Dyslipidemia Fact Sheet in South Korea, 2022

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Background: This study aimed to investigate the prevalence and status of dyslipidemia management among South Korean adults, as performed by the Korean Society of Lipid and Atherosclerosis under the name Dyslipidemia Fact Sheet 2022.
Methods: We analyzed the lipid profiles, age-standardized and crude prevalence, management status of hypercholesterolemia and dyslipidemia, and health behaviors among Korean adults aged ≥20 years, using the Korea National Health and Nutrition Examination Survey data between 2007 and 2020.
Results: In South Korea, the crude prevalence of hypercholesterolemia (total cholesterol ≥240 mg/dL or use of a lipid-lowering drug) in 2020 was 24%, and the age-standardized prevalence of hypercholesterolemia more than doubled from 2007 to 2020. The crude treatment rate was 55.2%, and the control rate was 47.7%. The crude prevalence of dyslipidemia—more than one out of three conditions (low-density lipoprotein cholesterol ≥160 or the use of a lipid-lowering drug, triglycerides ≥200, or high-density lipoprotein cholesterol [HDL-C] [men and women] <40 mg/dL)—was 40.2% between 2016 and 2020. However, it increased to 48.2% when the definition of hypo-HDL-cholesterolemia in women changed from <40 to <50 mg/dL.
Conclusion: Although the prevalence of hypercholesterolemia and dyslipidemia has steadily increased in South Korea, the treatment rate remains low. Therefore, continuous efforts are needed to manage dyslipidemia through cooperation between the national healthcare system, patients, and healthcare providers.

Keywords: Cholesterol; Disease management; Dyslipidemias; Health behavior; Prevalence; Republic of Korea

INTRODUCTION

Dyslipidemia is defined as elevated plasma concentrations of low-density lipoprotein cholesterol (LDL-C) or triglycerides (TG), a low plasma concentration of high-density lipoprotein cholesterol (HDL-C), or a combination of these features and is a major risk factor for cardiovascular disease, a leading cause of death in most countries [1,2]. Despite constant public edu-

cation and improvement in awareness of dyslipidemia, management, and control rates have been insufficient [3].

Hypercholesterolemia is defined as a total cholesterol (TC) level of >240 mg/dL, which is a major risk factor for cardiovascular disease. It can be measured regardless of diet; therefore, it is commonly used to compare the status of cholesterol metabolism diseases among countries. According to a recent World Health Organization report, hypercholesterolemia was approximately 39% in adults aged ≥25 years in 2008, and more than one-third of deaths due to ischemic heart disease or ischemic stroke were attributable to elevated plasma LDL-C levels [3].

To evaluate national dyslipidemia statistics, including awareness, treatment rate, control rate, and health behaviors, the Korean Society of Lipid and Atherosclerosis has been publishing the Dyslipidemia Fact Sheet (DFS) since 2015. Previous DFS studies have reported a gradually increasing prevalence of hypercholesterolemia and dyslipidemia. It is necessary to update the prevalence trends, management status, and health behaviors of adults with dyslipidemia over time.

This study (DFS 2022) aimed to investigate the lipid profiles, prevalence, and management of hypercholesterolemia or dyslipidemia, comorbidities, and health behaviors among Korean adults aged ≥20 years, using the Korea National Health and Nutrition Examination Survey (KNHANES) data between 2007 and 2020.

METHODS

Data source and study participants
We analyzed data from the KNHANES between 2007 and 2020. The KNHANES is a nationwide survey that assesses the health and nutritional status of Koreans and monitors trends in health-related risk factors and the prevalence and management of major chronic diseases in Korea [4]. The target population comprised non-institutionalized citizens aged ≥1 year residing in Korea, and the survey participants were sampled using a complex survey design. To represent the Korean population, sample weights were assigned to each participant by accounting for the sampling design, survey response, and post-stratification. Diverse information on socioeconomic status, health behaviors, anthropometric measures, health status (measured using biochemical and clinical profiles), and dietary intake was collected. Participants were limited to those aged ≥20 years, with fasting blood lipid measurements, and with information on physician diagnosis and treatment for dyslipidemia. The data was anony-

mized and provided at the website of the KNHANES of the Korea Centers for Disease Control and Prevention. The study protocol was approved by the Institutional Review Board of Yonsei University Health System, Seoul, Korea (approval 4-2021-0940). National Health Insurance Service data are provided as personal information has been deleted, and the IRB has approved consent waivers. The Korean and English atlas versions of the "Dyslipidemia fact sheet in Korea 2022" are also available at https://lipid.or.kr/.

Measurements and definitions
Serum lipid concentrations such as TC, TG, LDL-C, and HDL-C were measured using blood samples after fasting for at least 8 hours. Since LDL-C measures were available only for some of the participants, the calculated values based on the Friedwald formula were used for those without direct measurement of LDL-C [5]. Non-HDL-C was derived by subtracting HDL-C from TC. Information on physicians' diagnoses of diseases, medication use, and health behaviors was obtained through a health interview survey. Anthropometric measurements and dietary intake data were obtained through physical examinations and nutritional surveys, respectively.

