Risk Analysis of Coronary Heart Diseases in Korean Adults by Using The National Cholesterol Education Program Adult Treatment Panel III

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The National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III), updated in 2001, quantified the risk factors and made it possible to assess risks for metabolic syndrome (MS) and coronary heart diseases (CHD). Many reported the prevalence of MS by NCEP ATP III in Orientals but few did risk analysis of CHD. We investigated the risk of CHD in Korean adults and the distribution of population for therapeutic lifestyle change (TLC) and drug therapy according to the NCEP ATP III guidelines. Based on ATP III risk factors, estimates of the 10-year risk for CHD on 16,383 Koreans and the distributions of population for the TLC and additional drug therapy by sex

and age were calculated. High-, intermediate-, and low-risk groups were 8.1%, 24.1%, and 67.8%, respectively; 12.1% (high-, intermediate-, and low-risk groups: 32.0%, 45.1%, and 6.0%, respectively) needed TLC and 6.1% (high-, intermediate-, and low-risk groups: 39.4%, 16.6%, and 1.3%, respectively) needed additional drug therapy. The groups with higher risk needed more TLC and drug therapy. In the same age group, the rates of high risk in men showed a 1.0–6.6 fold increase compared with those in women. In Koreans, those who needed TLC and drug therapy were substantially lower than those in Americans. *J. Clin. Lab. Anal.* 21:178–182, 2007. © 2007 Wiley-Liss, Inc.

Key words: adult treatment panel III; coronary heart disease; Korean; low-density lipoprotein cholesterol; national cholesterol education program; therapeutic lifestyle change.

INTRODUCTION

The U.S. National Heart, Lung, and Blood Institute (NHLBI) has released the National Cholesterol Education Program (NCEP) Adult Treatment Panel (ATP) guidelines three times (1–3). They defined therapeutic criteria for low density lipoprotein cholesterol (LDL-C) reduction treatment according to each individual's risk for coronary heart diseases (CHD) (4,5). Risk assessment and treatment guidelines by ATP II were simply determined by the number of major risk factors and the LDL-C level. NCEP ATP III introduced Framingham projections of 10-year absolute CHD risk (the percent

probability of having a CHD event in 10 years) to identify certain patients with multiple (two or more) risk

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factors for more intensive treatment. And diagnostic criteria for metabolic syndrome (MS) were also established (3). Many reported the risk analysis and prevalence of MS by NCEP ATP III in Orientals but few did risk analysis of CHD using quantitative analysis of risk factors and Framingham projection (6–9).

This study was carried out to investigate the risk of CHD in Korean adults and the distribution of population for therapeutic lifestyle change (TLC) and additional drug therapy by using the NCEP ATP III.

MATERIALS AND METHODS

The subjects for this study were 16,383 adults aged from 20 to 79 years old who visited the Health Promotion Center of Asan Medical Center from July to December of 2001. Among them, men and women were 9,795 and 6,588, respectively. The mean age of men and women populations was 46.5 ± 9.8 and 46.1 ± 10.6 years. Of the subjects, 65% were living in Seoul and had regular check ups and subsequent consultations regarding diet and exercise if needed.

Among major risk factors by ATP III, cigarette smoking, family history of premature CHD (CHD in male first-degree relative <55 years of age; CHD in female first-degree relative <65 years of age) and age (men ≥ 45 years; women ≥ 55 years) were investigated by using survey questionnaire written by study subjects. Hypertension was defined as having mean systolic pressure over 140 mmHg or diastolic pressure over 90 mmHg after two measurements in stable and comfortable state or on antihypertensive medication. If high-density lipoprotein cholesterol (HDL-C) is <1.03 mmol/L, it was considered as low HDL-C.

Applying Framingham projections using age, total cholesterol, cigarette smoking, HDL-C, and systolic blood pressure, 10-year absolute CHD risk (i.e., the percent probability of having a CHD event in 10 years) was calculated (3).

Blood samples were taken in the morning after fasting more than 9 hr. Serum total cholesterol, triglycerides (TG), HDL-C and glucose concentrations were measured with enzymatic methods on Hitachi 747–200 analyzers (Hitachi, Tokyo, Japan). Serum LDL-C concentration was calculated with the Friedewald formula (10). High-sensitive C-reactive protein (hs-CRP) concentration was measured with immunoturbidimetry on a Cobas Integra 800 (Roche Diagnostic Systems, Basel, Switzerland).

