PREVALENCE AND RISK FACTORS OF HYPERCHOLESTEROLEMIA AMONG THAI MEN AND WOMEN RECEIVING HEALTH EXAMINATIONS

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Abstract. The purpose of our study was to evaluate risk factors for hypercholesterolemia and correlates of serum lipid concentrations in Thai men and women. A cross-sectional study was conducted in 1,392 patients (380 men and 1,012 women) who received health examinations during July 1999 - February 2000 at King Chulalongkorn Memorial Hospital, Bangkok, Thailand. Serum total cholesterol (TC), triglyceride (TG) and high density lipoprotein- cholesterol (HDL-C) concentrations were determined using standard procedures. Logistic and linear regression procedures were used to assess the association of several covariates with risk for hypercholesterolemia. The results reveal that the prevalences of hypercholesterolemia (TC≥200 mg/dl) among men and women were 66.8% and 66.0%, respectively. Among men, hypercholesterolemia was associated with older adults (OR=3.26), and previous alcohol consumption (OR=2.05). Risk factors for women included advanced age (OR=3.19), and a family history of dyslipidemia (OR=1.59). Serum TC and TG were positively associated with age and previous alcohol consumption among men. Among women, TC and TG were strongly associated with age, body mass index (BMI) and family history of dyslipidemia. In men and women, HDL-C was inversely associated with BMI. More emphasis should be placed on understanding the epidemiology of hypercholesterolemia and other dyslipidemias in Thai men and women. More information regarding risk factors will aid in the development of effective health promotion and disease prevention efforts.

INTRODUCTION

Hypercholesterolemia is associated with increased risk for cardiovascular disease (Koanantakul *et al*, 2004; Li *et al*, 2005). The condition is rapidly becoming more prevalent in developing countries, leading to a global increase in coronary heart disease. Thailand, moving toward changes in lifestyle and behavior similar to that of Western cultures, is likely to face increasing challenges with preventing and controlling coronary heart disease, as well as other diseases prevalent among more obese and sedentary populations.

Cardiovascular diseases have been the leading cause of death in Thailand since 1987. Available data indicates lipid concentrations and mean blood pressure values have increased among Thais during the 12-year period of 1985-1997 (Sritara *et al*, 2003). Investigators noted these pivotal cardiovascular disease risk factors are increasing concomitantly with the prevalence of overweight and obesity among Thais (Sritara *et al*, 2003). Al-

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though much is known about hypercholesterolemia risk factors in European, North and South American populations (Donahue *et al*, 1985; de Souza *et al*, 2003; Nawrot *et al*, 2004), relatively little is known about the epidemiology of dyslipidemia in Thai men and women. In this study, we examined risk factors for hypercholesterolemia and their correlation with serum lipid and lipoprotein concentrations in Thai men and women using multivariate analytical methods.

MATERIALS AND METHODS

Study population and data collection

We conducted a cross-sectional study of 1,392 patients (380 men and 1,012 women) who participated in annual health examinations at the Preventive Medicine Clinic of the King Chulalongkorn Memorial Hospital in Bangkok, Thailand during the period of July 1999 through February 2000. During routine clinic visits participants were asked to provide information about their age, marital status, occupation, educational attainment, medical history, smoking status, alcohol consumption habits, participation in regular weekly physical exercise and other leisure activities. Participants were also asked to report on a family history of hypertension, type 2 diabetes mellitus, dyslipidemia, and cardiovascular disorders.

Participants underwent routine physical examinations, including determining their height, weight, resting blood pressure, and collecting an overnight fasting venous blood sample. Standing height was measured without shoes to the nearest 0.5 centimeter. Weight was determined without shoes and with participants lightly clothed. Weight was measured using an automatic electronic scale (Seca, Hamburg, Germany) to the nearest 100 grams. Blood pressure was determined using an automatic sphygmomanometer (UDEX-IIα, UEDA, Tokyo, Japan). Participants were instructed to sit resting for 5 minutes before blood pressure measurements were determined.