Prevalence and management of hypercholesterolemia
Hypercholesterolemia was defined as TC ≥240 mg/dL or the use of a lipid-lowering drug. The awareness rate was defined as the proportion of patients with physician-diagnosed hypercholesterolemia among all patients with hypercholesterolemia. The treatment rate was defined as the proportion of patients using lipid-lowering drugs for ≥20 days per month among those with hypercholesterolemia. The control rate was defined as follows: (1) the proportion of patients with TC <200 mg/dL among all patients with hypercholesterolemia and (2) the proportion of patients with TC <200 mg/dL among those on lipid-lowering medication for hypercholesterolemia.

Prevalence of dyslipidemia
Hyper-LDL-cholesterolemia was defined as LDL-C ≥160 mg/dL or the use of a lipid-lowering drug. Hypertriglyceridemia was defined as TG ≥200 mg/dL. Hypo-HDL-cholesterolemia was defined as follows: HDL-C <40 mg/dL in both men and women (hypo-HDL-cholesterolemia 1) and HDL-C <40 mg/dL in men and <50 mg/dL in women (hypo-HDL-cholesterolemia 2).

Dyslipidemia was defined as having at least one of the fol-

lowing conditions: hyper-LDL-cholesterolemia, hypertriglyceridemia, and hypo-HDL-cholesterolemia. In DFS 2022, we analyzed the prevalence of dyslipidemia in two ways according to two different definitions of hypo-HDL-cholesterolemia: dyslipidemia 1 as dyslipidemia with hypo-HDL-cholesterolemia 1 and dyslipidemia 2 as dyslipidemia with hypo-HDL-cholesterolemia 2.

Dyslipidemia in a specific population

To evaluate the magnitude of dyslipidemia and the management status of blood lipids according to the presence of chronic conditions such as diabetes, hypertension, and obesity, we analyzed the KNHANES data from 2016 to 2020. Diabetes was defined as fasting glucose ≥126 mg/dL, glycosylated hemoglobin (HbA1c) ≥6.5%, previously diagnosed, or the use of glucose-lowering drugs or insulin. Prediabetes was defined as fasting glucose 100–125 mg/dL or HbA1c 5.7%–6.4%. Hypertension was defined as systolic blood pressure (SBP) ≥140 mm Hg, diastolic blood pressure (DBP) ≥90 mm Hg, or the use of blood pressure-lowering drugs, whereas prehypertension was defined as SBP 120–139 mm Hg or DBP 80–89 mm Hg. People were divided into four groups according to their body mass index: underweight (<18.5 kg/m^2), normal weight (18.5–22.9 kg/m^2), overweight (23.0–24.9 kg/m^2), and obesity (≥25.0 kg/m^2) [6]. Abdominal obesity was defined as a waist circumference ≥90 cm for men and ≥85 cm for women.

Health behaviors among adults with dyslipidemia

The health behaviors of adults with dyslipidemia were evaluated using the KNHANES data between 2016 and 2018. Dietary intake was assessed using a 24-hour dietary recall. Dietary quality aspects, such as balanced, moderate, and adequate consumption, were evaluated using the components of the Korean Healthy Eating Index [7] provided by the Korea Disease Control and Prevention Agency. We defined balanced total energy intake as 75% to 125% of the energy requirement by sex and age. The recommended proportions of calorie intake were 7%–20% for protein, 56%–65% for carbohydrates, and 15%–30% for fat. Physical activity was measured using the Global Physical Activity Questionnaires and divided into two groups: aerobic physical activity (moderate-intensity activity for ≥2.5 hours, vigorous-intensity activity for ≥1.25 hours, or an equivalent combination of moderate- and vigorous-intensity activity over the past week) and inactivity. The smoking status was classified as current smoking, ex-smoking, or nonsmoking. Drink-ing was defined as the consumption of alcohol more than once per month in the past year.

Statistical analysis

All analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA), accounting for the sample weights assigned to the participants to represent the Korean population. To evaluate the magnitude of the prevalence and management of dyslipidemia, both crude and age-standardized rates were estimated. Age-standardized rates were calculated via the direct standardization method using the 2005 Korean population structure provided by the Population and Housing Census, Statistics Korea.

RESULTS

Lipid profile in Korean adults

Trends in the age-standardized mean concentrations of blood lipids are shown in Fig. 1A. In 2020, mean concentration of TC was 192.1 mg/dL, non-HDL-C was 140.1 mg/dL, TG was 134.3 mg/dL, LDL-C was 115.1 mg/dL, and HDL-C was 52 mg/dL.

Blood lipid profiles were slightly different between men and women (Fig. 1B). Men had a higher median concentration of non-HDL-C (142 and 135 mg/dL in men and women, respectively) and TG (125 and 96 mg/dL in men and women, respectively) than women. The median HDL-C level was higher in women than in men (46 and 54 mg/dL in men and women, respectively).

Hypercholesterolemia

The prevalence of hypercholesterolemia has steadily increased. The age-standardized prevalence of hypercholesterolemia in 2020 was 19.9%, doubling from 8.8% in 2007 (Fig. 2A). The crude prevalence of hypercholesterolemia in 2020 was 24.0% (Fig. 2B). The awareness, treatment, and control rates during 2019–2020 were 63.0%, 55.2%, and 47.7%, respectively. The control rate among lipid-lowering drug users was 85% (Fig. 3).