By counting major risk factors by ATP III and then assessing 10-year CHD risk with Framingham scoring for persons with multiple risk factors, subjects were divided into four risk categories (RC); RC I (high risk group): CHD, CHD risk equivalents or 10-year risk

>20%; RC II (intermediate risk group): ≥ 2 CHD risk factors and 10-year risk 10 to 20%; RC III (intermediate risk group): ≥ 2 CHD risk factors and 10-year risk <10%; RC IV (low risk group): ≤ 1 CHD risk factor. In each risk category, groups for initiation of TLC or additional drug treatment were divided by LDL-C goals and cut-points (3).

RESULTS

Based on ATP III, RC I, RC II, RC III, and RC IV were 8.1%, 12.0%, 12.1%, and 67.8%, respectively. With advancing age, the proportion of RC I increased both in men and women. In the same age group, the rates of RC I in men showed 1.0- to 6.6-fold increase compared with those of RC I in women (Table 1).

Persons who needed TLC were 12.1% (RC I, 32.0%; RC II, 29.5%; RC III, 15.6%; and RC IV, 6.0%) and those who needed drug therapy were 6.1% (RC I, 39.4%; RC II, 10.2%; RC III, 6.4%; and RC IV 1.3%) in total subjects (Table 2). The high risk groups had the higher percentage of those needing TLC and drug therapy. With advancing age, the percentage of those who needed TLC increased both in men and women (men, 2.4–25.6%; women, 1.2–23.4%), and the percentage of those who needed drug therapy increased for both sexes (men, 1.9–13.2%; women, 0.3–20.6%). In the same age group, men had a larger need for TLC and

TABLE 1. Estimated relative frequencies of risk categories for coronary heart diseases according to Adult Treatment Panel III

Age (years)	Relative frequencies of risk categories (%)				
	I ^a	II ^b	III ^c	IV ^d	Total
Men					
20–29	0.5	0.3	17.2	82.0	100.0
30–39	3.3	5.1	15.4	76.2	100.0
40–49	8.0	16.3	19.0	56.7	100.0
50–59	15.6	30.4	13.5	40.5	100.0
60–69	21.1	42.8	0.9	35.2	100.0
≥ 70	41.1	30.2	0.0	28.7	100.0
Women					
20–29	0.5	0.0	1.8	97.7	100.0
30–39	0.5	0.0	1.8	97.6	100.0
40–49	2.5	0.1	1.9	95.5	100.0
50–59	7.5	0.3	14.5	77.7	100.0
60–69	17.5	3.1	27.2	52.2	100.0
≥ 70	19.6	15.0	13.1	52.3	100.0

^aPersons with CHD, CHD risk equivalents or 10-year risk for CHD of >20%.

^bPersons with multiple (2+) risk factors and 10-year risk for CHD of 10–20%.

^cPersons with multiple (2+) risk factors and 10-year risk for CHD of <10%.

^dPersons with 0–1 risk factors.

TABLE 2. Distribution of adults who need therapeutic lifestyle change or drug treatment to prevent coronary heart diseases according to risk categories

Risk categories	Baseline LDL-cholesterol levels below cut-points		Therapeutic lifestyle change		Drug treatment		Total	
	n	%	n	%	n	%	n	%
I ^a	381	2.3	426	2.6	524	3.2	1,331	8.1
II ^b	1,182	7.2	579	3.5	199	1.2	1,960	12.0
III ^c	1,544	9.4	308	1.9	126	0.8	1,978	12.1
IV ^d	10,301	62.9	665	4.1	148	0.9	11,114	67.8
Total	13,408	81.8	1,978	12.1	997	6.1	16,383	100.0

^aPersons with CHD, CHD risk equivalents or 10-year risk for CHD of >20%.

^bPersons with multiple (2+) risk factors and 10-year risk for CHD of 10–20%.

^cPersons with multiple (2+) risk factors and 10-year risk for CHD of <10%.

^dPersons with 0–1 risk factors.

TABLE 3. Relative frequencies of adults who need therapeutic lifestyle change and drug treatment to prevent coronary heart diseases according to age and sex

Age (years)	Therapeutic lifestyle change (%)		Drug treatment (%)	
	Men	Women	Men	Women
20–29	2.4	2.8	1.9	0.3
30–39	8.9	1.2	3.5	0.7
40–49	14.1	5.1	6.6	2.4
50–59	20.3	14.3	10.4	7.6
60–69	19.3	19.4	9.5	13.5
≥70	25.6	23.4	13.2	20.6
Average	15.1	11.0	7.5	7.5

drug therapy than women, but after age 60 years, women had a larger need than men for intervention (Table 3).