Laboratory analyses

Participants provided an overnight fasting venous blood sample. Serum samples were used to determine participants' lipid profiles. Serum triglyceride (TG) and total cholesterol (TC) concentrations were determined using standardized enzymatic procedures. TG was analyzed by glycerol phosphate oxidase assay. TC was quantified using the Trinder endpoint reaction in an automatic chemistry analyzer. High density lipoprotein-cholesterol (HDL) was measured by a chemical precipitation technique using dextran sulfate. All laboratory assays were completed without knowledge of the participants' medical history. Lipid and lipoprotein concentrations were reported in mg/dl.

All participants provided informed consent and the research protocol was reviewed and approved by the Ethics Committee of the Faculty of Medicine, Chulalongkorn University, and the Division of Human Subject Research, University of Washington.

Analytical variable specification

Participant body mass index (BMI) was calculated as weight (kilograms) divided by height (meters) squared. BMI was evaluated both as a continuous variable and as a categorical variable. We used the World Health Organization criteria (WHO, 1995) to classify subjects according to lean, normal, overweight and obese status per BMI: <20.0, 20.0-24.9, 25.0-29.9, and ≥30 kg/m^2, respectively.

Using the criteria of the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III), we defined subjects as hypercholesterolemic if their serum TC concentration was ≥200 mg/dl (NCEP, 2001). We performed analyses separately for TG, TC and HDL-C expressed as continuous variables. Additionally, we calculated the ratio of TC and

HDL-C and repeated analyses that integrated these two lipid measures.

For initial analyses, we categorized age by decades (<20, 20-29, 30-39, 40-49, 50-59, 60-69 and ≥70 years). For multivariable analyses we collapsed the categories to represent three groups (<40, 40-59, and ≥60 years). Other variables were categorized as follows: education (primary school only, incomplete bachelor degree, bachelor degree or higher); manual laborer (no *vs* yes); participants in regular weekly exercise (no *vs* yes); participant in leisure time activities (no *vs* yes); cigarette smoking history (never, past and current) and (never *vs* ever); and alcohol consumption (never, past and current). We also assessed family history of chronic disorders (no *vs* yes) for hypertension, type 2 diabetes, cardiovascular disease and dyslipidemia, respectively.

Statistical analyses

We first explored the frequency distributions of sociodemographic, behavioral characteristics and medical histories. For categorical variables we used the chi-square test to evaluate the differences in distribution of covariates for affected and unaffected patients. We examined the distribution of continuous variables, such as serum lipid concentrations and found them to be approximately normal. We used the Student's *t*-test to assess differences in mean values for covariates of interest among affected and unaffected subjects.

Logistic regression procedures were used to examine the risks of having elevated total cholesterol (≥200 mg/dl) concentrations. Univariate and multiple variable logistic regression procedures were employed to calculate unadjusted odds ratios (OR) of potential risk factors associated with hypercholesterolemia. Confidence intervals, at the 95% level, were also reported for each OR. Confounding factors were evaluated on the basis of their hypothesized relationship with the covariates of interest and with hypercholesterolemia. Confounding was assessed by entering potential confounders into a logistic regression model one at a time, and by comparing the adjusted and unadjusted OR (Rothman and Greenland, 1998). Final logistic regression models included covariates that altered unadjusted OR by at least 10%. Forward logistic regression modeling procedures combined with the change-in-estimate approach were used to identify the final models.

We used multiple linear regression models to assess the impact of several covariates on each lipid concentration (*ie*, TC, TG, HDL-C, and TC/HDL-C ratio). To assess confounding, we entered variables into a linear regression model one at a time, then compared coefficients. Final linear regression models included covariates that altered unadjusted coefficients by at least 10%, as well as those covariates of *a priori* interest (*eg*, alcohol consumption and BMI). Adjusted R^2 values are reported for each model and represent the total variation of the dependent variable (*eg*, TC, TG, and HDL-C) explained by that model. All analyses were completed separately for male and female patients. Statistical analyses were performed using SPSS (version 13.0, SPSS Chicago, IL, USA) software. All reported p-values are two tailed, and confidence intervals were calculated at the 95% level.

