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Prevalence and Management of Dyslipidemia in Korea: Korea National Health and Nutrition Examination Survey during 1998 to 2010

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Background: Dyslipidemia is a major risk factor of cardiovascular disease. The aim of this study was to investigate the changing trends in the prevalence and management status of dyslipidemia among Korean adults.
Methods: The prevalence of dyslipidemia and the rates of awareness, treatment, and control of dyslipidemia were investigated in adults aged ≥20 years from the Korea National Health and Nutrition Surveys (KNHANES) 1998 to 2010. The updated National Cholesterol Education Program criteria was used, which define dyslipidemia as having one or more of the following lipid abnormalities: hypercholesterolemia (total cholesterol ≥240 mg/dL or diagnosis of dyslipidemia or use of lipid-lowering drugs), hypertriglyceridemia (≥150 mg/dL), hyper-low density lipoprotein (LDL) cholesterolemia (≥160 mg/dL or diagnosis of dyslipidemia or use of lipid-lowering drugs), and hypo-high density lipoprotein (HDL)-cholesterolemia (<40 mg/dL in men and <50 mg/dL in women).
Results: The number of participants was 6,921, 4,894, 5,312, 2,733, 6,295, 6,900, and 5,738 in KNHANES 1998, 2001, 2005, 2007, 2008, 2009, and 2010, respectively. Age-standardized prevalence rates of dyslipidemia were 54.0%, 65.8%, 66.5%, 60.6%, 58.7%, 58.9%, and 59.0% in 1998, 2001, 2005, 2007, 2008, 2009, and 2010, respectively. Hypertriglyceridemia and hypo-HDL-cholesterolemia were the two most frequent lipid abnormalities. The overall prevalence of hypercholesterolemia and hyper-LDL-cholesterolemia increased by 1.36- and 1.35-fold in 2010 compared with 2007, respectively. Awareness, treatment, and control rates of dyslipidemia improved over the period of surveys in both sexes. In 2010, about 30% of dyslipidemic patients who received lipid-lowering treatment reached target levels.
Conclusion: Although the management status of dyslipidemia has improved during recent years, effective strategy is required for achieving better prevention, treatment, and control of dyslipidemia.

Keywords: Dyslipidemia, Korea; Prevalence

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INTRODUCTION

Cardiovascular disease is one of main causes of death worldwide [1]. In Korea, cardiovascular disease accounted for approximately 1 of every 10 deaths from 2011 mortality data [2]. Metabolic syndrome is an important risk factor for cardiovascular disease [3,4] and adult Koreans with the metabolic syndrome are more likely to have a history of cardiovascular disease than those without the syndrome [5]. Among the five components of the metabolic syndrome, dyslipidemia, and abdominal obesity were the major factors influencing the increased prevalence of metabolic syndrome in Koreans for the past 10 years [6]. Previous epidemiologic studies revealed that high-carbohydrate diet, abdominal obesity, and physical inactivity were related with greater risk of elevated triglyceride and low high density lipoprotein cholesterol (HDL-C) levels in Korean population [7,8].

Since dyslipidemia has been considered as an important risk factor that contributes to the development of cardiovascular disease, the assessment of the prevalence and management status of dyslipidemia in recent years would be an initial step for planning preventive strategy reducing the development of cardiovascular disease. Studies from the United States using the data from the National Health and Nutrition Examination Surveys (NHANES) 1988 to 2010 reported a decrease in total cholesterol and low density lipoprotein cholesterol (LDL-C), an increase in triglyceride, and an unchanged HDL-C level in United States [9]. Meanwhile, in Japanese general population, the total cholesterol level and triglyceride level (only in men) increased in past 10 years (1990 to 2000) [10]. Lee et al. [11] reported that prevalence of dyslipidemia in Korea gradually increased from 1998 to 2005 through the data from Korea National Health and Nutrition Survey (KNHANES) 1998, 2001, and 2005. However, a relatively short duration of the study, as well as the differences in the definition of dyslipidemia between KNHANES 2005 and 1998/2001 make direct comparisons difficult [11].

In this study, we investigated the recent changes in the prevalence, awareness, treatment, and control rates of dyslipidemia among Korean adults in KNHANES 1998 to 2010 by adopting an updated National Cholesterol Education Program Adult Treatment Panel (NCEP-ATP) III definition [12]. We also investigated the changes in the factors constituting dyslipidemia among Korean adults.

METHODS

Data source and study population

This study was performed using the data from KNHANES I (1998), II (2001), III (2005), and IV (2007 to 2009), V (2010). KNHANES is a nationwide, community-based cross-sectional survey examining the general health and nutrition status of the noninstitutionalized civilians of Korea, conducted by the Division of Health and Nutritional Survey under the Korean Centers for Disease Control and Prevention (KCDCP). It consisted of three distinct surveys: health interview survey, health examination survey, and nutrition survey. Participants were selected from sampling units based on geographical area-, sex-, and age-groups using household registries with a stratified, multistage, clustered, probability sampling design. This sampling method is certified as producing representative statistics by the Korea Department of Statistics. KNHANES was conducted according to the guidelines laid down in the Declaration of Helsinki. All participants in the survey signed an informed consent form. The Institutional Review Board of KCDCP approved the protocol.

In KNHANES I (1998) and II (2001), individuals were not asked about their prior diagnosis and management in the health interview survey because the prevalence of dyslipidemia was considered to be very low in Korea at that time period. Self-reported prior diagnosis of dyslipidemia and current use of lipid-lowering drugs were available since 2005. We analyzed subjects over 20 years old and completed the health examination and health interview survey as well. In the analysis, any measurements that were missing total cholesterol, HDL-C, or triglycerides were excluded. All individuals voluntarily agreed to participate in this survey and informed consent was obtained from all of them. The survey protocol was approved by an Institutional Review Board of KCDCP.

Dyslipidemia was defined entirely based on the blood test results in the health examination performed in 1998 and 2001. The definition of dyslipidemia was made according to the presence of one or more of the following criteria: hypercholesterolemia (total cholesterol ≥240 mg/dL); hypertriglyceridemia (triglyceride ≥150 mg/dL); hyper-LDL-cholesterolemia (LDL-C ≥160 mg/dL); and hypo-HDL-cholesterolemia (HDL-C <40 mg/dL in men and <50 mg/dL in women). Since 2005, dyslipidemia was determined with fasting blood tests as well as health interview survey data. Hypercholesterolemia was defined by previous diagnosis by physician or current use of lip-

id-lowering drugs or total cholesterol of ≥240 mg/dL. Hyper-LDL-cholesterolemia was defined by previous diagnosis by medical doctor or current use of lipid-lowering medications or LDL-C of ≥160 mg/dL. Hypo-HDL-cholesterolemia and hypertriglyceridemia were defined in the same manner as in 1998 and 2001.

And then, we divided the participants into diabetic and non-diabetic subjects to compare the prevalence and management status of dyslipidemia between the two groups. The diagnostic criteria for diabetes mellitus were obtained from the American Diabetes Association (ADA) guidelines [13]: diabetes was diagnosed in subjects whose level of fasting plasma glucose was over 126 mg/dL or who responded to health interview survey as having had a previous diagnosis of diabetes by physician or treated with antidiabetic agents or insulin. We categorized the lipid-related risks of coronary artery disease in diabetic participants according to the updated NCEP-ATP III and the 2008 ADA/American College of Cardiology Statement [14]. Patients with diabetes alone should be considered to be at high risk, while patients with diabetes and one or more additional risk factors of coronary artery disease are considered to be at very high risk. The major risk factors of coronary artery disease included high LDL-C (≥160 mg/dL), cigarette smoking, hypertension (systolic/diastolic blood pressure ≥140/90 mm Hg or use of antihypertensive medication), low HDL-C (<40 mg/dL), and age (men ≥45 years, women ≥55 years). When HDL-C concentration was ≥60 mg/dL, one risk factor was subtracted from a patient's overall risk profile.

Awareness rate, treatment rate, and control rate of dyslipidemia were defined using the health interview survey and the health examination survey results from KNHANES. Awareness rate was defined as the number of individuals who were identified in the health interview survey as having had a previous diagnosis of dyslipidemia by a physician divided by the number of people with dyslipidemia. Treatment rate was defined as participants whose response to the health interview survey indicated that they have been taking lipid-lowering drugs among those with dyslipidemia. Treatment goal was defined according to the American Association of Clinical Endocrinologists guidelines for management of dyslipidemia [15]. Control rate was defined based on individuals who reached treatment goal (LDL-C levels <160 mg/dL, triglyceride levels <150 mg/dL, HDL-C levels >40 mg/dL in men and >50 mg/dL in women) among who have taken lipid-lowering drugs. For the definition of control rate in diabetic participants, LDL-C target of <100 mg/dL was used. Dyslipidemic patients with a very high risk of coronary artery disease had LDL-C target of <70 mg/dL.