The awareness, treatment, and control rates in people with hypercholesterolemia and control rates among lipid-lowering drug users consistently increased from 38.3%, 25.8%, 19.1%, and 72.4%, respectively, in 2007–2009 to 63.0%, 55.2%, 47.7%, and 85.0% in 2019–2020 (Supplementary Fig. 1). The crude prevalence, awareness, treatment, and control rates have been consistently slightly higher in women than in men throughout the years since 2007 (Supplementary Fig. 2). In particular, the
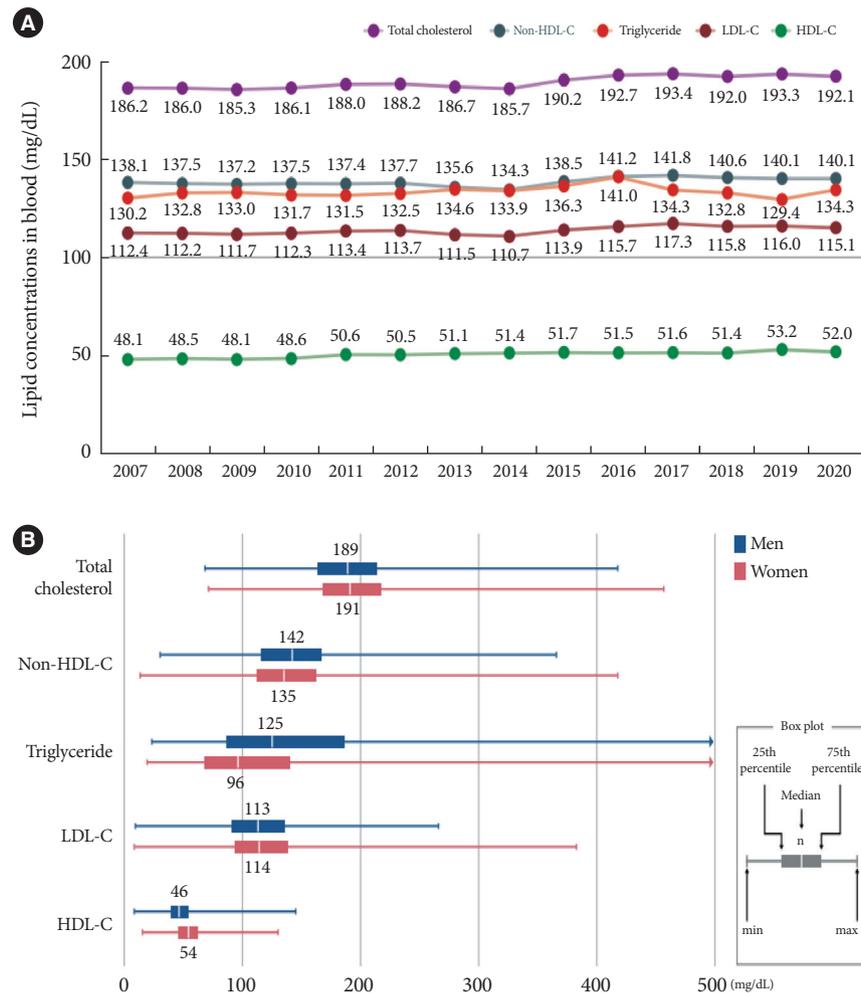
Fig. 1. (A) Age-standardized mean blood lipid concentrations. Age-standardized to the 2005 population. Data source from Korea National Health and Nutrition Examination Survey (KNHANES) 2007 to 2020. (B) Blood lipid concentration distributions in men (blue) and women (red). Data from 2016 to 2020 KNHANES; adults aged 20 years and older. HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol.

control rate among adults treated with lipid-lowering drugs differed according to sex; however, this difference decreased. The previous control rate was higher in men than in women (78.6% and 68.2% in men and women, respectively) between 2007 and 2009. However, currently, the control rate is almost the same in both sexes: 85.1% in men and 85% in women (Supplementary Fig. 2D).

Dyslipidemia

The age-standardized prevalence in 2020 was 37.7% for dyslipidemia 1 and 45.4% for dyslipidemia 2 (Fig. 4A). The crude prevalence during 2016–2020 was 40.2% and 48.2% for dyslipidemia 1 and dyslipidemia 2, respectively (Fig. 4B). The preva-

lence of dyslipidemia 1 in women was lower than that in men (47.4% and 33.0% in men and women, respectively); however, the prevalence of dyslipidemia 2 in women was similar to that in men (47.4% and 49.0% in men and women, respectively) (Fig. 4B).