RESULTS

A description of characteristics according to hypercholesterolemia status within the study groups of Thai men and women are presented in Table 1. Of the 380 male participants, 66.8% were noted to be hypercholesterolemic (TC ≥200 mg/dl). The corresponding frequency of hypercholesterolemia among 1,012 women was 66.0%. Men with hypercholesterolemia were older than those without the condition (p=0.001). Women with

Table 1
Characteristics of study population according to hypercholesterolemia status.

Covariate	Among men High total cholesterol				p-value	Among women High total cholesterol				p-value
	No (N = 126)		Yes (N = 254)			No (N = 344)		Yes (N = 668)		
	n	%	n	%		n	%	n	%	
Age group (Years)					0.001					0.000
< 20	5	4.0	1	0.4		7	2.0	3	0.4	
20-29	28	22.2	31	12.2		71	20.6	66	9.9	
30-39	39	31.0	58	22.8		102	29.7	140	21.0	
40-49	19	15.1	65	25.6		102	29.7	196	29.3	
50-59	14	11.1	53	20.9		41	11.9	171	25.6	
60-69	15	11.9	36	14.2		18	5.2	78	11.7	
≥70	6	4.8	10	3.9		3	0.9	14	2.1	
Education					0.808					0.085
≤Primary education	37	29.4	68	26.8		155	45.1	338	50.6	
<Bachelor degree	48	38.1	105	41.3		93	27.0	175	26.2	
≥Bachelor degree	39	31.0	78	30.7		92	26.7	139	20.8	
Missing	2	1.6	3	1.2		4	1.2	16	2.4	
Labor work					0.206					0.163
Yes	13	10.3	38	15.0		52	15.1	80	12.0	
No	113	89.7	215	84.6		292	84.9	587	87.9	
Missing	0	0.0	1	0.4		0	0.0	1	0.1	
Body Mass Index (kg/m^2)					0.461					0.000
Underweight (<20.0)	23	18.3	36	14.2		96	27.9	111	16.6	
Normal (20.0-24.9)	65	51.6	122	48.0		164	47.7	312	46.7	
Overweight (25.0-29.9)	33	26.2	85	33.5		63	18.3	176	26.3	
Obesity (≥30.0)	5	4.0	11	4.3		21	6.1	66	9.9	
Missing	0	0.0	0	0.0		0	0.0	3	0.4	
Smoking status					0.864					0.650
Never smoker	66	52.4	126	49.6		324	94.2	623	93.3	
Previous smoker	39	31.0	80	31.5		15	4.4	28	4.2	
Current smoker	21	16.7	47	18.5		4	1.2	13	1.9	
Missing	0	0.0	1	0.4		1	0.3	4	0.6	
Ever smoked					0.636					0.686
Never	66	52.4	126	49.6		324	94	623	93.3	
Ever	60	47.6	127	50.0		19	5.5	41	6.1	
Missing	0	0.0	1	0.4		1	0.3	4	0.6	
Drinking status					0.161					0.433
Never drinker	50	39.7	81	31.9		260	75.6	517	77.4	
Previous drinker	31	24.6	85	33.5		62	18.0	101	15.1	
Current drinker	44	34.9	88	34.6		21	6.1	48	7.2	
Missing	1	0.8	0	0.0		1	0.3	2	0.3	
Exercise					0.913					0.328
Yes	63	50.0	126	49.6		115	33.4	244	36.5	
No	62	49.2	127	50.0		227	66.0	420	62.9	
Missing	1	0.8	1	0.4		2	0.6	4	0.6	

Table 1 (Continued).