Biochemical measurements

The blood samples were drawn from antecubital vein of each participant in the morning after fasting for at least 8 hours. Samples were properly processed, refrigerated at 2°C to 8°C, and immediately sent to the Central Testing Institute in Seoul, Korea, where plasma was separated immediately by centrifugation. The fasting plasma concentrations of glucose and lipids were measured enzymatically in a central laboratory; a 747-chemistry analyzer was used (Hitachi, Tokyo, Japan) in the 1998 and 2001 studies, while an Advia 1,650/2,400 was employed (Siemens, New York, NY, USA) in 2005 and 2007, and a Hitachi Automatic Analyzer 7600 (Hitachi) was used in 2008, 2009, and 2010. Because the analysis tool and the method of measuring HDL-C were changed due to changes in clinical laboratory organization, revised HDL-C level was derived since 2007 according to the Lipid Standardization Program [16] made by Centers for Disease Control and Prevention (CDC) in the United States. LDL-C was calculated using Friedewald's formula [17] in individuals with triglycerides ≤400 mg/dL. LDL-C level has been directly measured using automated enzymatic techniques since 2009 in KNHANES IV.

Statistical analysis

Statistical analyses were performed with complex-samples analysis procedures in SPSS version 19.0 (IBM Co., Armonk, NY, USA). We used KNHANES stratification variables and sampling weights designated by KCDCP, which were based on the sample design of each survey year. Data were presented as percentage (standard error) for nominal data or means±standard error for continuous variables. The age-standardized prevalence of dyslipidemia and other lipid abnormalities were calculated by the age- and sex-specific structure of the 2010 Korean population. As the definition of dyslipidemia changed in KNHANES 2005 and revised HDL-C level have been available since the KNHANES 2007, we compared the prevalence of dyslipidemia during 2007 to 2010. In order to compare the prevalence rates of each year, logistic regression analyses were used. Every comparison among the studies was done after age adjustment.

RESULTS

A total of 6,921 (aged 43.2±0.37 years), 4,894 (45.8±0.40),

5,312 (43.5±0.35), 2,733 (44.2±0.48), 6,295 (44.7±0.38), 6,900 (44.9±0.36), and 5,738 (45.0±0.44) respondents were available for analysis from KNHANES in the 1998, 2001, 2005, 2007, 2008, 2009, and 2010, respectively. Table 1 shows the characteristics of participants in KNHANES during 1998 to 2010. Age-standardized prevalence rates of dyslipidemia were 54.0% in 1998, 65.8% in 2001, 66.5% in 2005, 60.6% in 2007, 58.7% in 2008, 58.9% in 2009, and 59.0% in 2010. The prevalence of

Table 1. Anthropometric and biochemical parameters in the Korea National Health and Nutrition Survey during 1998 to 2010

	1998	2001	2005	2007	2008	2009	2010
No.	6,921	4,894	5,312	2,733	6,295	6,900	5,738
Age, yr	43.2±0.37	45.8±0.40	43.5±0.35	44.2±0.48	44.7±0.38	44.9±0.36	45.0±0.44
Women, %	53.2 (0.5)	58.9 (0.6)	50.7 (0.7)	50.7 (1.0)	49.9 (0.6)	49.9 (0.6)	50.3 (0.7)
BMI, kg/m^{2a}	23.0±0.05	23.3±0.06	23.5±0.07	23.5±0.09	23.5±0.07	23.5±0.05	23.5±0.07
WC, cm[a]	80.2±0.16	79.9±0.16	79.8±0.19	81.3±0.30	80.6±0.22	80.2±0.21	80.2±0.22
SBP, mm Hg[a]	121.8±0.32	119.8±0.39	113.9±0.32	113.2±0.45	112.5±0.34	114.1±0.29	114.5±0.29
Hb, g/dL[a]	14.1±0.03	13.5±0.03	14.1±0.03	14.1±0.04	14.2±0.03	14.1±0.03	14.2±0.03
AST, IU/L[a]	27.2±0.26	21.8±0.17	23.8±0.23	24.5±0.42	21.4±0.22	22.1±0.19	21.8±0.22
ALT, IU/L[a]	28.1±0.35	20.0±0.25	23.1±0.40	24.7±0.57	22.2±0.33	22.7±0.35	21.7±0.30
Cr, mg/dL[a]	0.90±0.003	0.95±0.003	0.99±0.003	0.97±0.005	0.89±0.006	0.83±0.005	0.82±0.003
FPG, mg/dL[a]	98.6±0.57	96.2±0.40	92.2±0.31	92.3±0.55	95.9±0.35	94.9±0.29	95.0±0.35
HbA1c, %[a,b]	5.1±0.02	5.8±0.01	7.5±0.11	7.0±0.11	7.5±0.09	7.3±0.07	7.4±0.10
DM, %[c]	9.6 (0.5)	7.9 (0.4)	7.3 (0.4)	7.9 (0.7)	7.2 (0.3)	8.2 (0.4)	8.4 (0.4)
HTN, %[d]	25.1 (0.8)	24.9 (0.9)	15.9 (0.7)	20.1 (1.0)	19.2 (0.6)	22.8 (0.7)	23.5 (0.8)
TC, mg/dL[a]							
Total	183.9±0.64	184.9±0.64	180.8±0.69	183.9±1.13	184.2±0.66	184.1±0.58	185.1±0.70
Men	184.9±1.01	186.7±0.91	182.5±1.00	184.4±1.74	184.6±1.02	185.2±0.86	186.6±1.03
Women	183.5±0.65	184.2±0.81	179.4±0.76	183.8±1.14	184.1±0.70	183.2±0.69	183.9±0.83
TG, mg/dL[a]							
Total	116.2±1.11	132.3±1.43	129.2±2.16	126.6±1.99	130.9±1.84	130.4±1.67	129.3±2.19
Men	131.2±1.69	155.3±2.33	152.9±3.77	144.9±2.86	154.4±2.86	155.0±2.93	154.9±3.97
Women	103.4±1.16	117.4±1.58	105.6±1.45	108.9±2.17	107.5±1.92	105.2±1.55	103.6±1.53
HDL-C, mg/dL[a]							
Total	50.4±0.22	46.8±0.31	45.3±0.21	48.3±0.30	48.7±0.23	48.2±0.20	48.8±0.21
Men	47.7±0.27	44.1±0.36	42.6±0.30	45.5±0.36	45.7±0.28	45.7±0.26	45.9±0.30
Women	52.6±0.28	48.5±0.35	48.0±0.26	51.0±0.39	51.6±0.28	50.8±0.26	51.7±0.25
LDL-C, mg/dL[a]							
Total	110.3±0.55	111.7±0.60	111.0±0.57	110.6±1.05	110.7±0.57	111.0±0.51	111.5±0.62
Men	111.0±0.88	111.5±0.83	111.9±0.89	110.5±1.57	110.2±0.88	110.6±0.74	111.7±0.93
Women	110.2±0.58	112.3±0.73	110.6±0.63	111.0±1.05	111.4±0.60	111.7±0.61	111.6±0.67

Values are presented as mean±standard error or percentage (standard error).
BMI, body mass index; WC, waist circumference; SBP, systolic blood pressure; Hb, hemoglobin; AST, aspartate aminotransferase; ALT, alanine aminotransferase; Cr, creatinine; FPG, fasting plasma glucose; HbA1c, glycated hemoglobin; DM, diabetes mellitus; HTN, hypertension; TC, total cholesterol; TG, triglyceride; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol.
[a]Age-adjusted value, [b]HbA1c were measured mainly among patients with diabetes mellitus, [c]Diabetes mellitus was diagnosed in subjects whose level of fasting plasma glucose ≥126 mg/dL or who responded to health interview survey as having had a previous diagnosis of diabetes by physician or treated with antidiabetic agents or insulin, [d]Hypertension were defined based on systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥90 mm Hg or current use of antihypertensive medication.

dyslipidemia was higher in women than in men every year (57.6% in men and 60.4% in women in 2010).

Table 2, Fig. 1 show age-standardized prevalence rates of dyslipidemia and each lipid abnormalities of it in KNHANES during 2007 to 2010. In women, the prevalence of hypo-HDL-cholesterolemia tended to decrease and the prevalence in 2010 has decreased by 0.76-fold (95% confidence interval [CI], 0.66 to 0.88) compared with the prevalence reported in 2007. In men, the prevalence of hypo-HDL-cholesterolemia was the second frequent lipid abnormality and accounted for almost one third of all dyslipidemia. In contrast to women, the prevalence of hypo-HDL-cholesterolemia in men tended to increase: prevalence in 2010 had increased by 1.13-fold (95% CI, 0.93 to 1.38) compared with that in 2007. The prevalence of hypertri-

Table 2. Age-standardized prevalence rates of each lipid abnormalities of dyslipidemia in the Korea National Health and Nutrition Survey during 2007 to 2010