When we analyzed the prevalence rate based on dyslipidemia 1, the prevalence in women in their 20s to 50s was lower than that in men, but the prevalence gap between men and women decreased when we analyzed the prevalence rate based on dyslipidemia 2. In the 30 to 49 years age group, the prevalence of dyslipidemia 2 was higher in men; however, in the 60s age group, the sex trend started to reverse. In particular, the prevalence of dyslipidemia in men was steady in their 40s (55.8%) to
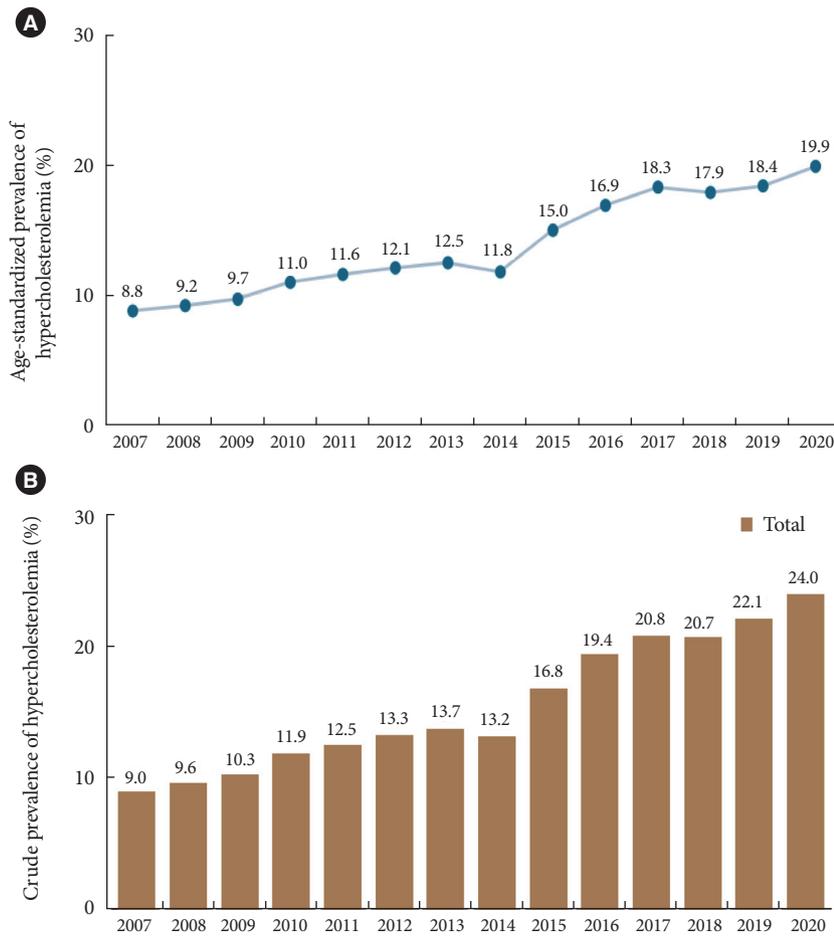
A

B

Fig. 2. Prevalence of hypercholesterolemia. (A) Age-standardized prevalence of hypercholesterolemia. Standardized for the 2005 Korean population. (B) Crude prevalence of hypercholesterolemia. Data from 2007 to 2020 Korea National Health and Nutrition Examination Survey; adults aged 20 years or older. Hypercholesterolemia: total cholesterol ≥240 mg/dL or taking a lipid-lowering drug.
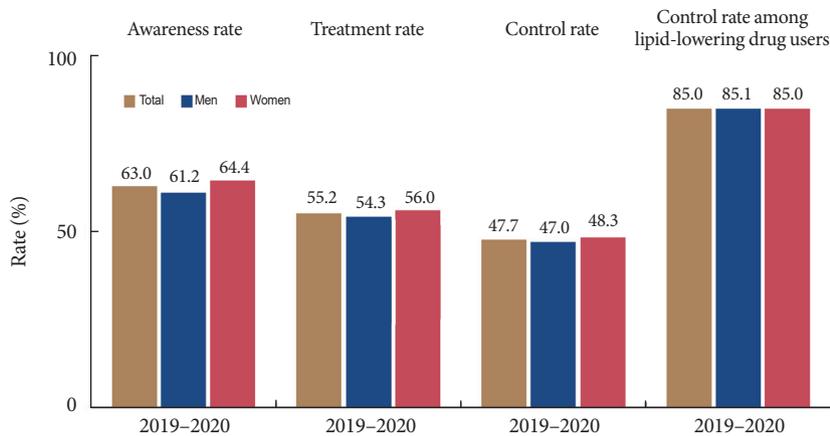