The mean concentrations of total cholesterol, TG, LDL-C, and HDL-C in the Korean population are shown in Table 4.

Mean value of TG and hs-CRP for each risk category showed that TG and hs-CRP were statistically higher in the high risk category. The mean value of TG and hs-CRP for RC I showed a 1.7-fold and 2.2-fold increase compared to RC IV (Table 5).

DISCUSSION

Among Koreans, 12.1% needed TLC and 6.1% needed drug therapy by ATP III criteria, which was about one third of the American data of 33% and 18%, respectively. Compared with the same age groups in Americans by NHANES III, Koreans were lower in total cholesterol levels and higher in HDL-C levels,

which resulted in lower percentage of high risk group and lower percentage of the need for TLC and drug therapy might be attributed to lower LDL-C levels (3,11). Additionally, the reasons why Koreans had lower percentages for TLC and drug therapy than Americans were presumed to be lower prevalence of hypertension and diabetes mellitus in Koreans. The prevalence of hypertension and diabetes mellitus was 14.8% and 9.2%, respectively, which was substantially lower than 28% and 14% in Americans by National Health and Nutrition Examination Surveys (NHANES) (12,13). The smoking rate in this study was 29%, which was higher than 25% in Americans by the National Center For Chronic Disease Prevention and Health Promotion in 1999 (14).

In all age groups, Korean men were a higher percentage of the high risk group than women. This finding was due to the fact that Korean men had a higher prevalence of diabetes mellitus (men, 10.5%; women, 7.4%), smoking (men, 46.0%; women, 3.9%) and hypertension (men, 16.4%; women, 12.4%) as well as higher total cholesterol levels (men, $1,969 \pm 352$ mg/L; women, $1,927 \pm 363$ mg/L; $P < 0.01$). It was consistent with arguments that age applicable to risk factor started from 45 years in men and 55 years in women and that with the same Framingham point score men had a higher 10-year risk percent than women.

With advancement of age, need for TLC and drug therapy increased and the need for intervention in men was higher than in women at the same age group. However, the need for intervention was higher in women than in men after the age of 60 years, which might be due to higher LDL-C level in women after the age of 50 years.

In subjects of this study, those who needed drug therapy by ATP II were 3.3%. Using ATP III, those who needed drug therapy showed an 1.8-fold increase

TABLE 4. Total cholesterol, triglyceride, HDL-cholesterol, and LDL-cholesterol levels by age and sex

	Mean±standard deviation of serum concentration (mg/dL)				
Age (years)	n	Total cholesterol	Triglyceride	HDL-cholesterol	LDL-cholesterol
Men					
20–29	373	172.7±34.0	118.4±81.5	52.1±11.8	96.9±30.2
30–39	1,750	192.2±34.3	163.5±104.2	48.8±10.9	110.8±31.7
40–49	4,348	198.6±35.7	164.2±113.6	49.4±11.3	116.4±32.7
50–59	2,318	201.7±33.6	159.2±99.8	50.3±11.6	119.5±32.2
60–69	877	195.5±33.6	153.0±97.9	50.6±12.6	114.3±32.5
≥70	129	192.8±34.8	137.6±92.6	50.9±13.6	114.5±31.9
Total	9,795	196.9±35.2	159.8±106.5	49.8±11.5	115.2±32.6
Women					
20–29	389	169.1±29.5	81.8±38.8	60.9±13.8	91.9±26.0
30–39	1,359	174.6±29.7	91.7±58.0	58.4±12.3	97.9±26.7
40–49	2,521	190.9±32.6	102.6±57.0	59.3±13.1	111.1±29.4
50–59	1,568	207.9±36.3	133.3±77.9	56.6±13.1	124.7±33.1
60–69	644	210.6±36.3	150.5±80.7	54.6±13.3	125.9±32.9
≥70	107	222.9±45.8	162.6±84.5	55.9±13.4	134.5±39.6
Total	6,588	192.7±36.3	112.1±68.5	58.0±13.1	112.3±32.3

TABLE 5. Triglyceride and high sensitive C-reactive protein (hs-CRP) levels according to risk categories

