood lipids has been firmly established, and an effective well-known dietary guideline for reducing blood lipids has been developed by the National Cholesterol Education Program. The onset guideline was the Step I and Step II diet. In the year 2002, the NCEP presented a new guideline called the therapeutic lifestyle change (TLC) diet that aimed to reduce LDL cholesterol[9,10]. Their recommendations included total fat intake of 25 to 35% of total calories (less than 7% of SFAs, up to 20% of MUFAs and up to 10% of PUFAs). In contrast to the aims of the Step I and Step II diet, the quality of fats was of more concern than the reduction of total fat intake. The overall composition of the TLC diet is consistent with that of American populations. The Fifth National Food and Nutrition Survey of Thailand 2003[4] reported that the dietary pattern of the population in the central area indicated the energy intake from fat was 30% of total calories, in line with Thai RDI[12]. The Dietary approach for the present study was developed based on the Thai dietary pattern (energy from carbohydrate:protein:fat = 55:15:30) and the adjusted distribution of fatty acids was in accordance with the TLC diet (less than 7% of SFAs, up to 15% of MUFAs and less than 10% of PUFAs) including cholesterol intake of 200 mg/day and dietary fiber of 10g/1,000 kcal.

In the intervention group, the results indicated that four and three participants respectively managed to achieve reduction of TC and LDL-C to a desirable level. Additionally, 14 cases in a high-risk group of TC and 8 cases in a high-risk group of LDL-C were able to reduce TC and LDL-C to a borderline-high level. In contrast to the control group, only 8 cases in a high-risk group of TC and 1 case in a high-risk group of LDL-C managed to reduce TC and LDL-C to a borderline-high level. The change in the LDL cholesterol distribution demonstrated that dietary approach could be applied to reduce the number of cases referred for drug therapy. The overall reduction in TC and LDL-C attributable to dietary advice in the intervention group were 8.5% and 10% respectively at the end of the 3-month period. It was lower than the recommendation of the TLC diet that aimed to reduce LDL-cholesterol 20 to 30%[10]. The reduction in blood total cholesterol and LDL-C in the control group was 3.0% and 2.4%, respectively. These results are controversial when compared with several studies following the Step I and Step II diet with subjects who were allowed to choose their own foods and were able to achieve an average reduction of 5-10% in TC and LDL-C[15-18].

As the authors know, SFAs can increase LDL-C concentration by decreasing LDL receptor-mediated catabolism, in the present study the authors recommended and promoted a proportion of SFAs less than 7% of the total energy from fat. The participants in both groups consumed higher levels of SFAs than the recommendation in all time periods, even though

Table 3. Comparison of nutrients intake during diet interventions of the intervention and control group