Fig. 3. Management of hypercholesterolemia. Summary of awareness, treatment, and control rates. Data from 2019 to 2020 Korea National Health and Nutrition Examination Survey; adults aged 20 years or older with hypercholesterolemia. Hypercholesterolemia: total cholesterol ≥240 mg/dL or use of a lipid-lowering drug. Awareness: self-reported physician-diagnosed hypercholesterolemia or dyslipidemia. Treatment: self-reported use of a lipid-lowering drug. Control: total cholesterol level <200 mg/dL.
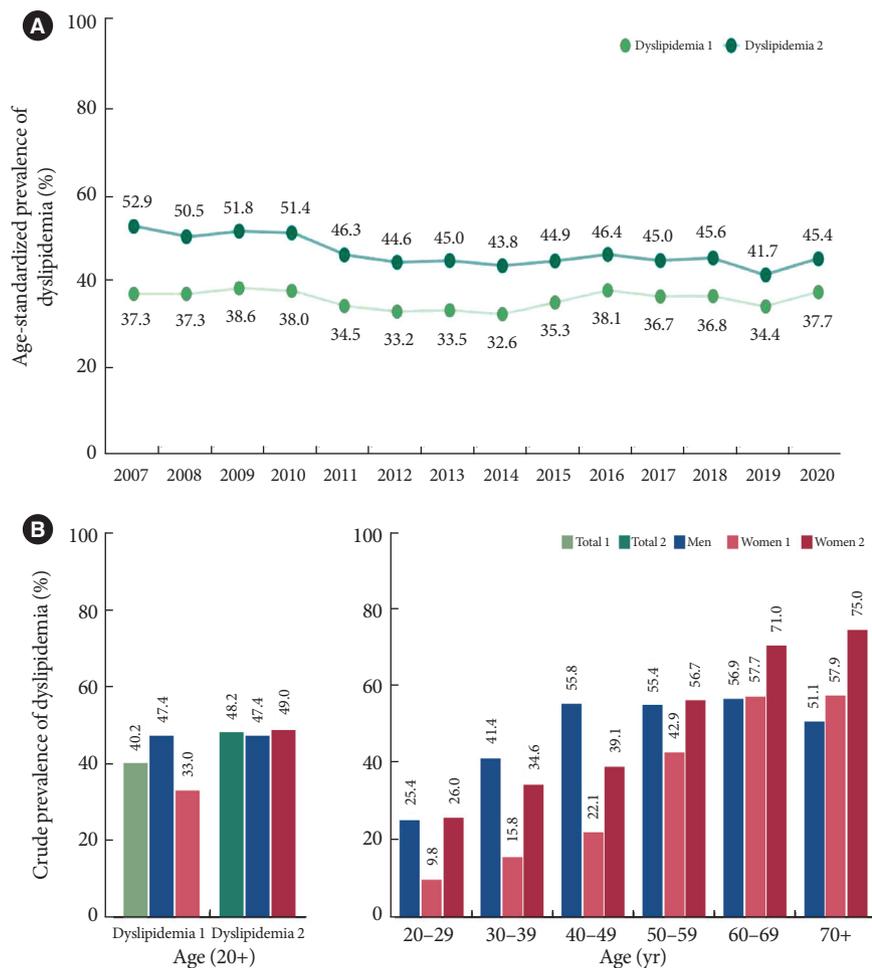
Fig. 4. Prevalence of dyslipidemia. (A) Age-standardized prevalence of dyslipidemia. Data from 2007 to 2020 Korea National Health and Nutrition Examination Survey (KNHANES); adults aged 20 years or older. (B) Crude prevalence of dyslipedemia according to sex and age. Data from 2016 to 2020 KNHANES; adults aged 20 years or older. Dyslipidemia 1: hyper-low-density lipoprotein (LDL) cholesterolemia, hypertriglyceridemia, or hypo-high-density lipoprotein (HDL) cholesterolemia (<40 mg/dL in both men and women). Dyslipidemia 2: hyper-LDL-cholesterolemia, hypertriglyceridemia, or hypo-HDL-cholesterolemia (<40 mg/dL in men and <50 mg/dL in women).

60s (56.9%) and then decreased to 51.1% in their 70s. However, in the case of women, it continued to increase with age, with the prevalence of dyslipidemia 2 reaching 75% in their 70s (Fig. 4B).

Hyper-LDL-cholesterolemia
The age-standardized prevalence of hyper-LDL-cholesterolemia steadily increased from 8.7% in 2007 to 19.1% in 2020 (Supplementary Fig. 3A). Based on the data from 2016 to 2020, nearly one in five Korean adults had hyper-LDL-cholesterolemia (crude prevalence, 20.4%). The prevalence of hyper-LDL-cholesterolemia in both sexes reversed since their 50s (Supplementary Fig. 3B). In their 40s, the prevalence of hyper-LDL-

cholesterolemia in men was 20.0%, almost twice as high as that in women (11.4%). However, the prevalence in women in their 60s was 45.9%, which was 1.57 times higher than that in men (29.1%) (Supplementary Fig. 3B).