Year	Hypercholesterolemia		Hyper-LDL-cholesterolemia		Hypertriglyceridemia		Hypo-HDL-cholesterolemia	
	Prevalence, %	OR (95% CI)	Prevalence, %	OR (95% CI)	Prevalence, %	OR (95% CI)	Prevalence, %	OR (95% CI)
Total								
2007	11.7	1	12.1	1	30.7	1	44.1	1
2008	13.1	1.16 (0.97-1.39)	13.6	1.17 (0.98-1.40)	29.1	0.95 (0.83-1.08)	42.1	0.91 (0.80-1.03)
2009	13.1	1.19 (0.99-1.42)	13.3	1.17 (0.99-1.40)	28.5	0.93 (0.81-1.06)	43.5	0.99 (0.88-1.11)
2010	14.7	1.36 (1.13-1.63)	15	1.35 (1.12-1.62)	28.9	0.95 (0.83-1.08)	41.6	0.91 (0.81-1.03)
Men								
2007	10.9	1	10.8	1	36.9	1	31.6	1
2008	12.3	1.16 (0.89-1.53)	12.7	1.24 (0.96-1.60)	37.2	1.02 (0.86-1.22)	33.4	1.05 (0.87-1.27)
2009	12.2	1.15 (0.88-1.50)	12.5	1.19 (0.92-1.52)	36.5	0.98 (0.82-1.17)	33.7	1.11 (0.92-1.33)
2010	13.8	1.35 (1.03-1.79)	14.3	1.43 (1.10-1.87)	37.9	1.06 (0.88-1.28)	34.1	1.13 (0.93-1.38)
Women								
2007	12.4	1	13.2	1	24.5	1	56.2	1
2008	13.9	1.16 (0.93-1.46)	14.3	1.12 (0.89-1.39)	21.2	0.85 (0.71-1.01)	50.5	0.80 (0.69-0.93)
2009	13.8	1.22 (0.98-1.53)	14	1.17 (0.93-1.46)	20.8	0.85 (0.71-1.00)	53.2	0.91 (0.78-1.05)
2010	15.6	1.36 (1.09-1.70)	15.8	1.28 (1.03-1.60)	20.1	0.80 (0.67-0.96)	48.9	0.76 (0.66-0.88)

Complex samples logistic regression analysis.
LDL, low density lipoprotein; HDL, high density lipoprotein; OR, odds ratio; CI, confidence interval.

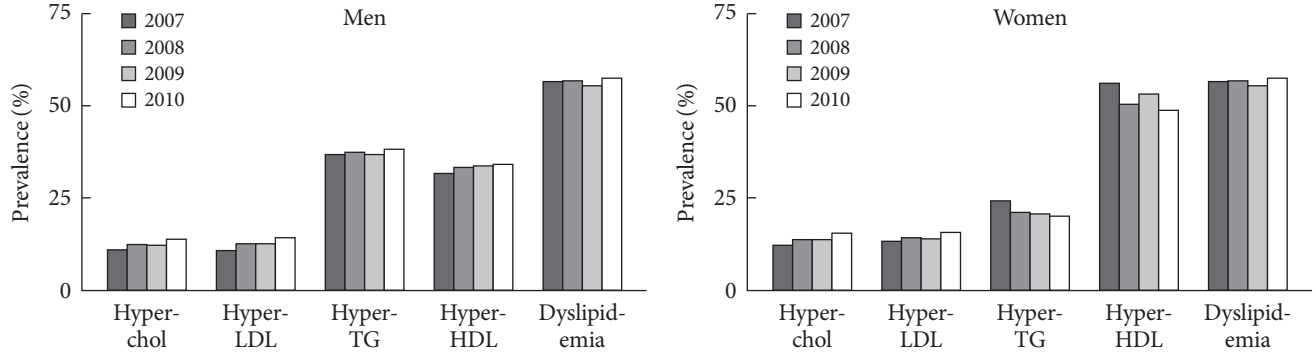

Fig. 1. Prevalence rates of dyslipidemia and each factors of it according to sex in the Korea National Health and Nutrition Survey during 2007 to 2010. (A) Men. (B) Women. Hyper-chol, hypercholesterolemia; Hyper-LDL, hyper-low density lipoprotein-cholesterolemia; Hyper-TG, hypertriglyceridemia; Hypo-HDL, hypo-high density lipoprotein-cholesterolemia.

glyceridemia, most frequent lipid abnormality in men, has not changed significantly in men, while a significantly decreasing tendency was found in women. Compared with the prevalence in 2007, the prevalence in 2010 has decreased by 0.80-fold (95% CI, 0.67 to 0.96) in women. On the other hand, the prevalence of hypercholesterolemia and hyper-LDL-cholesterolemia, the two lowest frequent lipid abnormalities, has significantly increased in both sexes after 2007. In 2010, the overall prevalence of hypercholesterolemia and hyper-LDL-cholesterolemia has increased by 1.36- and 1.35-fold compared with the prevalence in 2007, respectively.

The prevalence of dyslipidemia and its individual lipid abnormalities by sex- and age-category in 2010 are shown in Fig. 2. The prevalence of dyslipidemia peaked in the 50 to 60 year age groups in men and has decreased after age 70 years. In contrast, the prevalence had rapidly increasing trend as age increased in women. In subjects ≥70 years the prevalence of dyslipidemia in women was about 1.5 times higher than that of men. The prevalence of hypercholesterolemia and hyper-LDL-cholesterolemia were higher in men than in women in the 30 to 40 age groups, although the prevalence rate was higher in women after age 50. The prevalence of hypertriglyceridemia was much higher in men in younger age groups. Women had a higher prevalence of hypo-HDL-cholesterolemia in all

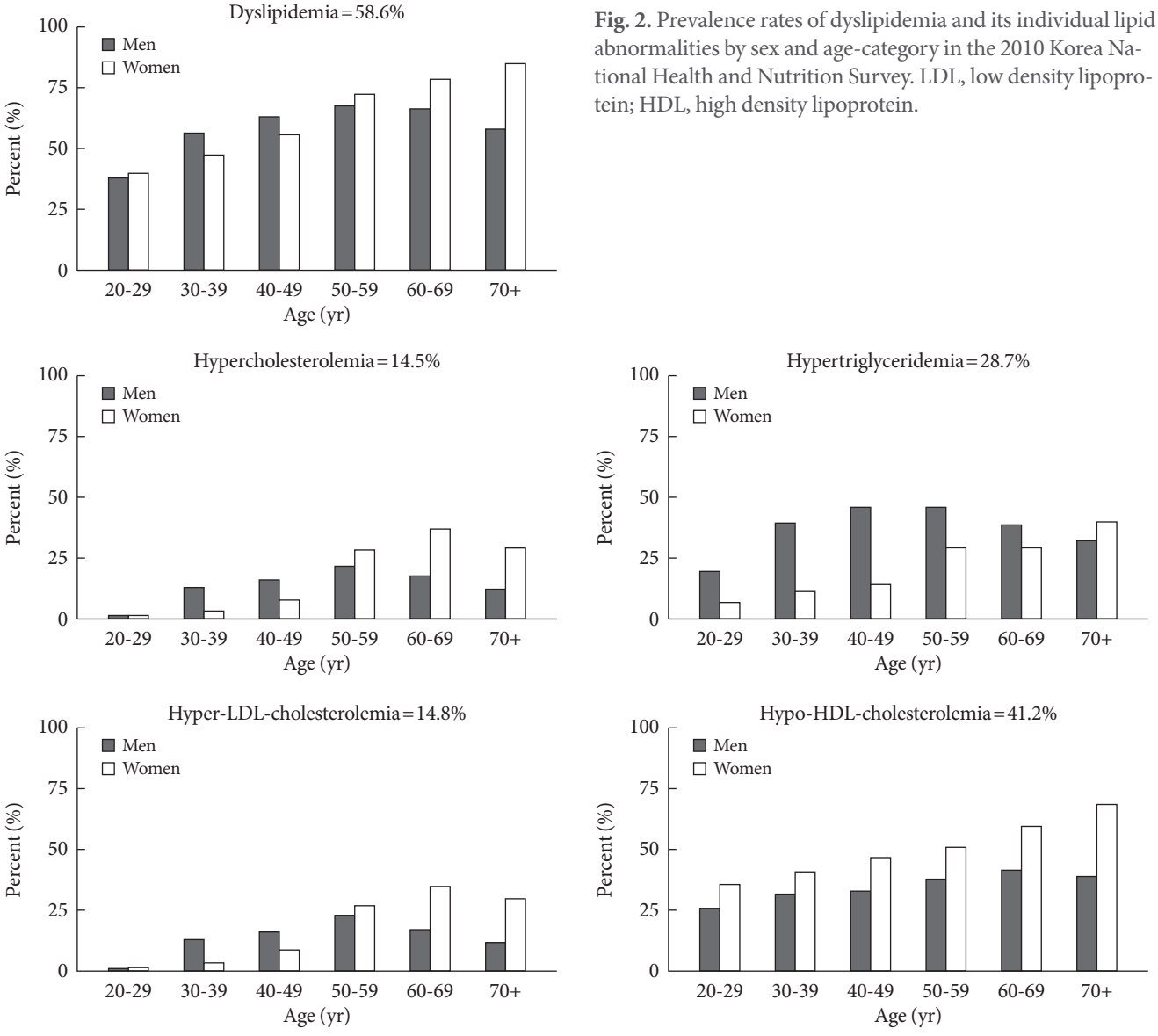

Fig. 2. Prevalence rates of dyslipidemia and its individual lipid abnormalities by sex and age-category in the 2010 Korea National Health and Nutrition Survey. LDL, low density lipoprotein; HDL, high density lipoprotein.

age groups than men. The percentage of women with HDL-cholesterolemia below 45 mg/dL was similar to that of men with hypo-HDL-cholesterolemia (HDL-C <40 mg/dL) in KNHANES during 1998 to 2010 (data not shown). The prevalence of dyslipidemia and its respective components by sex- and age-category during 1998 to 2010 are described in detail in Appendixes 1-5 (1, prevalence of dyslipidemia; 2, prevalence of hypercholesterolemia; 3, prevalence of hypertriglyceridemia; 4, prevalence of hyper-LDL-cholesteroleamia; 5, prevalence of hypo-HDL-cholesterolemia).