Variables	Group	Baseline mean ± SD	Week 6 mean ± SD	Week 12 mean ± SD	Friedman test p-value
Energy intake (kcal) male	1	1,317.3±317.8	1,237.4±323.5	1,196.3±308.9	0.607
	2	1,686.9±301.9[b]	1,463.8±303.0	1,528.7±338.4[b,*]	0.039
p-value		0.031	0.143	0.076	
Energy intake (kcal) female	1	1,241.2±274.8	1,150.2±253.7	1,150.5±199.2	0.738
	2	1,301.1±248.9	1,252.9±219.4	1,200.2±268.0	0.241
p-value		0.318	0.220	0.456	
Energy from carbohydrate (%)	1	50.3±6.5	51.4±7.0	51.1±6.6	0.365
	2	52.6±5.0	54.8±7.6	55.5±7.6	0.249
p-value		0.210	0.091	0.068	
Total carbohydrate (gram)	1	171.0±40.2	160.3±40.9	160.7±38.6	0.542
	2	186.0±39.0[b]	176.7±35.4[b]	176.7±38.0[b]	0.206
p-value		0.003	0.001	0.001	
Complex carbohydrate (gram)	1	33.0±22.2	44.6±28.6	44.7±28.3	0.169
	2	28.0±19.3[b]	45.3±29.3	45.7±31.2	0.206
p-value		0.043	0.938	0.949	
Simple carbohydrate (gram)	1	136.7±40.0	118.4±36.0	116.4±37.3	0.250
	2	158.5±40.0[b]	134.0±35.2[b]	131.0±39.8[b,*]	0.002
p-value		0.001	0.001	0.003	
Dietary fiber (mg/day)	1	8.3±3.6	9.1±5.0	8.4±4.0	0.508
	2	7.9±2.6	8.7±3.8	8.5±3.7	0.900
p-value		0.683	0.735	0.927	
Energy from protein (%)	1	17.3±3.2	17.0±3.4	17.1±3.3	0.592
	2	17.3±3.2	16.8±3.8	17.6±3.6	0.159
p-value		0.816	0.905	0.451	
Total protein (gram)	1	57.9±18.9	52.3±16.3	60.3±54.7	0.502
	2	62.5±21.5	56.0±17.4	58.2±19.4	0.657
p-value		0.110	0.095	0.082	
Vegetable protein (gram)	1	14.8±5.2	15.7±5.7	14.7±5.2	0.657
	2	16.2±6.0	16.0±6.3	15.0±5.2	0.108
p-value		0.195	0.871	0.593	
Cholesterol intake (mg/day)	1	228.2±122.3	159.7±97.0	155.9±56.4	0.053
	2	253.2±129.6	192.1±103.6	206.3±103.5	0.067
p-value		0.335	0.226	0.080	
Animals protein (gram)	1	42.7±16.0	36.9±15.6	38.6±15.6	0.122
	2	46.6±17.5	40.1±16.5	43.0±17.5[b]	0.446
p-value		0.082	0.113	0.043	
Energy from fat (%)	1	32.3±5.3	31.8±6.4	31.6±5.3	0.508
	2	30.1±4.8	28.5±6.8	27.1±6.5[b]	0.235
p-value		0.111	0.098	0.009	
Saturated fatty acid (%)	1	12.9±4.3	10.8±2.9	12.0±3.2*	0.048
	2	15.0±4.4[b]	12.7±4.9	12.3±4.8*	0.036
p-value		0.042	0.085	0.720	
Monounsaturated fatty acid (%)	1	12.8±2.6	13.8±3.3	13.4±2.9	0.406
	2	9.9±2.9[b]	9.9±3.8[b]	9.2±2.8[b]	0.740
p-value		0.001	0.001	0.001	
Polyunsaturated fatty acid (%)	1	6.9±3.2	7.1±2.3	6.3±2.0	0.521
	2	5.2±2.4[b]	5.8±2.5	5.6±2.4	0.405
p-value		0.035	0.051	0.118	

Values are represented as mean ± SD
1 = intervention group (n = 31); 2 = control group (n = 31)
* Significant difference by Friedman test
[b] Significant difference by Mann-Whitney U test

the control group's consumption of SFAs dropped from baseline to week 6 and again at week 12. In terms of dietary patterns, it appeared that at the first week both the intervention and control groups consumed a greater high-fat diet than at the end of the 3-month period. Their main food sources consisted of pork, sausages, nam (pork, shredded and salted, bound tightly with banana leaves, and eaten slightly fermented), ham and bacon. The favorite oil product was palm oil, which contains high SFAs. Furthermore, the participants in both groups always consumed one meal of dishes such as khao pad, khao ka moo, khao man kai, kanom jean nam ya, Pad sea aew, Pad Thai, Kanom jean kaeng khiuw wan, which contain total energy from fat of 30 to 40%. Moreover, the dinner they usually consumed was a fried dish and a stir-fried dish.

With regard to MUFAs, many studies have shown that, when MUFAs substitute SFAs, the most important effect is a decrease in LDL-C at a level comparable to low fat-diets, with up to 30% total calories provided by fat and 55 to 60% of total calories as carbohydrate. Another benefit is that the cholesterol transported in HDL is maintained at higher levels when SFA rather than polyunsaturated fatty acid or carbohydrate is replaced by MUFAs in the diet[19,20]. The NCEP (ATP III) recommends a higher intake of MUFAs, in accordance with the experience of the Mediterranean Diet. Results have shown that populations living in this area has a low prevalence of CHD and low plasma cholesterol levels despite consumption of a diet high in total fat (33-40% of energy) and low in SFA (less than or equal to 8% of energy). Food sources high in MUFAs and low in SFAs are vegetable oil (especially olive oil) and nuts and seeds (such as almonds, macadamia, peanuts and cashew nuts)[21,22]. In the present study, the recommended MUFAs levels were 15% of total energy from fat. In the intervention group, participants consumed less than the recommendation amounts throughout the present study period. Foods, which were sources of high MUFAs, were recommended to the intervention group at each time period, such as using rice bran oil instead of palm or soybean oil for cooking and adding two to three tablespoons/day of peanuts and cashew nuts. One-third of the participants changed their oil product to rice bran oil and tried to cook for themselves. Moreover, one in three of the participants consumed peanuts and cashew nuts as a snack in their dietary pattern. Even though the percentage of MUFAs was not significantly different at each time period, the type of food and oil product used was different from that of the baseline. In the control group, participants demonstrated a significantly lower intake of MUFAs than the intervention group. They also consumed one side dish of Kaeng som, Kaeng liang, Kaeng jue or Kaeng pa instead of one plate of fast food such as fried rice, Khao ka moo, Khao man kai, Pad thai, resulting in a decrease in SFAs in each time period. However, the level was still consistently higher than the recommendation at every time period and 70% of the participants used palm oil for cooking. Only five participants changed their cooking oil product from palm oil to soybean oil.