Hypertriglyceridemia
The age-standardized prevalence of hypertriglyceridemia gradually increased from 15.3% in 2007 to 16.8% in 2016, decreased to 13.6% in 2019, and then increased again to 15% in 2020 (Supplementary Fig. 4A). The prevalence of hypertriglyceridemia was much higher in men between their 30s and 50s; the most substantial difference being in their 40s (31.6% in men and 7.5%
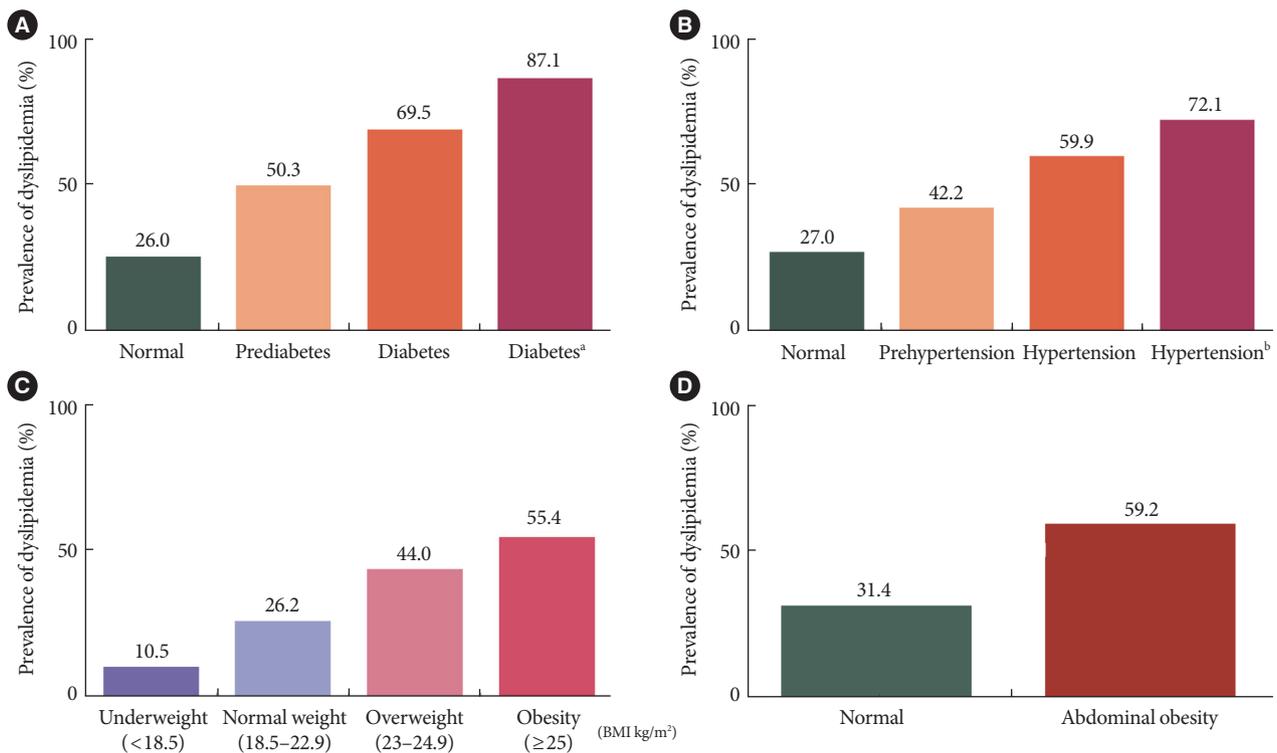
Fig. 5. Prevalence of dyslipidemia in specific populations. (A) Prevalence of dyslipidemia according to diabetes status. Data from 2016 to 2020 Korea National Health and Nutrition Examination Survey (KNHANES); adults aged 20 years or older. Prediabetes: fasting glucose 100–125 mg/dL or glycosylated hemoglobin (HbA1c) 5.7%–6.4%. Diabetes: fasting glucose ≥126 mg/dL, HbA1c ≥6.5%, previously diagnosed or taking glucose-lowering drugs or insulin. Dyslipidemia: low-density lipoprotein cholesterol (LDL-C) ≥160 mg/dL, triglyceride ≥200 mg/dL, high-density lipoprotein cholesterol (HDL-C) <40 mg/dL, or the use of a lipid-lowering drug. (B) Prevalence of dyslipidemia according to the hypertension status. Data: 2016 to 2020 KNHANES; adults aged 20 years. Prehypertension: systolic blood pressure (SBP) 120–139 mm Hg or diastolic blood pressure (DBP) 80–89 mm Hg. Hypertension: SBP ≥140 mm Hg, DBP ≥90 mm Hg, or use of a blood pressure-lowering drug. Dyslipidemia: LDL-C ≥160 mg/dL, triglyceride ≥200 mg/dL, HDL-C <40 mg/dL, or the use of a lipid-lowering drug. (C) Prevalence of dyslipidemia according to the obesity status. Data from 2016 to 2020 KNHANES; adults aged 20 years or older. Dyslipidemia: LDL-C ≥160 mg/dL, triglyceride ≥200 mg/dL, HDL-C <40 mg/dL, or the use of a lipid-lowering drug. (D) Prevalence of dyslipidemia according to abdominal obesity. Data from 2016 to 2020 KNHANES; adults aged 20 years or older. Abdominal obesity was defined as waist circumference ≥90 cm in men, ≥85cm in women. BMI, body mass index. [a]Dyslipidemia: LDL-C ≥100 mg/dL, triglyceride ≥200 mg/dL, HDL-C <40 mg/dL, or taking a lipid-lowering drug, [b]Dyslipidemia: LDL-C ≥130 mg/dL, triglyceride ≥200 mg/dL, HDL-C <40 mg/dL, or taking a lipid-lowering drug.

in women), which was nearly four times higher in men than in women. The difference decreased gradually with age and was reversed in their 70s (Supplementary Fig. 4B).

Hypo-HDL-cholesterolemia

The age-standardized prevalence in 2020 was 15.5% for hypo-HDL-cholesterolemia 1 and 26.8% for hypo-HDL-cholesterolemia 2 (Supplementary Fig. 5A). The crude prevalence of hypo-HDL-cholesterolemia 1 was much higher in men throughout all ages than in women (24.3% and 9.1% in men and wom-

en, respectively), but the prevalence of hypo-HDL-cholesterolemia 2 in women was higher than that in men (24.3% and 34.6% in men and women, respectively). The difference was maximized in their 70s, with a prevalence of 53.1% in women and 29.3% in men (Supplementary Fig. 5B).

Dyslipidemia in specific populations
Diabetes mellitus

The prevalence of dyslipidemia differs according to the glucose metabolism status. In individuals with normal glucose levels,

the prevalence of dyslipidemia was 26%. However, the prevalence of dyslipidemia increases as the blood glucose levels increase. During the prediabetic status, defined as fasting glucose 100–125 mg/dL or HbA1c is 5.7%–6.4%, the prevalence of dyslipidemia was 50.3%. The prevalence of dyslipidemia increased up to 69.5% in people with diabetes. When we used LDL-C ≥100 mg/dL instead of LDL-C ≥160 mg/dL to define dyslipidemia in people with diabetes, the prevalence increased to 87.1% (Fig. 5A).

Hypertension

Similar to diabetes, the prevalence of dyslipidemia increases with blood pressure. In normotensive individuals, the prevalence of dyslipidemia was 27%, and in individuals with prehypertension, the prevalence was 42.2%. In people with hypertension, the prevalence was high (59.9%). When we applied the criteria of LDL-C ≥130 mg/dL instead of LDL-C ≥160 mg/dL in patients with hypertension, the prevalence of dyslipidemia increased to 72.1% (Fig. 5B).