Participants with diabetes had a higher prevalence of dyslipidemia and more respective lipid abnormalities than nondiabetic subjects during 1998 to 2010 period (Fig. 3). In 2010, the prevalence of dyslipidemia was 79.6% in diabetic and 56.7% in nondiabetic subjects. The prevalences of hypercholesterolemia and hyper-LDL-cholesterolemia were 36.0% and 35.1% in diabetic and 12.5% and 12.9% in nondiabetic subjects, respectively. The prevalence of hypertriglyceridemia was 49.3% in diabetic and 26.8% in nondiabetic subjects. The prevalence of hypo-HDL-cholesterolemia was 53.7% in diabetic and 40.0% in nondiabetic subjects in 2010.

Awareness rate had increased annually during 2005 to 2010 from 6.1% in 2005 to 13.7% in 2010. Treatment rate tended to increase: it was 1.9% in 2005 and 7.4% in 2010 (Table 3). The

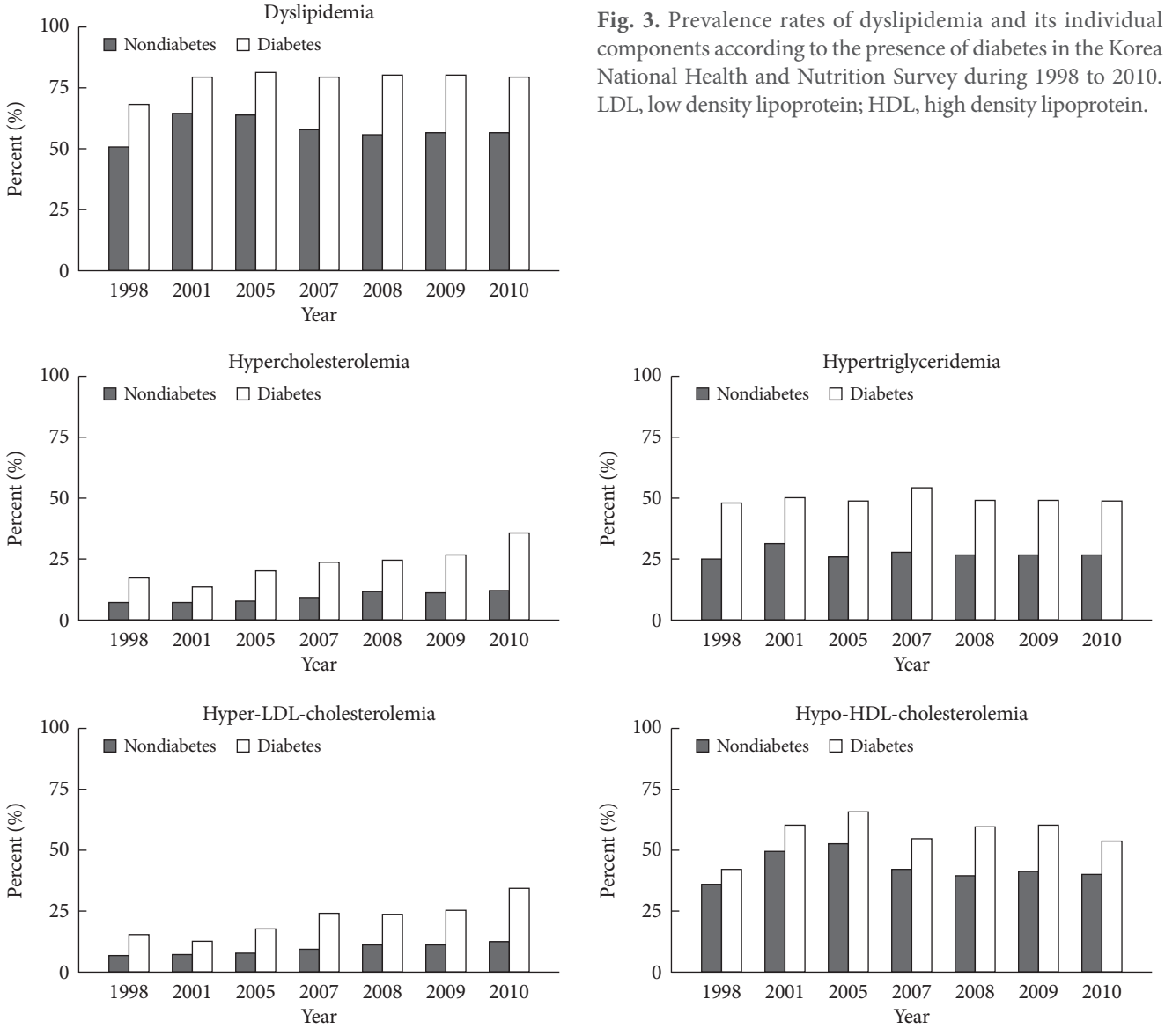

Fig. 3. Prevalence rates of dyslipidemia and its individual components according to the presence of diabetes in the Korea National Health and Nutrition Survey during 1998 to 2010. LDL, low density lipoprotein; HDL, high density lipoprotein.

Table 3. Awareness and treatment rates of dyslipidemia in the Korea National Health and Nutrition Survey during 2005 to 2010

	2005	2007	2008	2009	2010
Awareness rate					
All subjects					
Total	6.1 (0.4)	8.8 (1.0)	11.2 (0.6)	11.9 (0.6)	13.7 (0.7)
Men	7.3 (0.7)	10.6 (1.6)	11.5 (1.0)	11.4 (0.8)	12.7 (1.1)
Women	5.2 (0.5)	7.3 (0.9)	10.9 (0.7)	12.3 (0.8)	14.6 (0.9)
Nondiabetic subjects					
Total	5.3 (0.4)	7.7 (1.0)	10.1 (0.6)	10.4 (0.6)	11.0 (0.7)
Men	6.6 (0.7)	9.5 (1.6)	11.2 (1.1)	9.9 (0.9)	10.4 (1.1)
Women	4.5 (0.5)	6.1 (1.0)	9.1 (0.8)	10.8 (0.8)	11.5 (0.8)
Diabetic subjects					
Total	12.9 (1.8)	18.4 (3.4)	19.2 (1.8)	23.4 (2.2)	34.6 (3.0)
Men	12.2 (2.5)	17.5 (5.6)	14.1 (2.5)	22.3 (3.1)	29.7 (3.8)
Women	13.6 (2.7)	19.6 (4.4)	23.9 (2.6)	24.5 (2.8)	39.8 (3.9)
Treatment rate					
All subjects					
Total	1.9 (0.2)	3.0 (0.4)	3.8 (0.3)	5.2 (0.4)	7.4 (0.6)
Men	1.9 (0.4)	3.2 (0.7)	3.0 (0.4)	4.4 (0.5)	6.3 (0.8)
Women	1.9 (0.3)	2.8 (0.5)	4.6 (0.4)	6.0 (0.6)	8.4 (0.8)
Nondiabetic subjects					
Total	1.3 (0.2)	2.3 (0.4)	3.0 (0.3)	4.1 (0.4)	5.3 (0.5)
Men	1.6 (0.4)	2.5 (0.7)	2.4 (0.5)	3.0 (0.5)	4.5 (0.7)
Women	1.2 (0.2)	2.0 (0.6)	3.5 (0.4)	5.0 (0.5)	6.0 (0.6)
Diabetic subjects					
Total	7.3 (1.4)	9.5 (2.3)	10.0 (1.4)	14.4 (1.7)	23.6 (2.8)
Men	4.5 (1.5)	8.1 (3.0)	7.0 (1.7)	14.5 (2.6)	16.0 (0.6)
Women	10.1 (2.4)	11.2 (3.6)	12.9 (2.0)	14.4 (2.3)	28.2 (3.9)

Values are presented as percentage (standard error).

rates of awareness and treatment in diabetic subjects were much higher than nondiabetic subjects in both sexes. In 2010, awareness rate was 34.6% in diabetic and 11.0% in nondiabetic subjects. Treatment rate in 2010 was 23.6% in diabetic and 5.3% in nondiabetic subjects. Control rate of dyslipidemia among treated patients showed an increasing tendency (Table 4). The rate of dyslipidemic subjects who reached treatment goal (LDL-C levels <160 mg/dL, triglyceride levels <150 mg/dL, HDL-C levels >40 mg/dL in men and >50 mg/dL in women) among who have taken lipid-lowering drugs was 21.8% in 2005 and 29.7% in 2010. The rate of diabetic patients who reached treatment goal (LDL-C levels <100 mg/dL, triglyceride levels <150 mg/dL, HDL-C levels >40 mg/dL in men and >50 mg/dL in women) increased from 5.8% in 2005 to17.4% in 2010. The control rate in LDL-C defined as below 100 mg/dL in diabetic subjects tended to increase from 41.9% in 2005 to 62.6% in 2010. Among diabetic subjects with a very high risk of cardiovascular disease treated with lipid-lowering drug, the rate of subjects who had LDL-C level <70 mg/dL increased from 8.6% in 2005 to 22.2% in 2010.