Covariate	Among men High total cholesterol				p-value	Among women High total cholesterol				p-value
	No (N = 126)		Yes (N = 254)			No (N = 344)		Yes (N = 668)		
	n	%	n	%		n	%	n	%	
Leisure time activities					0.679					0.893
Yes	87	69.0	168	66.1		215	62.5	414	62.0	
No	39	31.0	83	32.7		129	37.5	253	37.9	
Missing	0	0.0	3	1.2		0	0.0	1	0.1	
Family history of high blood pressure					0.449					0.799
Yes	32	25.4	49	19.3		80	23.3	159	23.8	
No	79	62.7	148	58.3		205	59.8	391	58.5	
Unknown	15	11.9	57	22.4		59	17.2	118	17.7	
Family history of diabetes mellitus					0.379					0.530
Yes	32	25.4	70	27.6		80	23.3	167	25.0	
No	79	62.7	138	54.3		214	62.2	404	60.5	
Unknown	15	11.9	46	18.1		50	14.5	97	14.5	
Family history of cardiovascular disease					0.719					0.478
Yes	20	15.9	33	13.0		65	18.9	114	17.1	
No	91	72.2	168	66.1		225	65.4	447	66.9	
Unknown	15	11.9	53	20.9		54	15.7	107	16.0	
Family history of dyslipidemia					0.647					0.045
Yes	16	12.7	31	12.2		36	10.5	99	14.8	
No	95	75.4	158	62.2		246	71.5	445	66.6	
Unknown	15	11.9	65	25.6		62	18.0	124	18.6	

hypercholesterolemia were more likely to be older ($p<0.001$), heavier ($p<0.001$), and have a family history of dyslipidemia ($p=0.045$) than their counterparts without the condition.

Table 2 summarizes adjusted OR with 95% confidence intervals (CI) for selected risk factors for hypercholesterolemia among men and women. Overall, the risk of hypercholesterolemia increased with increasing age in men. The OR for 40-59 year old men, with men <40 years of age as the referent, was 3.26 (95% CI 1.82-5.34), and the OR for men age 60 years was 2.05 (95% CI 1.01-4.15). History of alcohol consumption was also noted to be a statistically significant risk factor for hypercholesterolemia among men. Those who reported having consumed alcohol in the past had a 2.05-fold increased risk of hypercholesterolemia (95% CI=1.08-3.89) compared to never drinkers. There was no clear evidence of an association between current alcohol consumption and hypercholesterolemia risk among men (OR=1.18, 95% CI=0.67-2.07). Risk for hypercholesterolemia among women increased with increasing age group. Those who were 40-59 years of age experienced a 1.77-fold increased risk (95% CI=1.27-2.48) compared to women who were <40 years of age. Women ≥60 years of age experienced a 3.19-fold increased risk of hypercholesterolemia (95% CI=1.71-5.92). A 1.59-fold increased risk of hypercholesterolemia (95% CI=1.04-2.43) was found among women with a family history of dyslipidemia, compared to

Table 2
Odds ratios (OR) and 95% confidence intervals (CI) of selected risk factors for hypercholesterolemia among Thai men and women receiving health examinations.

	Men		Women	
	OR	95% CI	OR	95% CI
Age (years)				
< 40	1.00	REF	1.00	REF
40-59	3.26	1.82-5.34	1.77	1.27-2.48
≥ 60	2.05	1.01-4.15	3.19	1.71-5.92
Body Mass Index (kg/m^2)				
Underweight (<20.0)	1.44	0.69-3.00	0.74	0.50-1.10
Normal (20.0-24.9)	1.00	REF	1.00	REF
Overweight (25.0-29.9)	1.11	0.62-2.01	1.34	0.90-1.99
Obesity (≥30.0)	1.22	0.35-4.35	1.29	0.72-2.29
Drinking status				
Never drinker	1.00	REF	1.00	REF
Previous drinker	2.05	1.08-3.89	0.93	0.62-1.40
Current drinker	1.18	0.67-2.07	1.00	0.56-1.81
Family history of dyslipidemia				
No	1.00	REF	1.00	REF
Yes	1.41	0.71-2.82	1.59	1.04-2.43

All OR adjusted for all other covariates in the model
Separate models were estimated for men and women

those without a family history of dyslipidemia.