Following the dietary modifications, the reduction in SFAs and the increase in MUFAs in this study did not attain the recommended levels. The reasons stated by most participants was that they ate out two meals per day so they were usually served with high-fat food, medium-to-high-fat meat, processed meat, palm oil and soybean oil. Besides, if they did not avoid or eliminate high fat foods they could not reduce SFAs in their dietary pattern. Additionally, peanuts or cashew nuts that contained high MUFAs also provide high-energy intake from fat; therefore, if the participants consumed more than two to three tablespoons per day the total energy from fat would exceed recommended levels. Moreover, the participants view Palm oil, Soybean oil, and Rice bran oil as very similar. The price of Palm oil and Soybean oil is lower than the other oils and they were favored in every market. Therefore, price is an important factor in the participants' decision as to which oil product they buy.

Distribution of energy from protein showed similar results in both groups (mean = 17%). Protein consumption was higher than the recommendation (15% of total energy intake). The main food source of protein was commonly animal protein. The advice given to both groups focused on replacing animal protein with vegetable protein. The benefit of the increase in vegetable protein is that it can manipulate SFAs to reach the recommendation and decrease cholesterol intake. A meta-analysis of the effects of soy protein on serum lipid reported that the consumption of soy protein at the average 47 g/day was associated with a decrease in serum blood lipids, both TC and LDL-C[23]. Soymilk and soy products such as white Tofu were recommended. In the present study, five participants in the intervention group usually consumed soymilk with legumes for breakfast. Most of the participants were unable to replace animal products by soy products because soy was difficult to find in their locality. Moreover, the less-appetizing taste and smell of soy products were other reasons for the participants' refusal to eat it. However, two-thirds of the participants in both groups tried to change their type of animal protein from red meat to fish, poultry without skin, and lean meat. Although the amount of energy obtained from protein could not be reduced to the recommended levels, the quality of protein improved. Furthermore, cholesterol intake decreased from the baseline to the end of the 12-week period. Moreover, participants limited their consumption of whole egg to two or three times per week and consumed only egg white.

With regard to dietary fiber, the average was 8 g/day in both groups. Compared with the total energy intake, this was not up to the recommendation and reflected low consumption of complex CHO, fruits, and vegetables. The recommendation is that 2/3 of CHO should come from complex CHOs. Common sources of complex CHO in Thai food are brown rice, whole grain, fruits and vegetables. Neither group complied with the recommendation. Only 1/3 of the participants in each group consumed brown rice with one meal per day. Two-thirds of the participants gave the reasons that it was difficult to cook brown rice and it was not very tasty. Therefore, consuming brown rice was not popular, and it was not available in their local areas. The Fifth National Food Nutrition Survey of Thailand 2003 reported only 11% of populations always consume brown rice[4]. In Thai RDI, 400 milligrams per day of fruit and vegetables was recommended[4,11]. Both groups consumed less than the recommendation amount (average 250 and 300 g/day, respectively) of fruits and vegetables. Mostly, they could not add fruits in every meal plan.