DISCUSSION

This is the first national-scale epidemiologic study to evaluate the changing trends of the prevalence of dyslipidemia and individual components of dyslipidemia including awareness,

Table 4. Control rates of dyslipidemia among treated in the Korea National Health and Nutrition Survey during 2005 to 2010

Control rate	2005	2007	2008	2009	2010
All subjects (treatment goal: LDL-C <160 mg/dL+TG <150 mg/dL+HDL-C [>40 mg/dL in men and >50 mg/dL in women])					
Total	21.8 (6.4)	24.3 (6.5)	32.9 (4.3)	24.8 (3.4)	29.7 (3.2)
Men	24.2 (11.8)	37.2 (10.8)	45.7 (7.5)	28.0 (5.5)	28.1 (5.2)
Women	19.7 (6.0)	11.2 (4.9)	24.9 (4.7)	22.8 (3.6)	30.8 (4.0)
Diabetic subjects (treatment goal: LDL-C <100 mg/dL+TG <150 mg/dL+HDL-C [>40 mg/dL in men and >50 mg/dL in women])					
Total	5.8 (5.6)	11.3 (7.3)	14.5 (4.5)	13.7 (5.4)	17.4 (4.4)
Men	17.7 (15.6)	20.2 (14.6)	12.0 (6.8)	21.7 (8.8)	16.1 (6.7)
Women	-	3.0 (3.0)	15.7 (6.0)	6.0 (3.1)	18.3 (5.8)
Diabetic subjects (LDL-C goal: LDL-C <100 mg/dL)					
Total	41.9 (11.9)	70.4 (11.8)	45.1 (7.4)	62.6 (6.5)	62.6 (5.6)
Men	62.5 (20.1)	81.8 (17.4)	63.2 (12.6)	70.7 (9.7)	64.3 (9.8)
Women	33.6 (13.5)	61.1 (15.3)	36.7 (8.6)	55.1 (8.9)	61.6 (7.3)
Diabetic subjects with 1 or more risk factor of CAD[a] (LDL-C goal: LDL-C <70 mg/dL)					
Total	8.6 (5.6)	17.1 (9.1)	14.8 (5.3)	23.6 (5.3)	22.2 (4.8)
Men	19.6 (17.8)	-	24.7 (12.2)	27.4 (7.8)	30.0 (10.1)
Women	4.3 (4.2)	31.2 (15.0)	9.9 (4.7)	19.8 (6.9)	17.2 (5.4)

Values are presented as percentage (standard error).
LDL-C, low density lipoprotein cholesterol; TG, hypertriglyceride; HDL-C, high density lipoprotein cholesterol; CAD, coronary artery disease.
[a]Risk factors of coronary artery disease are high LDL-C (≥160 mg/dL), cigarette smoking, hypertension (systolic/diastolic blood pressure ≥140/90 mm Hg or use of antihypertensive medication), low HDL-C (<40 mg/dL), and age (men ≥45 years, women ≥55 years). Subtract one risk factor if the person has high HDL-C (≥60 mg/dL).

treatment, and control rates in Korean adults. The prevalence of dyslipidemia was greater than 50% in both men and women during the past 12 years. About one half of the women had a low level of HDL-cholesterolemia. However, the prevalence of hypo-HDL-cholesterolemia has decreased in women, while it showed an increasing tendency in men during recent 4 years. The proportion of adults with elevated levels of triglyceride significantly decreased in women while it has not changed recently in men. The increase in the prevalence of hypercholesterolemia and hyper-LDL-cholesterolemia, the two lowest frequent lipid abnormalities in both sexes, was significant during recent 4 years in Korea. The proportion of dyslipidemic subjects who had been previously diagnosed by a medical doctor and who have been taking lipid-lowering medications and who reached treatment goals after treatment with lipid-lowering drugs increased over the past 5 years.

Elevated total cholesterol and LDL-C levels are independent risk factors of development of cardiovascular disease [18,19]. A 10 mg/dL increase of total cholesterol was associated with 9% increase of death from cardiovascular disease during in a 30-year follow-up study [20]. Reducing plasma LDL-C levels with the use of statins reduced the incidence of death from cardiovascular causes [21,22]. A large-scale epidemiological study in United States observed the decreases in total and LDL-C levels in recent 20 years due to the increase in the percentage of adults taking lipid-lowering drugs [9]. A previous report on trends in total cholesterol worldwide indicated mean cholesterol levels declined in developed countries (North America, Western Europe, Australia, and some Asian regions) [9,23]. A recent increasing trend of the prevalence of hypercholesterolemia and hyper-LDL-cholesterolemia in Korea is consistent with the increasing prevalence of cardiovascular disease [2]. A relatively low proportion of adults taking lipid-lowering drugs (7.4% from KNHANES 2010 vs. 15.5% from NHANES 2007 to 2010 [9]) might have affected the increasing trend of the prevalence of hypercholesterolemia and hyper-LDL-cholesterolemia.

Low-carbohydrate diet contributes to favorable effects on atherogenic dyslipidemia including elevated serum triglyceride and reduced HDL-C [24,25]. The high prevalence of hy-

pertriglyceridemia and hypo-HDL-cholesterolemia in Korean adults could be related with high-carbohydrate diet. A recent Korean study revealed that previous traditional Korean diet with high-carbohydrate content was related with elevated triglyceride and low HDL-C [7]. It is also well-known that body mass index is inversely related to the concentration of HDL-C [26] and positively with triglyceride levels [27]. The recent decreasing trend in the prevalence of hypertriglyceridemia and hypo-HDL-cholesterolemia in Korean women is consistent with a decreased prevalence of obesity in young and middle-aged Korean women [28]. A social preference for thin body image may have affected the decreasing trend of the prevalence of obesity in these female age subgroups [29,30]. Meanwhile, an increasing trend in the prevalence of obesity in Korean men might be one of the reasons of recently increased prevalence of hypo-HDL-cholesterolemia in men [28].

HDL-C is known as an inverse predictor of cardiovascular disease [31-33]. A 1 mg/dL increase of HDL-C is associated with 2% reduction in the relative risk of cardiovascular disease in men and 3% reduction in women [34]. Triglyceride is a risk factor of cardiovascular disease for both men and women in the general population, independent of HDL-C [35]. High body mass index, abdominal obesity, cigarette smoking, and physical inactivity were associated with a greater risk of low HDL-C levels in Korean adults [8]. Thus, smoking cessation, increasing physical activity, and decreasing body weight would all contribute to increasing HDL-C levels in Korean population [36].

The characteristic features of diabetic dyslipidemia are high plasma triglyceride concentration, low HDL-C concentration, and increased concentration of small, dense LDL-C particles [37]. In this study, we found that Korean diabetic patients had a higher prevalence of all lipid abnormalities of dyslipidemia than that of nondiabetic subjects. A higher prevalence of hypercholesterolemia and hyper-LDL-cholesterolemia in diabetic subjects is considered to be affected by a higher rate of self-reported prior diagnosis or current use of lipid-lowering drugs in diabetic participants.

This study had some limitations. Although KNHANES collected nationally representative data, it is a cross-sectional evaluation of the health and nutritional status of Koreans. To prevent the potential errors in survey methods, the prevalence estimated in each KNHANES was standardized according to the 2010 Korean population. Each KNHANES was conducted with different subjects and since it was based on self-administered questionnaire, recall bias, confounding factors, and unintentional errors should be considered. The change in the definition of hypercholesterolemia and hyper-LDL-cholesterolemia in 2005 by an introduction of questionnaire for previous diagnosis of dyslipidemia by physician and current use of lipid-lowering drugs made it difficult to analyze trends over time using the 1998 and 2001 KNAHNES data. Also, the change in the protocol of HDL-C measurement could have affected the HDL-C results. For this reason, the values were standardized according to the United States Centers for Disease Control and Prevention Lipid Standardization Program to minimize method effects since 2007.