Serum concentrations of total cholesterol, triglycerides, and TC:HDL-C ratio were positively associated with increasing age and body mass index (BMI) (Table 3). Men who were ≥60 years of age had higher mean total cholesterol concentrations (β=22.24, p=0.003) compared to those <40 years of age. Mean triglyceride concentrations were elevated by approximately 30 mg/dl in men ≥60 years of age compared to those <40 years of age. Mean values for TC:HDL-C ratio were 0.48 units higher among the oldest men compared to the referent group (p=0.014). We observed no evidence of an association between age and HDL-C concentrations.

Overweight (25.0-29.9 kg/m^2) and obese (≥30 kg/m^2) men had higher mean TG concentrations (β=28.14, p=0.017; and β=71.36, p=0.044, respectively) than men in the referent group (20.0-24.9 kg/m^2). Similar associations were observed when TC and TC:HDL-C ratios were examined. Notably, a statistically significant inverse relationship was observed between BMI and serum HDL-C concentrations. HDL-C concentrations were lower by approximately 5.63 mg/dl in overweight men (p<0.001) and 6.26 mg/dl in obese men (p=0.071), as compared to men in the referent group.

Previous drinkers had TC concentrations that were 16.44 mg/dl higher (p=0.012) on average than never drinkers. Current drinkers had higher mean triglyceride and HDL-C concentrations (β=18.66, p=0.106; and β=4.58, p=0.004, respectively) than men in the referent group. Individuals with a family history of dyslipidemia had a marginal statistically insig-

Table 3
Relationship between risk factor and lipid concentration: estimated linear regression coefficients (β), standard errors (SE), and p-values.

Independent covariates	Total cholesterol (mg/dl)		Triglyceride (mg/dl)		HDL-cholesterol (mg/dl)		Total Cholesterol: HDL Cholesterol ratio	
	β ± SE	p-value	β ± SE	p-value	β ± SE	p-value	β ± SE	p-value
Among men								
Age 40-59	27.67 ± 5.93	0.000	40.06 ± 11.36	0.000	0.05 ± 1.55	0.974	0.56 ± 0.16	0.000
Age ≥ 60	22.24 ± 7.47	0.003	29.58 ± 14.29	0.039	-0.16 ± 1.94	0.936	0.48 ± 0.20	0.014
BMI (kg/m^2)								
<20.0	2.76 ± 7.68	0.719	-20.42 ± 14.69	0.166	2.66 ± 1.99	0.183	-0.25 ± 0.20	0.218
20.0-24.9	REF		REF		REF		REF	
25.0-29.9	0.78 ± 6.11	0.899	28.14 ± 11.67	0.017	-5.63 ± 1.59	0.000	0.50 ± 0.16	0.002
≥30.0	14.85 ± 12.84	0.248	71.36 ± 24.52	0.044	-6.26 ± 3.45	0.071	1.12 ± 0.35	0.001
Previous drinking	16.44 ± 6.48	0.012	10.73 ± 12.44	0.389	2.63 ± 1.69	0.120	0.12 ± 0.17	0.465
Current drinking	1.82 ± 6.01	0.762	18.66 ± 11.49	0.106	4.58 ± 1.57	0.004	-0.29 ± 0.16	0.071
Family history of dyslipidemia	12.67 ± 7.14	0.077	-11.82 ± 13.65	0.387	2.69 ± 1.86	0.150	-0.02 ± 0.19	0.919
Adjusted R^2	8.10%		11.10%		7.70%		14.20%	
Among women								
Age 40-59	16.04 ± 3.58	0.000	26.35 ± 5.69	0.000	-1.73 ± 1.06	0.102	0.45 ± 0.09	0.000
Age ≥ 60	31.92 ± 5.71	0.000	57.79 ± 9.07	0.000	-1.90 ± 1.68	0.258	0.75 ± 0.14	0.000
BMI (kg/m^2)								
<20	-9.37 ± 4.26	0.028	-6.97 ± 6.76	0.303	1.59 ± 1.25	0.206	-0.22 ± 0.11	0.042
20-24.99	REF		REF		REF		REF	
25-29.99	6.16 ± 3.96	0.120	32.07 ± 6.29	0.000	-6.26 ± 1.17	0.000	0.61 ± 0.10	0.000
≥30	6.20 ± 5.67	0.275	39.25 ± 9.01	0.000	-8.65 ± 1.67	0.000	0.82 ± 0.14	0.000
Previous drinking	1.13 ± 4.33	0.794	1.59 ± 6.89	0.817	3.94 ± 1.28	0.002	-0.23 ± 0.11	0.036
Current drinking	3.54 ± 6.05	0.559	-5.12 ± 9.61	0.595	2.07 ± 1.78	0.247	-0.09 ± 0.15	0.564
Family history of dyslipidemia	14.67 ± 4.16	0.000	11.47 ± 6.61	0.083	1.06 ± 1.23	0.387	0.17 ± 0.11	0.108
Adjusted R^2	8.50%		13.40%		9.30%		17.60%	