In conclusion, considering dietary approach in the intervention group, it was found that only cholesterol intake recommendations were achieved (<200 mg/d). Consumption of SFAs could not be reduced to lower than 7%, and promoting high MUFAs intake did not manage to get participants to limit their total energy from fat to 15%. Furthermore, the consumption of vegetable protein and complex CHO was lower than the target. There were many obstacles to the participants' compliance: for example, high MUFAs intake was not achieved because the food sources of MUFAs were not their habitual food items for snacks. In addition, the majority of the participants did not cook at home, so the use of high MUFAs oil was not possible as street food vendors normally use palm oil or soybean oil in their cooking. The consumption of vegetable protein to replace animal protein was not achieved either because vegetable protein products such as tofu were not participants' preference. Therefore, the dietary approach focusing on reducing SFAs, consuming more vegetable protein and complex CHO may be more appropriate than promoting higher use of MUFAs.

The limitation of the present study was that it showed effects of the dietary approach on lipid profiles over a 12-week period only. Eating-behavior modifications may take longer to develop in real-life situations, and our experiment could not control environment factors in participants' everyday lives. In addition, it was not possible to take account of the role of stress, exercise, and social support that affect participants' health status. Data of dietary intake were obtained from only a 3-day food record, and it may not be reliable, as the participants may have been more compliant with their diet during recording days. Furthermore, the finding of the present study cannot be generalized to all hyperlipidemia subjects.

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What is already known on this topic?

The link between intake of dietary fat, hyperlipidemia, and CHD is well established. Both epidemiology studies and controlled clinical trials have demonstrated that diet and plasma lipids are causally related. A diet high in total fat and saturated fat contributes to elevated level of serum TC and LDL-C. Thus, encouraging dietary fat reduction is one of the core objectives in treating hyperlipidemia.

The surveys of health status in Thai working age group demonstrated prevalence of hyperlipidemia was increasing dramatically but dietary pattern and dietary approach for controlling lipid profiles was not clear.

However, the Therapeutic Lifestyle Changes (TLC) was developed based on American dietary pattern, which typically contain high energy from fat (38-40% of total energy) that was different from typical Thai diet which contain energy only 24% of total energy from fat. Therefore, a modified dietary approach for lowering LDL cholesterol was developed based on

TLC diet and Thai RDI recommendation and applied to hyperlipidemia subjects.

What this study adds?

The recommendation of dietary approach following NCEP guideline was difficult to compliant for hyperlipidemia subjects in free living.

Personal skill in food choices and food preparation should be implemented as well as supporting environment by create healthy canteen increasing availability of healthy food choices.

The high motivation level throughout the intervention was important for continuous dietary change. Individual motivation need to be identified, focus on the individualized dietary outcome must be emphasized and closely monitored to enhance their skill to adopt new eating behavior.

Potential conflicts of interest

None.

References

1. Carleton RA, Dwyer J, Finberg L, Flora J, Goodman DS, Grundy SM, et al. Report of the Expert Panel on Population Strategies for Blood Cholesterol Reduction. A statement from the National Cholesterol Education Program, National Heart, Lung, and Blood Institute, National Institutes of Health. Circulation 1991; 83: 2154-232.
2. Krudkool K. Situation analysis and literature review on dyslipidemia [Internet].2006 [cited 2013 Jan 1]. Available from: http://www.thaincd.com/media/paper-manual/non-communicable-disease.php?pn=8
3. Tatsanavivat P, Klungboonkrong V, Chirawatkul A, Bhuripanyo K, Manmontri A, Chitanondh H, et al. Prevalence of coronary heart disease and major cardiovascular risk factors in Thailand. Int J Epidemiol 1998; 27: 405-9.
4. InterASIA Collaborative Group. Cardiovascular risk factor levels in urban and rural Thailand—The International Collaborative Study of Cardiovascular Disease in Asia (InterASIA). Eur J Cardiovasc Prev Rehabil 2003; 10: 249-57.
5. Poarapakarm Y, Boonyaratapan P. Report the Third National health examination survey in Thailand [in Thai]. Nonthaburi: Ministry of Public Health, Thailand; 2006.
6. Nutrition Division, Department of Health, Ministry of Public Health. The Fifth National food nutrition survey of Thailand 2003. Bangkok: War Veterans Organization Printing; 2006.
7. Henkin Y, Shai I. Dietary treatment of hypercholesterolemia: can we predict long-term success? J Am Coll Nutr 2003; 22: 555-61.
8. Poarapakarm Y, Boonyaratapan P. Fruit and vegetable consumptions in Thai [Internet]. 2006 [cited 2013 Jan 1]. Available from: http://www.hiso.or.th/hiso/brochure/b15_1.php?color=4&title=2& lesson=15&lesson_id=5.
9. National Cholesterol Education Program. Second Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel II). Circulation 1994; 89: 1333-445.
10. Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. Circulation 2002; 106: 3143-421.
11. Food and Drug Administration, Ministry of Public Health. Thai recommended dietary intakes. Bangkok: Food and Drug Administration, Ministry of Public Health; 1995.
12. Nutrition Department, Ministry of Public Health. Dietary reference intake for Thais 2003. Bangkok: War Veterans Organization Printing; 2003.
13. Dansathakul P. Cross-sectional study: facet of health status leading to risk of coronary heart disease in a selected population in the Bangkok Metropolis. [thesis]. Bangkok: Mahidol University; 2001.
14. Nutrition Department, Ministry of Public Health. The fatty acids composition and cholesterol in Thai foods. Bangkok: Nutrition Department, Ministry of Public Health; 2002.
15. Denke MA, Grundy SM. Individual responses to a cholesterol-lowering diet in 50 men with moderate hypercholesterolemia. Arch Intern Med 1994; 154: 317-25.
16. Denke MA. Individual responsiveness to a cholesterol-lowering diet in postmenopausal women with moderate hypercholesterolemia. Arch Intern Med 1994; 154: 1977-82.
17. Schaefer EJ, Lichtenstein AH, Lamon-Fava S, Contois JH, Li Z, Rasmussen H, et al. Efficacy of a National Cholesterol Education Program Step 2 diet in normolipidemic and hypercholesterolemic middle-aged and elderly men and women. Arterioscler Thromb Vasc Biol 1995; 15: 1079-85.