In conclusion, more than half of Korean adults have had dyslipidemia from KNHANES 1998 to KNHANES 2010. Elevated triglyceride and low HDL-C levels were the two most frequent lipid abnormalities in Korean population. A recent increasing trend of hypercholesterolemia and hyper-LDL-cholesterolemia is associated with an increasing prevalence of cardiovascular mortality in Korea. Although the awareness and treatment rates of dyslipidemia have improved during this period, the low control rate in dyslipidemia suggests a need for a national strategy to prevent increasing trend of atherogenic dyslipidemia. Proper lifestyle management with weight loss, low carbohydrate diet, and regular exercise are recommended to reduce the burden of dyslipidemia and cardiovascular mortality.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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Appendix 1. Prevalence rates of dyslipidemia in the Korea National Health and Nutrition Survey during 1998 to 2010 by sex- and age-category

	1998		2001		2005		2007		2008		2009		2010	
	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)
Total	3,762	52.7 (0.8)	3,231	65.9 (1.0)	3,584	65.3 (0.9)	1,736	59.5 (1.3)	3,887	57.9 (0.9)	4,233	58.4 (0.7)	3,508	58.6 (0.8)
Men	1,548	49.2 (1.1)	1,298	62.3 (1.4)	1,416	60.7 (1.3)	657	56.1 (1.8)	1,546	56.4 (1.2)	1,708	55.2 (1.1)	1,471	57.6 (1.3)
Women	2,214	55.8 (1.0)	1,933	68.4 (1.2)	2,168	69.8 (1.1)	1,079	62.9 (1.5)	2,341	59.4 (1.1)	2,525	61.5 (1.0)	2,037	59.5 (1.1)
Total[a]	3,762	54.0 (0.7)	3,231	65.8 (0.9)	3,584	66.5 (0.8)	1,736	60.6 (1.1)	3,887	58.7 (0.7)	4,233	58.9 (0.7)	3,508	59.0 (0.8)
Men[a]	1,548	49.4 (0.9)	1,298	61.9 (1.3)	1,416	61.4 (1.2)	657	56.6 (1.7)	1,546	56.7 (1.1)	1,708	55.5 (1.0)	1,471	57.6 (1.2)
Women[a]	2,214	57.8 (0.9)	1,933	69.1 (1.0)	2,168	71.2 (1.0)	1,079	64.3 (1.4)	2,341	60.5 (0.9)	2,525	62.3 (0.9)	2,037	60.4 (1.0)
Total														
20-29	509	39.9 (1.4)	416	52.4 (2.3)	352	50.8 (2.4)	135	43.5 (2.9)	278	35.5 (2.2)	368	39.9 (1.9)	255	38.9 (2.4)
30-39	834	48.6 (1.3)	744	59.9 (1.8)	745	62.7 (1.7)	336	55.4 (2.5)	700	52.5 (1.5)	737	55.0 (1.4)	602	51.9 (1.5)
40-49	783	54.6 (1.6)	717	63.7 (1.9)	911	70.0 (1.5)	319	60.1 (2.5)	807	64.1 (1.4)	856	58.9 (1.4)	657	59.6 (1.5)
50-59	721	64.4 (1.7)	538	74.1 (1.9)	662	75.0 (1.8)	336	70.6 (2.3)	726	66.0 (1.8)	800	67.2 (1.5)	794	70.0 (1.7)
60-69	572	63.5 (1.8)	493	77.6 (2.4)	555	70.9 (1.9)	320	72.0 (2.7)	757	72.6 (1.7)	840	73.9 (1.5)	691	72.6 (1.6)
70+	343	60.9 (2.5)	323	79.5 (2.3)	359	75.4 (2.3)	290	73.2 (3.0)	619	73.2 (1.8)	632	70.1 (1.7)	509	74.2 (2.1)
Men														
20-29	196	34.9 (2.1)	154	48.2 (3.4)	116	42.6 (3.8)	55	41.9 (4.0)	107	35.4 (3.1)	168	38.4 (2.8)	95	38.1 (3.7)
30-39	399	50.4 (1.9)	322	58.3 (2.5)	309	63.5 (2.4)	129	55.9 (4.0)	310	55.1 (2.1)	313	55.6 (2.0)	275	56.3 (2.6)
40-49	382	56.3 (2.1)	315	66.2 (2.5)	407	69.4 (2.2)	149	62.1 (3.7)	373	67.3 (2.1)	365	58.5 (2.3)	324	63.0 (2.3)
50-59	285	57.8 (2.2)	219	68.9 (3.0)	278	71.1 (2.8)	121	65.5 (4.0)	295	62.7 (2.6)	329	63.2 (2.5)	307	67.5 (2.4)
60-69	196	50.9 (2.7)	186	66.2 (3.9)	211	58.3 (3.1)	110	56.3 (4.9)	260	63.0 (2.8)	327	67.0 (2.4)	282	66.4 (2.4)
70+	90	40.2 (3.8)	102	70.5 (4.4)	95	59.5 (4.1)	93	58.5 (4.6)	201	60.4 (3.1)	206	54.8 (3.0)	188	58.0 (3.5)
Women														
20-29	313	44.1 (2.1)	262	55.4 (2.7)	236	59.2 (3.0)	80	45.2 (3.9)	171	35.5 (2.9)	200	41.6 (2.5)	160	39.8 (3.2)
30-39	435	46.9 (1.8)	422	61.1 (2.1)	436	61.9 (2.2)	207	55.0 (3.4)	390	49.8 (2.0)	424	54.4 (2.1)	327	47.4 (2.2)
40-49	401	52.9 (2.1)	402	62.2 (2.6)	504	70.6 (1.9)	170	58.1 (3.5)	434	60.8 (2.2)	491	59.3 (1.9)	333	55.9 (2.2)
50-59	436	70.6 (2.2)	319	77.8 (2.4)	384	79.0 (2.1)	215	75.8 (2.9)	431	69.4 (2.0)	471	71.3 (1.8)	487	72.5 (2.0)
60-69	376	73.6 (2.1)	307	87.2 (2.2)	344	81.4 (2.3)	210	85.1 (2.6)	497	81.1 (1.9)	513	80.0 (1.9)	409	78.4 (2.4)
70+	253	71.5 (2.7)	221	85.3 (2.6)	264	84.5 (2.6)	197	82.1 (3.3)	418	81.3 (2.0)	426	80.4 (1.9)	321	84.9 (2.0)

SE, standard error.
[a]Age-standardized (standard population: 2010 Korean population).

Appendix 2. Prevalence rates of hypercholesterolemia in the Korea National Health and Nutrition Survey during 1998 to 2010 by sex- and age-category

	1998		2001		2005		2007		2008		2009		2010	
	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)
Total	637	8.6 (0.4)	392	8.2 (0.4)	528	8.8 (0.5)	341	11.0 (0.7)	890	12.7 (0.5)	974	12.8 (0.5)	957	14.5 (0.6)
Men	249	7.8 (0.6)	158	7.6 (0.6)	227	8.6 (0.6)	127	10.6 (1.1)	341	12.2 (0.7)	385	12.1 (0.7)	373	13.8 (0.9)
Women	388	9.3 (0.6)	234	8.5 (0.6)	301	9.0 (0.7)	214	11.5 (0.9)	549	13.2 (0.7)	589	13.4 (0.6)	584	15.1 (0.7)
Total[a]	637	9.3 (0.4)	392	8.0 (0.4)	528	9.5 (0.5)	341	11.7 (0.7)	890	13.1 (0.5)	974	13.1 (0.5)	957	14.7 (0.5)
Men[a]	249	7.9 (0.5)	158	7.5 (0.7)	227	8.8 (0.6)	127	10.9 (1.1)	341	12.3 (0.7)	385	12.2 (0.6)	373	13.8 (0.8)
Women[a]	388	10.5 (0.6)	234	8.7 (0.6)	301	10.1 (0.6)	214	12.4 (1.0)	549	13.9 (0.6)	589	13.8 (0.6)	584	15.6 (0.7)
Total														
20-29	53	3.8 (0.5)	28	3.8 (0.7)	13	1.8 (0.7)	7	1.8 (0.7)	28	3.8 (0.7)	28	3.2 (0.7)	16	2.0 (0.6)
30-39	83	4.7 (0.5)	60	5.2 (0.7)	58	5.2 (0.7)	36	7.1 (1.1)	86	7.3 (0.8)	94	8.2 (0.9)	89	8.4 (1.0)
40-49	120	8.5 (0.9)	80	6.4 (0.8)	126	10.0 (0.9)	58	11.1 (1.5)	150	12.3 (1.0)	178	12.3 (1.0)	146	12.5 (1.1)
50-59	179	15.9 (1.2)	82	11.6 (1.2)	139	16.0 (1.4)	88	18.4 (2.6)	244	21.7 (1.3)	271	22.4 (1.3)	292	25.2 (1.6)
60-69	126	14.7 (1.4)	100	16.3 (1.9)	134	17.1 (1.7)	93	22.7 (2.7)	233	23.4 (1.5)	270	22.7 (1.5)	262	27.8 (1.9)
70+	76	13.4 (1.6)	42	9.9 (1.7)	58	11.6 (1.8)	59	16.4 (2.3)	149	17.6 (1.7)	133	15.7 (1.5)	152	22.7 (2.2)
Men														
20-29	23	3.6 (0.8)	17	5.8 (1.5)	5	2.3 (1.3)	4	2.6 (1.4)	14	4.7 (1.3)	16	3.3 (0.9)	6	2.1 (0.9)
30-39	54	6.5 (1.0)	33	6.0 (1.1)	39	7.9 (1.2)	22	10.1 (2.1)	53	10.0 (1.4)	58	11.0 (1.4)	63	13.1 (1.8)
40-49	70	10.0 (1.4)	45	8.5 (1.3)	80	12.7 (1.3)	36	14.9 (2.4)	87	16.0 (1.5)	92	14.2 (1.4)	92	16.4 (1.8)
50-59	61	12.5 (1.5)	26	8.7 (1.8)	51	12.4 (1.9)	31	16.5 (3.8)	83	17.0 (1.9)	100	18.7 (1.9)	97	21.8 (2.2)
60-69	33	9.7 (1.7)	27	10.3 (2.7)	41	10.9 (1.8)	22	11.5 (3.4)	67	17.1 (2.1)	85	17.1 (1.9)	74	17.9 (2.4)
70+	8	3.5 (1.2)	10	6.3 (2.1)	11	5.1 (2.1)	12	7.2 (2.5)	37	9.6 (1.7)	34	10.3 (2.0)	41	12.5 (2.6)
Women														
20-29	30	3.9 (0.7)	11	2.3 (0.7)	8	1.3 (0.5)	3	1.0 (0.6)	14	3.0 (0.9)	12	2.9 (0.9)	10	2.0 (0.8)
30-39	29	3.1 (0.6)	27	4.6 (1.0)	19	2.3 (0.6)	14	4.1 (1.2)	33	4.6 (0.9)	36	5.1 (0.9)	26	3.4 (0.9)
40-49	50	7.0 (1.1)	35	5.1 (1.0)	46	7.2 (1.2)	22	7.1 (1.6)	63	8.4 (1.2)	86	10.4 (1.2)	54	8.3 (1.4)
50-59	118	19.0 (1.9)	56	13.6 (1.7)	88	19.7 (2.2)	57	20.4 (3.4)	161	26.3 (2.0)	171	26.3 (1.9)	195	28.7 (2.1)
60-69	93	18.6 (2.1)	73	21.4 (2.6)	93	22.3 (2.5)	71	32.1 (3.9)	166	28.9 (2.0)	185	27.5 (2.0)	188	37.0(2.7)
70+	68	18.5 (2.4)	32	12.1 (2.4)	47	15.3 (2.5)	47	22.0 (3.7)	112	22.6 (2.4)	99	19.3 (2.0)	111	29.5 (3.0)