Obesity

The prevalence of dyslipidemia was 10.5%, 26.2%, 44%, and 55.4% in the underweight, normal weight, overweight, and obesity groups, respectively (Fig. 5C). Abdominal obesity was strongly associated with dyslipidemia. Among people with normal-ranged abdominal circumference, 31.4% had dyslipidemia, but among those with abdominal obesity, 59.2% had dyslipidemia (Fig. 5D).

Health behaviors

Among adults with dyslipidemia, 49.7% of men and 48.7% of women had a balanced total energy intake. Protein intake was balanced in 85.5% of men and 91% of women, whereas carbohydrate intake was balanced only in 29.2% of men and 22.8% of women. Balanced fat intake was observed in 53.6% of men and 44.7% of women (Supplementary Fig. 6A).

Only 26.8% of men and 20.4% of women with dyslipidemia ate vegetables more than 8 servings/day (for women aged ≥65 years, more than 6 servings/day). Approximately 62.2% of men and 72.5% of women with dyslipidemia consumed an adequate amount of saturated fat (<7% of the total energy). Approximately 40% of men and 30% of women with dyslipidemia consumed more saturated fat than was recommended (Supplementary Fig. 6B).

Among individuals with dyslipidemia, 54.3% of men and 61.9% of women did not meet the recommendations for physical activity. Moreover, 39.5% of men and 5.5% of women smoked cigarettes, and 71.6% of men and 32.1% of women consumed alcohol (Supplementary Fig. 6C).

In Korean adults, the total energy intake increased until the mid-2010s and decreased again to 2,281 kcal for men and 1,615 kcal for women in 2020. Carbohydrate intake decreased gradually, whereas fat intake increased in both sexes (Supplementary Fig. 7A). Cigarette smoking decreased gradually, with age-standardized prevalence peaking at 48.3 in 2010 and then decreasing to 34.0 in 2020, which was attributable to the decreased prevalence in men (Supplementary Fig. 7B).

DISCUSSION

In the DFS reported in 2015, the prevalence of dyslipidemia among adults aged ≥30 years was 47.8%. In the DFS reported in 2018, the prevalence of hypercholesterolemia and dyslipidemia in adults aged ≥30 years was 19.9% and 40.5%, respectively, in 2016. In the DFS reported in 2020, the prevalence of dyslipidemia among adults aged ≥20 years was 38.4%.

The most recent DFS (2022) revealed an increasing prevalence of hypercholesterolemia. Almost one-fourth of adults were diagnosed with hypercholesterolemia in Korea in 2020: 22.9% and 25% in men and women, respectively. When hypo-HDL-cholesterolemia was defined as <50 mg/dL in women, the prevalence of dyslipidemia in women increased, which was similar to that in men (47.4% and 49% in men and women, respectively).

The leading cause is the increase in hypercholesterolemia due to the westernization of nutrition and lifestyle. However, the increase in the intake of cholesterol-lowering drugs is also a cause of the increase in the prevalence of hypercholesterolemia because the definition of hypercholesterolemia contains the concept of 'taking lipid-lowering drugs.' Because of this, the LDL-C level did not increase significantly, although the prevalence of hypercholesterolemia increased.

Notably, awareness of hypercholesterolemia is also increasing. There were notable sex differences in the earlier periods (2013–2015 and 2016–2018), and awareness and treatment rates showed a relatively steeper increase in men than in women during 2019 to 2020. The control rate of hypercholesterolemia has significantly increased from 19.1% to 47.7% over the past 10 years. However, there are still limitations to the control rates, with more than half of the adults with hypercholesterol-

emia without adequate control.

Considering that the ideal goals for hypercholesterolemia have been increasingly changing (Korean guidelines for the management of dyslipidemia 5th), there are two things to note [8,9]. First, as treatment targets become stricter, the control rate of dyslipidemia is expected to decrease gradually. Second, owing to the current standstill of those reaching the target blood cholesterol level, the community should be educated regarding aggressive drug treatment strategies, including the combinatorial use of drugs with different mechanisms.

The prevalence of dyslipidemia differed from that of hypercholesterolemia. The age-standardized prevalence of dyslipidemia 1 and dyslipidemia 2 slightly decreased from 2007 to 2019 and then increased in 2020 (Fig. 4A). This trend is probably attributable to the decrease in physical activity and increase in obesity due to social distancing owing to SARS-CoV-2 pandemic [10]. This trend shows a similar pattern for hypo-HDL-cholesterolemia and hypertriglyceridemia. Both hypo-HDL-cholesterolemia and hypertriglyceridemia are atherogenic dyslipidemias caused by insulin resistance, which can increase the incidence of metabolic syndrome and the risk of cardiovascular diseases.

In DFS 2022, unlike the previous DFS editions, the epidemiologic characteristics of dyslipidemia were additionally analyzed by defining hypo-HDL-cholesterolemia as <50 mg/dL in women, unlike in men. The definition of hypo-HDL-cholesterolemia differs according to sex. It has been proven in many countries, besides Korea, that HDL-C levels are approximately 10 mg/dL higher in women than in men. When defining metabolic syndrome, the criteria for hypo-HDL-cholesterolemia are also defined differently in men and women [11].