18. Walden CE, Retzlaff BM, Buck BL, McCann BS, Knopp RH. Lipoprotein lipid response to the National Cholesterol Education Program step II diet by hypercholesterolemic and combined hyperlipidemic women and men. Arterioscler Thromb Vasc Biol 1997; 17: 375-82.
19. Mata P, Alvarez-Sala LA, Rubio MJ, Nuno J, De Oya M. Effects of long-term monounsaturated- vs polyunsaturated-enriched diets on lipoproteins in healthy men and women. Am J Clin Nutr 1992; 55: 846-50.
20. Gardner CD, Kraemer HC. Monounsaturated versus polyunsaturated dietary fat and serum lipids. A meta-analysis. Arterioscler Thromb Vasc Biol 1995; 15: 1917-27.
21. Hu FB, Manson JE, Willett WC. Types of dietary fat and risk of coronary heart disease: a critical review. J Am Coll Nutr 2001; 20: 5-19.
22. Kris-Etherton PM. AHA Science Advisory. Monounsaturated fatty acids and risk of cardiovascular disease. American Heart Association. Nutrition Committee. Circulation 1999; 100: 1253-8.
23. Anderson JW, Johnstone BM, Cook-Newell ME. Meta-analysis of the effects of soy protein intake on serum lipids. N Engl J Med 1995; 333: 276-82.

ประสิทธิผลของการควบคุมอาหารตามคำแนะนำของ The National Cholesterol Education Program (NCEP) ต่อระดับไขมันในเลือดในผู้ที่มีภาวะไขมันในเลือดสูง

สุรัสวดี เที่ยงวิบูลย์วงศ์, เรวดี จงสุวัฒน์, ภารดี เต็มเจริญ, วงเดือน ปั้นดี, พัชราณี ภวัตกุล

ภูมิหลัง: *ภาวะไขมันในเลือดสูง มีผลกระทบต่อการเกิดภาวะหลอดเลือดแดงตีบแข็งนำไปสู่การเกิดโรคหัวใจและหลอดเลือด ความชุกของภาวะไขมันในเลือดสูงเพิ่มสูงขึ้นมากในกลุ่มคนวัยทำงาน อาจเป็นผลมาจากการบริโภคอาหารที่ไม่เหมาะสม การควบคุมอาหารควรใช้เป็นปัจจัยหลักการในการจัดการกับระดับไขมันในเลือด*

วัตถุประสงค์: *เพื่อประเมินผลของการควบคุมอาหารตามคำแนะนำของ The National Cholesterol Education Program (NCEP) ต่อระดับไขมันในเลือดในผู้ที่มีภาวะไขมันในเลือดสูง*