SE, standard error.
[a]Age-standardized (standard population: 2010 Korean population).

Appendix 3. Prevalence rates of hypertriglyceridemia in the Korea National Health and Nutrition Survey during 1998 to 2010 by sex- and age-category

	1998		2001		2005		2007		2008		2009		2010	
	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)
Total	1,960	27.4 (0.7)	1,624	33.0 (0.9)	1,481	27.3 (0.9)	821	29.9 (1.1)	1,811	28.8 (0.7)	1,971	28.3 (0.7)	1,627	28.7 (0.7)
Men	1,111	35.2 (1.1)	909	44.0 (1.4)	858	36.0 (1.4)	423	36.5 (1.6)	969	37.2 (1.1)	1,108	36.3 (1.1)	962	38.0 (1.2)
Women	849	20.6 (0.8)	715	25.4 (1.0)	623	18.8 (0.9)	398	23.3 (1.2)	842	20.5 (0.8)	863	20.2 (0.8)	665	19.5 (0.9)
Total[a]	1,960	28.4 (0.6)	1,624	32.9 (0.8)	1,481	28.3 (0.8)	821	30.7 (1.0)	1,811	29.1 (0.6)	1,971	28.5 (0.3)	1,627	28.9 (0.7)
Men[a]	1,111	35.3 (1.0)	909	43.6 (1.2)	858	36.4 (1.2)	423	36.9 (1.6)	969	37.2 (1.1)	1,108	36.5 (1.0)	962	37.9 (1.2)
Women[a]	849	22.2 (0.8)	715	26.0 (0.9)	623	20.4 (0.9)	398	24.5 (1.2)	842	21.2 (0.7)	863	20.8 (0.7)	665	20.1 (0.8)
Total														
20-29	213	17.2 (1.3)	161	20.1 (1.7)	93	14.5 (2.0)	49	16.9 (2.2)	110	16.2 (1.6)	149	17.2 (1.5)	84	13.8 (0.2)
30-39	403	23.8 (1.1)	324	25.4 (1.5)	259	24.4 (1.6)	135	25.0 (2.0)	313	25.7 (1.2)	291	24.0 (1.2)	264	25.8 (1.4)
40-49	431	30.1 (1.6)	370	32.8 (1.7)	399	32.3 (1.4)	169	33.4 (2.5)	404	33.9 (1.4)	407	29.6 (1.4)	315	30.7 (1.6)
50-59	414	37.3 (1.7)	313	41.7 (2.2)	322	37.7 (2.0)	168	39.0 (2.3)	350	33.3 (1.6)	392	35.2 (1.7)	391	37.7 (1.9)
60-69	329	36.8 (1.9)	294	46.7 (2.4)	262	33.2 (2.0)	169	41.0 (3.3)	353	35.5 (2.0)	422	38.5 (1.8)	337	34.0 (2.2)
70+	170	29.3 (2.3)	162	41.3 (2.6)	146	30.4 (2.7)	131	35.1 (3.0)	281	34.5 (2.2)	310	33.5 (2.1)	236	37.1 (2.5)
Men														
20-29	129	23.0 (2.1)	99	30.9 (2.6)	59	20.8 (3.2)	31	24.0 (3.6)	72	23.8 (2.8)	108	24.2(2.3)	51	20.1 (3.0)
30-39	285	36.6 (1.6)	219	39.4 (2.4)	178	36.9 (2.8)	84	36.3 (3.4)	218	38.6 (2.0)	201	34.6 (2.1)	194	39.4 (2.6)
40-49	303	43.2 (2.3)	227	47.7 (2.4)	277	47.2 (2.5)	109	44.5 (3.6)	262	47.8 (2.3)	263	42.3 (2.2)	237	46.0 (2.7)
50-59	206	42.0 (2.4)	167	53.1 (3.3)	180	44.6 (2.8)	84	45.2 (3.9)	192	40.9 (2.6)	219	43.3 (2.4)	209	46.1 (2.7)
60-69	129	33.4 (2.8)	136	49.4 (3.6)	118	32.5 (2.9)	69	36.2 (4.7)	138	35.2 (2.8)	204	42.7 (2.5)	170	38.9 (3.1)
70+	59	25.8 (3.2)	61	44.8 (5.5)	46	27.3 (4.0)	46	28.8 (4.3)	87	28.2 (3.0)	113	30.1 (2.9)	101	32.4 (3.0)
Women														
20-29	84	12.4 (1.6)	62	12.5 (1.8)	34	7.8 (1.5)	18	9.4 (2.3)	38	8.1 (1.4)	41	9.4 (1.4)	33	7.2 (1.5)
30-39	118	12.1 (1.2)	105	15.5 (1.6)	81	11.2 (1.2)	51	13.1 (1.9)	95	12.3 (1.3)	90	12.5 (1.3)	70	11.7 (1.6)
40-49	128	16.7 (1.5)	143	23.3 (2.0)	122	16.9 (1.7)	60	21.9 (2.9)	142	19.3 (1.6)	144	17.2 (1.5)	78	14.6 (1.7)
50-59	208	32.9 (2.2)	146	33.7 (2.8)	142	30.8 (2.8)	84	32.7 (3.0)	158	25.7 (1.9)	173	26.8 (1.9)	182	29.5 (2.2)
60-69	200	39.5 (2.4)	158	44.4 (3.1)	144	33.8 (2.6)	100	45.0 (4.5)	215	35.8 (2.6)	218	34.8 (2.4)	167	29.5 (2.7)
70+	111	31.1 (2.9)	101	39.0 (3.0)	100	32.1 (3.2)	85	38.9 (4.2)	194	38.4 (2.7)	197	35.8 (2.5)	135	40.2 (2.9)

SE, standard error.
[a]Age-standardized (standard population: 2010 Korean population).

Appendix 4. Prevalence rates of hyper-low density lipoprotein cholesterolemia in the Korea National Health and Nutrition Survey during 1998 to 2010 by sex- and age-category