Risk categories	Triglyceride (mg/dL)		hs-CRP (mg/dL)	
	Mean $\pm$ standard deviation	<i>P</i> value ^a	Mean $\pm$ standard deviation	<i>P</i> value ^a
I ^b	202.1 $\pm$ 160.9	<0.05	0.26 $\pm$ 0.76	<0.05
II ^c	186.0 $\pm$ 102.0	<0.05	0.18 $\pm$ 0.37	<0.05
III ^d	171.0 $\pm$ 99.6	<0.05	0.17 $\pm$ 0.43	<0.05
IV ^e	119.9 $\pm$ 102.0	<0.05	0.12 $\pm$ 0.32	<0.05

^a*P* value obtained by using the analysis of variance (ANOVA) test.

^bPersons with CHD, CHD risk equivalents or 10-year risk for CHD of >20%.

^cPersons with multiple (2+) risk factors and 10-year risk for CHD of 10–20%.

^dPersons with multiple (2+) risk factors and 10-year risk for CHD of <10%.

^ePersons with 0–1 risk factors.

(6.1%/3.3%) compared with those by ATP II, which increment was lower than that of Americans (2.6-fold; 18%/7%) (3,11). The main reason for this was the relatively low prevalence of diabetes mellitus, a CHD risk equivalent, in Koreans.

ATP III recommended that young adults (men 20–35 years of age; women 20–45 years of age) with LDL-C over 3.36 mmol/L should institute TLC (3); 21.1% of men aged 20–35 years and 15.4% of women aged 20–45 years had LDL-C over 3.36 mmol/L. Among young adults with LDL-C over 3.36 mmol/L in this study, 58.5% of men (145/248) and 76.5% of women (385/503) were in categories that did not require any specific treatment by ATP III.

Not only young men who smoke and have LDL-C over 4.14 mmol/L but also young adults who have very

high LDL-C levels (≥ 4.91 mmol/L) may be candidates for LDL-lowering drug therapy. Young men who smoke and have LDL-C over 4.14 mmol/L were 3.7% and young adults with LDL-C over 4.91 mmol/L were 0.8%. However, 34.9% of men (15/43) and 18.5% of women (5/27) did not require any additional drug therapy by ATP III.

Lipoprotein(a), homocysteine, high fasting glucose, and prothrombotic and proinflammatory markers were not defined as major CHD risk factors by ATP III, but they have been reported as CHD risk factors (15–18). hs-CRP, a proinflammatory acute-phase reactant, was known as an independent risk factor to predict future coronary events in apparently healthy men and women (15). hs-CRP could also be used to screen those with a higher risk for coronary events independent of LDL-C (19). The mean value of hs-CRP in the high risk group

was 2.6 mg/L, which was significantly higher than 1.8 mg/L in the intermediate risk group and 1.2 mg/L in the low risk group, which highly suggested the value of the parameter as an independent risk factor predicting future coronary events in Koreans.

ATP III recommended that those who have a high TG (≥ 2.26 mmol/L) should have less than 0.78 mmol/L of difference between non-HDL cholesterol (sum of LDL-C and VLDL-C) and LDL-C (3). In this study, 17.4% of entire subjects (2,849/16,383) had a TG ≥ 2.26 mmol/L and all had over 1.03 mmol/L of difference between non-HDL cholesterol and LDL-C. Among those, 76.9% (2,191/2,849) were in a category that did not require any therapy by ATP III.

This study was based on the data from more than 16,000 visitors to the Health Promotion Center of Asan Medical Center for annual regular health checkups, a tertiary care center located in Seoul populated by more than a fourth of entire Korea. Thus, this study could represent the lipid profile of the population of a metropolitan area. In men, mean total cholesterol and LDL-C peaked in their 50s and TG in their 40s. Women had an increasing trend in those parameters with advancement of age. These accorded well with a previous report (20). Compared with the values of Americans in the same age groups by NHANES III, Koreans had lower mean total cholesterol, LDL-C, and TG and higher mean HDL-C (except in women over 50 years of age) (3).

In conclusion, the high risk group in Koreans by ATP III was 8.1%; 12.1% needed TLC and 6.1% needed drug therapy, which was significantly lower than the 33% and 18% in Americans. The reasons why Koreans had lower percentages for TLC and drug therapy than Americans might be due to the lower prevalence of hypertension and diabetes in Koreans.

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