Thus, when the hypo-HDL-cholesterolemia criteria were equally applied to men and women at <40 mg/dL, the prevalence of dyslipidemia in women was underestimated (Supplementary Fig. 5). Therefore, in DFS 2022, the prevalence of dyslipidemia was further analyzed according to the two different criteria for hypo-HDL-cholesterolemia (dyslipidemia 1 vs. dyslipidemia 2). The difference in the prevalence of dyslipidemia between men and women was significantly reduced when dyslipidemia 2 was applied compared with when dyslipidemia 1 was applied (Fig. 4). The prevalence of dyslipidemia was higher in men than in women in their 30s to 40s, but this was reversed after their 50s. Remarkably, hypo-HDL-cholesterolemia and growing hyper-LDL-cholesterolemia and hypertriglyceridemia as women age are the main factors contributing to this trend.

The crude prevalence of dyslipidemia in men was similar to that in men in their 40s to 60, decreasing slightly in their 70s. However, in women, the prevalence of dyslipidemia 2 in their 70s is particularly high, reaching 75%. This was mainly due to the high incidence of hyper-LDL-cholesterolemia (40.7%) and hypo-HDL-cholesterolemia (53.1%) among older women. The prevalence of hyper-LDL-cholesterolemia in women was almost half as low as that in men before their 50s, but it increased sharply from 11.4% in their 40s, 31.2% in their 50s, and up to 45.9% in their 60s, while the prevalence in men was 29.1% in their 60s.

Menopause significantly impacts cholesterol metabolism, contributing considerably to the increase in cardiovascular risk in postmenopausal women [12]. In the case of hypercholesterolemia, although we did not confirm the control rate in older individuals in this study, the overall control rate in women was 48.3%, which is less than half; therefore, it is necessary to encourage diagnosis and treatment of dyslipidemia in postmenopausal women. In men, the frequency of hyper-LDL-cholesterolemia and hypertriglyceridemia is high among relatively young people in their 40s and 50s, which is a sex hormone-dependent characteristic that and also likely related to unhealthy eating and drinking habits.

The prevalence of dyslipidemia among adults with comorbidities, including diabetes, hypertension, and obesity, remained stable when the analysis was extended from 2007–2018 to 2007–2020 [3]. The proportions of adults with dyslipidemia increased across the spectrum of normoglycemia to diabetes, normal blood pressure to hypertension, and underweight to obesity. Diabetes mellitus, hypertension, and obesity are important cardiovascular risk factors, and the risk increases when accompanied by dyslipidemia. To lower this risk, the target level of LDL-C control is lower than that of the general population, which is why more patients with those conditions are taking cholesterol-lowering drugs resulting in the diagnosis of hypercholesterolemia.

Adults with diabetes had a better distribution of LDL-C levels than those without diabetes, suggesting that many adults with diabetes were taking lipid-lowering agents. However, only 51.8% of adults with diabetes achieved lipid control of LDL-C <100 mg/dL for those without cardiovascular disease, based on the Korean guidelines for the management of dyslipidemia [1,13]. In contrast, a comparable distribution of LDL-C levels was observed between adults with and without hypertension. Approximately 60% of adults with dyslipidemia had hyperten-

sion and thus were at least at moderate risk of cardiovascular disease. The achievement of LDL-C <130 mg/dL was slightly higher in adults with hypertension (71.0%) than in those without hypertension (66.7%). Obesity and abdominal obesity are important risk factors for dyslipidemia. In Korea, the prevalence of obesity and abdominal obesity has steadily increased over the last decade [10]. Given the pathophysiological mechanisms, the increasing trend in obesity and abdominal obesity may affect the prevalence and control rate of dyslipidemia in the future [14]. Therefore, comprehensive management of dyslipidemia and its comorbidities is needed to reduce the risk of metabolic and cardiovascular complications.

In this DFS, we could not directly compare the eating and exercise patterns of people with and without dyslipidemia. Since this was a cross-sectional study, the survey may have been conducted in a state in which people diagnosed with dyslipidemia thoroughly improved their diet and exercise habits after the diagnosis. In this study, the lifestyles of people with dyslipidemia were analyzed and compared with the recommended lifestyles. Protein intake was appropriate; however, the intake of carbohydrates, vegetables, and saturated fatty acids required correction. Both men and women lacked physical activity, and smoking and drinking remained major health problems in men.

In conclusion, DFS 2022 showed that the prevalence of hypercholesterolemia has steadily increased in Korea, and the treatment rate remains low. Moreover, when hypo-HDL-cholesterolemia was defined as <50 mg/dL in women, the prevalence of dyslipidemia was high (up to 48.2%). Prevalence of dyslipidemia places a heavy burden on the affected individuals and society. Therefore, continuous efforts are needed to manage dyslipidemia through cooperation between the national healthcare system, patients, and healthcare providers. We hope that DFS 2022 will provide a better understanding of the characteristics of dyslipidemia, help enhance public awareness, and encourage adequate treatment.

SUPPLEMENTARY MATERIALS

Supplementary materials related to this article can be found online at https://doi.org/10.4093/dmj.2023.0135.

CONFLICTS OF INTEREST

Hyeon Chang Kim has been statistical advisor of the *Diabetes & Metabolism Journal* since 2022. He was not involved in the

review process of this article. Otherwise, there was no conflict of interest.

AUTHOR CONTRIBUTIONS

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