วัสดุและวิธีการ: *การศึกษากึ่งทดลองครั้งนี้เป็นแบบ pretest-posttest two groups design กลุ่มตัวอย่างเป็นผู้ที่มีภาวะไขมันในเลือดสูงกลุ่มละ 31 ราย มีระดับคอเลสเตอรอลรวม ≥240 mg/dl หรือ มีระดับไลโปโปรตีนชนิดความหนาแน่นต่ำ ≥130 mg/dl อายุ 30-59 ปี ดำเนินการเก็บข้อมูลระหว่างเดือนมกราคม ถึง เดือนมิถุนายน พ.ศ. 2552 ดำเนินการศึกษาโดยการให้คำปรึกษาทางโภชนาการเป็นเวลา 6 สัปดาห์ และติดตามผลทุก 2 สัปดาห์ จบครบ 12 สัปดาห์ รวบรวมข้อมูลโดยการใช้แบบสอบถามด้วยตนเอง และการบันทึกอาหารบริโภค 3 วัน ผลการตรวจทางห้องปฏิบัติการก่อนและหลังการทดลอง วิเคราะห์ข้อมูลทางสถิติโดยใช้ค่าเฉลี่ย, ส่วนเบี่ยงเบนมาตรฐาน, independent t-test, paired t-test, Friedman test, Mann-Whitney U test และ Wilcoxon signed ranks test*

ผลการศึกษา: *พบว่ากลุ่มทดลองมีระดับคอเลสเตอรอลรวม ไลโปโปรตีนชนิดความหนาแน่นต่ำ และไลโปโปรตีนชนิดความหนาแน่นสูงลดลงกว่าก่อนการทดลองอย่างมีนัยสำคัญทางสถิติ ($p<0.05$) ยิ่งกว่านั้นกลุ่มทดลองมีเปอร์เซ็นต์การลดลงของระดับคอเลสเตอรอลรวม และไลโปโปรตีนชนิดความหนาแน่นต่ำมากกว่ากลุ่มควบคุม (8%:3% และ 10%:2% ตามลำดับ) อย่างมีนัยสำคัญทางสถิติ ($p<0.05$) การกระจายของกรดไขมันไม่อิ่มตัวเชิงเดี่ยวในกลุ่มทดลองสูงกว่ากลุ่มควบคุมอย่างมีนัยสำคัญทางสถิติ ($p<0.05$) สัดส่วนการกระจายกรดไขมันอิ่มตัวสูง:กรดไขมันไม่อิ่มตัวเชิงเดี่ยว:กรดไขมันไม่อิ่มตัวเชิงซ้อนในกลุ่มทดลองเท่ากับ 12:13.4:6.3% กลุ่มควบคุมเท่ากับ 12.3:9.2:5.6% ของพลังงานที่ได้รับจากไขมันทั้งหมด การบริโภคอาหารของทั้ง 2 กลุ่มยังไม่สามารถลดปริมาณกรดไขมันอิ่มตัวสูงให้ <7% ตามที่กำหนด ปริมาณโปรตีนจากพืชได้รับไม่ถึง 1/3 ของโปรตีนทั้งหมด ปริมาณคาร์โบไฮเดรตเชิงซ้อนน้อยกว่า 2/3 ของปริมาณที่กำหนด ใยอาหารที่ได้รับน้อยกว่า 10 กรัม/1,000 กิโลแคลอรี ปริมาณคอเลสเตอรอลที่ได้รับในกลุ่มทดลองน้อยกว่ากลุ่มควบคุม (155.9: 206.3 กรัม/วัน)*

สรุป: *จากการศึกษานี้การควบคุมอาหารมีผลต่อการลดลงของระดับคอเลสเตอรอลรวม และไลโปโปรตีนชนิดความหนาแน่นต่ำอย่างมีนัยสำคัญทางสถิติ อย่างไรก็ตามการส่งเสริมการบริโภคอาหารที่มีกรดไขมันไม่อิ่มตัวเชิงเดี่ยวสูงนำไปปฏิบัติได้ยาก คำแนะนำที่ควรให้น่าจะเป็นการลดการบริโภคอาหารที่มีกรดไขมันอิ่มตัวสูง ส่งเสริมการบริโภคอาหารที่มีโปรตีนจากพืชทดแทนโปรตีนจากเนื้อสัตว์ และบริโภคอาหารกลุ่มที่เป็นคาร์โบไฮเดรตเชิงซ้อน ผัก และผลไม้ เพื่อเพิ่มปริมาณใยอาหาร*