	1998		2001		2005		2007		2008		2009		2010	
	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)
Total	620	8.4 (0.4)	381	7.9 (0.5)	539	9.1 (0.5)	345	11.4 (0.8)	906	13.0 (0.5)	976	13.0 (0.5)	957	14.8 (0.6)
Men	240	7.6 (0.6)	156	7.7 (0.8)	229	9.2 (0.7)	126	10.5 (1.1)	350	12.5 (0.7)	380	12.3 (0.6)	374	14.3 (1.0)
Women	380	9.0 (0.6)	225	8.1 (0.6)	310	9.0 (0.7)	219	12.2 (1.0)	556	13.6 (0.6)	596	13.6 (0.6)	583	15.2 (0.7)
Total[a]	620	9.2 (0.4)	381	7.9 (0.5)	539	9.9 (0.4)	345	12.1 (0.7)	906	13.6 (0.5)	976	13.3 (0.5)	957	15.0 (0.5)
Men[a]	240	7.8 (0.5)	156	7.6 (0.7)	229	9.5 (0.7)	126	10.8 (1.1)	350	12.7 (0.7)	380	12.5 (0.7)	374	14.3 (0.8)
Women[a]	380	10.3 (0.6)	225	8.4 (0.6)	310	10.2 (0.6)	219	13.2 (1.0)	556	14.3 (0.6)	596	14.0 (0.6)	583	15.8 (0.7)
Total														
20-29	45	3.1 (0.5)	29	3.3 (0.7)	11	1.8 (0.7)	8	2.4 (0.9)	23	3.4 (0.8)	28	3.3 (0.7)	17	2.2 (0.6)
30-39	78	4.5 (0.6)	57	4.6 (0.6)	63	5.6 (0.8)	36	7.2 (1.0)	76	6.1 (0.7)	97	8.7 (1.0)	91	9.0 (1.0)
40-49	107	7.8 (0.9)	79	6.1 (0.8)	135	11.0 (0.9)	55	10.5 (1.4)	162	13.8 (1.1)	176	12.7 (1.0)	143	13.1 (1.2)
50-59	165	14.6 (1.2)	87	13.1 (1.4)	143	17.2 (1.3)	90	19.9 (2.8)	245	22.8 (1.2)	259	21.7 (1.3)	291	25.6 (1.6)
60-69	140	16.5 (1.6)	79	13.9 (2.2)	128	15.9 (1.5)	89	22.2 (2.5)	244	24.6 (1.6)	275	23.3 (1.5)	254	26.9 (1.7)
70+	85	15.3 (1.8)	50	11.6 (1.8)	59	11.6 (1.7)	67	18.9 (2.4)	156	18.6 (1.5)	141	16.1 (1.4)	161	23.4 (1.9)
Men														
20-29	21	3.3 (0.7)	18	5.0 (1.2)	5	2.5 (1.4)	4	2.6 (1.4)	12	4.0 (1.2)	16	3.6 (1.0)	6	1.8 (0.8)
30-39	57	6.8 (1.1)	31	5.4 (0.9)	44	8.8 (1.4)	21	9.6 (1.7)	47	8.3 (1.2)	56	11.5 (1.6)	60	13.8 (1.9)
40-49	61	9.6 (1.4)	43	8.2 (1.4)	81	13.8 (1.4)	32	13.1 (2.3)	92	17.6 (1.8)	92	14.8 (1.4)	87	16.7 (2.0)
50-59	53	10.9 (1.4)	31	10.4 (2.0)	50	13.5 (2.1)	31	17.8 (3.9)	84	18.3 (1.9)	94	17.9 (1.9)	101	23.6 (2.3)
60-69	38	10.9 (1.7)	22	11.2 (3.9)	36	9.7 (1.7)	21	10.9 (3.5)	74	18.6 (2.2)	84	17.2 (1.9)	75	17.7 (2.3)
70+	10	4.5 (1.5)	11	7.2 (2.1)	13	6.9 (2.4)	17	11.5 (3.4)	41	11.3 (1.9)	38	11.3 (2.0)	45	12.4 (2.2)
Women														
20-29	24	3.0 (0.7)	11	2.2 (0.7)	6	1.2 (0.5)	4	2.1 (1.2)	11	2.6 (0.8)	12	2.9 (0.9)	11	2.6 (0.9)
30-39	21	2.4 (0.5)	26	4.1 (0.9)	19	2.4 (0.6)	15	4.7 (1.3)	29	3.8 (0.8)	41	5.7 (1.0)	31	4.1 (0.9)
40-49	46	6.0 (1.0)	36	4.8 (0.9)	54	8.2 (1.2)	23	7.8 (1.7)	70	9.9 (1.3)	84	10.7 (1.3)	56	9.3 (1.5)
50-59	112	18.1 (1.9)	56	14.9 (2.2)	93	20.7 (2.2)	59	21.9 (3.4)	161	27.2 (1.8)	165	25.5 (1.9)	190	27.5 (2.0)
60-69	102	20.9 (2.4)	57	16.1 (2.5)	92	21.0 (2.3)	68	31.7 (4.1)	170	29.9 (2.1)	191	28.7 (2.2)	179	35.3 (2.6)
70+	75	20.8 (2.5)	39	14.4 (2.7)	46	14.2 (2.3)	50	23.4 (3.5)	115	23.2 (2.3)	103	19.2 (1.9)	116	30.5 (2.7)

SE, standard error.
[a]Age-standardized (standard population: 2010 Korean population).

Appendix 5. Prevalence rates of hypo-high density lipoprotein cholesterolemia in the Korea National Health and Nutrition Survey during 1998 to 2010 by sex- and age-category

	1998		2001		2005		2007		2008		2009		2010	
	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)	No.	% (SE)
Total	2,624	36.7 (0.7)	2,471	50.4 (1.2)	2,975	53.4 (0.9)	1,308	43.4 (1.2)	2,903	41.5 (0.9)	3,200	43.1 (0.8)	2,497	41.2 (0.8)
Men	785	25.5 (0.8)	781	37.1 (1.5)	1,016	43.4 (1.4)	369	31.3 (1.7)	934	33.1 (1.1)	1,039	33.5 (1.0)	872	34.1 (1.3)
Women	1,839	46.5 (1.0)	1,690	59.6 (1.4)	1,959	63.1 (1.1)	939	55.1 (1.5)	1,969	49.7 (1.1)	2,161	52.6 (1.0)	1,625	48.2 (1.1)
Total[a]	2,624	37.5 (0.7)	2,471	50.3 (0.9)	2,975	54.2 (0.9)	1,308	44.1 (1.1)	2,903	42.1 (0.7)	3,200	43.5 (0.7)	2,497	41.6 (0.8)
Men[a]	785	25.5 (0.9)	781	36.8 (1.3)	1,016	43.8 (1.3)	369	31.6 (1.6)	934	33.4 (1.0)	1,039	33.7 (1.0)	872	34.1 (1.2)
Women[a]	1,839	48.0 (4.4)	1,690	60.1 (1.1)	1,959	64.0 (1.0)	939	56.2 (1.5)	1,969	50.5 (1.0)	2,161	53.2 (0.9)	1,625	48.9 (1.1)
Total														
20-29	373	29.1 (1.5)	341	42.9 (2.2)	308	43.0 (2.5)	104	32.7 (3.2)	211	25.4 (1.9)	278	29.4 (1.8)	212	31.3 (2.3)
30-39	607	35.4 (1.3)	588	47.6 (2.0)	642	53.0 (1.8)	268	41.5 (2.3)	549	39.2 (1.5)	585	41.9 (1.6)	442	36.8 (1.5)
40-49	534	37.4 (1.5)	522	47.2 (1.8)	738	54.8 (1.8)	225	42.1 (2.2)	573	43.8 (1.5)	637	42.7 (1.4)	454	40.0 (1.6)
50-59	454	39.9 (1.8)	387	52.8 (2.3)	521	57.8 (2.1)	233	46.7 (2.3)	497	44.0 (1.9)	569	46.7 (1.5)	514	44.8 (1.9)
60-69	390	43.2 (1.8)	375	58.3 (2.6)	456	58.0 (2.1)	244	53.9 (2.8)	574	53.1 (2.1)	613	54.5 (2.0)	482	51.4 (1.7)
70+	266	47.1 (2.4)	258	63.4 (2.7)	310	65.5 (2.5)	234	59.8 (3.3)	499	59.0 (2.0)	518	56.5 (1.9)	393	57.3 (2.6)
Men														
20-29	107	19.2 (1.7)	103	32.3 (3.2)	86	30.3 (3.4)	33	24.8 (4.1)	60	20.0 (2.5)	100	23.4 (2.3)	68	26.5 (3.2)
30-39	221	28.7 (1.8)	197	35.9 (2.6)	230	48.0 (2.4)	77	32.2 (3.8)	200	34.5 (2.2)	196	34.3 (2.2)	157	32.5 (2.4)
40-49	179	28.2 (1.9)	173	36.3 (2.3)	276	46.6 (2.6)	72	32.3 (3.1)	202	36.4 (2.3)	208	33.2 (2.1)	176	33.5 (2.6)
50-59	124	25.3 (2.3)	119	35.4 (3.1)	198	50.5 (3.1)	59	32.8 (3.3)	158	34.2 (2.6)	200	39.5 (2.4)	170	38.2 (2.9)
60-69	94	24.9 (2.4)	118	40.3 (4.2)	156	42.1 (3.3)	69	35.0 (4.1)	164	38.5 (2.7)	193	40.8 (2.8)	171	41.8 (2.7)
70+	60	25.5 (3.0)	71	50.1 (4.9)	70	44.2 (4.7)	59	37.0 (4.1)	150	45.4 (3.1)	142	36.2 (2.8)	130	39.5 (3.3)
Women														
20-29	266	37.3 (2.1)	238	50.4 (2.7)	222	56.2 (3.1)	71	41.0 (3.7)	151	31.3 (2.9)	178	36.1 (2.6)	144	36.4 (3.2)
30-39	386	41.6 (1.7)	391	55.9 (2.2)	412	58.2 (2.3)	191	51.3 (3.7)	349	43.9 (1.9)	389	50.2 (2.1)	285	41.3 (2.1)
40-49	355	46.9 (2.0)	349	54.2 (2.5)	462	63.2 (2.0)	153	52.3 (3.4)	371	51.5 (2.2)	429	52.3 (1.8)	278	46.9 (2.3)
50-59	330	53.8 (2.4)	268	65.1 (2.7)	323	65.2 (2.5)	174	60.8 (2.9)	339	53.8 (2.5)	369	54.1 (2.0)	344	51.3 (2.5)
60-69	296	57.8 (2.3)	257	73.4 (3.0)	300	71.2 (2.6)	175	69.6 (3.1)	410	66.1 (2.5)	420	66.6 (2.4)	311	60.2 (2.8)
70+	206	58.1 (2.9)	187	71.8 (2.8)	240	77.8 (2.9)	175	73.6 (4.2)	349	67.6 (2.3)	376	70.0 (2.2)	263	69.1 (3.1)

SE, standard error.
[a]Age-standardized (standard population: 2010 Korean population).