All coefficients and standard errors (β ± SE) adjusted for all other covariates in the model
Separate models were estimated for men and women

nificant increase in TC (β=12.67, p=0.077) concentrations.

Among women, we noted positive associations among increasing age and BMI and TC, TG, and the TC:HDL-C ratios. Women who were ≥60 years of age had higher mean TC concentrations (β=31.92, p<0.001) when compared with those who were <40 years of age. Likewise, mean TG concentrations were elevated by approximately 57.79 mg/dl (p<0.001) among women ≥60 years of age as compared with those <40 years of age. Mean values for the TC:HDL-C ratio were 0.75 higher among the oldest women compared to the referent group (p<0.001). We did not observe an association between HDL-C concentrations and age among women.

When compared to the referent group, overweight and obese women had higher mean TG concentrations (β=32.07, p<0.001; and β=39.25, p<0.001, respectively) than women with a normal BMI. A similar pattern of association was observed between BMI and TC: HDL-C ratios (β=0.61, p<0.001; and β=0.82, p<0.001, for overweight and obese women, respectively). As was seen in men, we noted statistically significant reductions in mean HDL-C concentrations among overweight (β=-6.26, p<0.001) and obese individuals (β=-8.65, p<0.001) when compared to the referent group.

Women who reported having previously consumed alcohol had statistically significantly higher HDL-C concentrations (by approximately 3.94 mg/dl, p=0.002) compared to women who reported never consuming alcohol. There was evidence of increased HDL-C concentrations (β=2.07, p=0.247) in those with current alcohol consumption, though this association did not reach statistical significance due to the small numbers. Notably, women with a positive family history of dyslipidemia had mean TC concentrations that were 14.67 mg/dl (p<0.001) higher than those women without a family history of dyslipidemia.

DISCUSSION

Using multivariable logistic regression procedures we noted that among men, hypercholesterolemia (TC ≥200 mg/dl) was associated with older adults (OR=3.26), and previous alcohol consumption (OR=2.05). Risk factors for women included older age (OR=3.19), and a positive family history of dyslipidemia (OR=1.59). From multivariable linear regression analyses, we noted that serum TC and TG were positively associated with age and previous alcohol consumption among men; whilst among women we found that TC and TG were strongly associated with age, BMI and family history of dyslipidemia. In both men and women, we noted that HDL-C was inversely associated with BMI. In regression models age, BMI, drinking status and family history of dyslipidemia accounted for approximately 8% and 9% of serum HDL-C concentrations in man and women, respectively.

Results from our study are largely similar to those reported by investigators who studied other populations (Hodge *et al*, 1996; Kawada, 2002; de Souza *et al*, 2003; Tsai *et al*, 2004; Deutch *et al*, 2005). Tsai *et al* (2004) in their study of Taiwanese subjects reported that after adjustment for age, lifestyle and sociodemographic characteristics, the risk of hypercholesterolemia increased with increasing BMI for both men and women. In a study of Japanese subjects, Kawada (2002) observed that odds ratios for hypercholesterolemia (≥240 mg/dl) increased across successively higher quartiles of BMI (ORs: 1.0, 2.1, 3.3 and 4.6, with the lowest quartile being the referent group). We noted a linear increase in risk of hypercholesterolemia with increasing BMI for Thai women. A similar pattern of risk was not seen in the men in our study. The relatively small sample of men in our study hindered our analyses.

The positive association we noted between age and hypercholesterolemia is also

consistent with several previous reports (Kawada, 2002; de Souza *et al*, 2003; Tsai *et al*, 2004). We, like others have reported a family history of dyslipidemia is associated with an increased risk of hypercholesterolemia (de Souza *et al*, 2003), however, the association we observed in men did not reach statistical significance. Consistent with other reports, we noted a modest increased hypercholesterolemia risk with low educational attainment (de Souza *et al*, 2003). In accordance with other studies we noted that overweight and obesity were more related to elevated mean TG concentrations than to TC concentrations (de Souza *et al*, 2003). The positive association noted between alcohol consumption and serum HDL-C concentrations in men and women is consistent with a report by Donahue *et al* (1985) who noted the risk of coronary heart disease is reduced among subjects who consume moderate amounts of alcohol on a regular basis (Mukamal and Rimm, 2001).

Several important limitations must be considered when interpreting the results of our study. First, information concerning subjects' behavioral and lifestyle characteristics was collected at the time of physical examination. Because of this cross sectional data collection design, we cannot be certain of the temporal relation between risk factors and the health indicators of interest. Second, information concerning lifestyle and behavioral characteristics (*eg*, alcohol consumption and physical activity) was based upon self-reports. Therefore, we cannot exclude the possibility that some misclassification may have occurred. Third, precise details of potentially important covariates, such as the frequency, amount, duration and intensity of physical activity, for example, were not collected. Therefore, inferences from our study are limited by the relatively imprecise data collection procedures used. Fourth, the number of men included in our analyses was relatively small, hence, the estimated odds ratios were often imprecise, as reflected by the wide 95% confidence intervals. The concordance of our findings with those from other investigations (Hodge *et al*, 1996; Kawada, 2002; de Souza *et al*, 2003; Tsai *et al*, 2004; Deutch *et al*, 2005), however, attenuates some concerns about study limitations, and suggests that valid inferences may be drawn from our study.

In conclusion, our study confirms associations between increasing age, overweight status, and family history of dyslipidemia as risk factors for hypercholesterolemia among Thai men and women. Results from linear regression models were generally consistent with findings derived from logistic regression analyses. We documented characteristic alterations in plasma lipids and lipoprotein concentrations in relation to several well established cardiovascular disease risk factors, such as advanced age, increased BMI, family history of dyslipidemia and alcohol consumption. It is important to note that in the regression analyses, not more than 18% of the variation in lipid and lipoprotein concentrations could be explained by the factors in the multivariate models. This implies that additional studies, designed to increase our understanding of the role modifiable factors (*eg*, dietary patterns and physical activity patterns) and genetic factors play in influencing the lipid profiles of Thai men and women, are needed. Information gained from such studies may then be used to develop effective health promotion and cardiovascular disease prevention programs.

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