Diet and lipid-lowering drug use among people with dyslipidemia in Korea

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Kwan Yeol Yang, Chul Soon Yong, Hye Duck Choi, Jong Oh Kim

College of Pharmacy, Yeungnam University, Gyeongsan, 712-749, Republic of Korea

Authors' email addresses and contributions:

KY Yang: conceived the study question and contributed to the study design, supervision of data collection, data analysis and interpretation, and writing the manuscript.

CS Yong: undertook data collection and analysis and contributed to data interpretation and writing the manuscript.

HD Choi: undertook data collection and analysis and contributed to data interpretation and writing the manuscript.

JO Kim: undertook data collection and analysis and contributed to data interpretation and writing the manuscript.

Corresponding Author: Dr Jong Oh Kim, College of Pharmacy, Yeungnam University, Gyeongsan, 712-749, Republic of Korea. Tel: +82-53-810-2813. Fax: +82-53-810-4654. Email: jongohkim@yu.ac.kr

ABSTRACT

Background and Objectives: Obesity and diet contribute to the development of hypercholesterolemia; therefore, controlling blood lipid concentration through diet is essential. To understand the role of diet in controlling blood lipid concentration, we evaluated the food and nutrient intakes, anthropometry, and blood lipid concentrations of adults with dyslipidemia with or without lipid-lowering drug use. **Methods and Study Design:** For this cross-sectional study, three-year data were obtained from the 6th–7th Korean National Health and Nutrition Examination Survey (2015–2017). Patients with dyslipidemia were categorized as users (1,734) or nonusers (856) of lipid-lowering drugs. **Results:** Age, education level, marital status, self-reported health status, hypertension, diabetes, and alcohol intake were significantly different between users and nonusers (p<0.05). Multiple logistic regression analysis revealed a significant association between hypertension and diabetes and blood cholesterol status among users. Total cholesterol, triglycerides, and low-density lipoprotein cholesterol were significantly lower in users than in nonusers. During the study period, intake of saturated fatty acids increased significantly among users and nonusers, and intakes of vitamins A and C decreased significantly with potential detrimental health effects. However, intakes of n-3 fatty acids and dietary fiber significantly increased in users and nonusers with potential health benefits. Intakes of vegetables and fish significantly increased in users. No associations were observed between intakes of nuts, fruits, or vegetables and blood cholesterol status. **Conclusions:** Changes in personal behaviors of dyslipidemic patients need reinforcement for effective blood lipid management, particularly for optimal food intake patterns, whether lipid-lowering drug users or nonusers.

Key Words: dyslipidemia, drugs, body mass index, nutrition, food intake

INTRODUCTION

Cardiovascular disease (CVD) is a major cause of death[1] worldwide and is a crucial health concern in South Korea.[2] Many risk factors are associated with CVD, including dyslipidemia, hypertension, a family history of CVD, insulin resistance, obesity, smoking, stress, and lifestyle.[1,3] According to the Korean National Health and Nutrition Examination Survey (KNHANES), the prevalence of hypercholesterolemia (total cholesterol [TC] ≥240 mg/dL) has gradually increased during the last decade from 8.5% in 2005 to 14.6% in 2014 (adults, age ≥30 years).[2] According to data from the 2015 KNHANES,[2] the prevalence of hypercholesterolemia in South Korea is 17.9%, which is higher than rates reported in America (15%)[4] and China (14.7%).[5]

Therapy with cholesterol-lowering drugs has beneficial effects on cardiovascular parameters and arterial wall composition.[6,7] However, in a population with hyperlipidemia, obese patients tend to exhibit atherosclerosis progression and a decrease in arterial stiffness despite receiving optimized lipid-lowering drug therapy.[8,9] Therefore, in dyslipidemia management, controlling blood lipid concentrations using a combination of pharmacotherapy and lifestyle changes is crucial.[10,11] Dyslipidemia should be treated using lipid-lowering drugs and behavioral interventions such as diet modification, exercise, and smoking cessation.[3] Obesity and diet are the two principal modifiable factors that affect the development of hypercholesterolemia.[12]

Excessive fat consumption is widely believed to be a major dietary cause of obesity,[13] and the intake of high-glycemic-index carbohydrates such as simple sugars and starch may also contribute to obesity.[14] Korean diets are traditionally high in carbohydrates and low in fat,[15] with carbohydrates, fat, and protein contributing to 63.7%, 21.8%, and 14.5% of the total energy intake, respectively.[2] Dietary patterns high in carbohydrates are associated with a risk of dyslipidemia and CVD in Korean adults.[16,17] Therefore, Korean patients with dyslipidemia must consume adequate amounts of all macronutrients (carbohydrates, proteins, and fats).

Recent studies have investigated the association between food intake patterns and dyslipidemia and have particularly focused on the effect of choosing particular individual foods or combinations of foods.[3,11,18] The 2013 American College of Cardiology/American Heart Association (AHA) guidelines recommend diet plans such as the DASH diet, the United States Department of Agriculture food pattern, and the AHA diet.[11] The Korean guidelines for dyslipidemia management should recommend a diet that consists of a high proportion of whole grains and foods such as vegetables, beans, fish, fruits, and dairy products.[3]

In the 6th KNHANES, the treatment rate (taking a lipid-lowering drug for 20 days or more per month; age ≥30 years) for hypercholesterolemia was 45.5%, and the rate of controlled hypercholesterolemia (total cholesterol <200 mg/dL; age ≥30 years) was 39.7%.[2] Statins are currently the most commonly used lipid-lowering agents for the treatment of hyperlipidemia. Because statins are administered orally, food intake plays a crucial role in achieving adequate therapeutic effects.[19] In a study using data from the National Health and Nutrition Examination Survey (NHANES, 1999–2010), the calorie intake of statin users was significantly lower than that of nonusers.20 However, in the same study, the calorie and fat intakes of statin users increased, and the increase in body mass index (BMI) was higher in statin users than in nonusers.[20] In a previous study based on the KNHANES that concerned adults with dyslipidemia, the physical activity of lipid-lowering drug users significantly decreased during 2010–2013, but no significant difference was observed between lipid-lowering drug users and nonusers in terms of the calorie intake trend.[21] The Study of Exercise and Nutrition in Older Rhode Islanders (SENIOR) project reported that statin users had more favorable lipid profiles than nonusers but had significantly lower micronutrient intake (vitamin B12, vitamin K, calcium, and potassium). However, no differences were noted between the groups in terms of reported physical activity.[22] In addition, studies on dyslipidemia,[23] the use of lipid-lowering drugs,[24] risk factors for dyslipidemia in Koreans, and evaluation of the effects of such drug use have been reported.[25]

Several studies have emphasized the importance of treating and managing dyslipidemia. However, studies focusing on nutritional status and blood lipid profiles based on the use or nonuse of lipid-lowering drugs are insufficient. Therefore, the present study investigated the BMI values, blood lipid profiles, and nutrient and food intakes of lipid-lowering drug users and nonusers among Korean adults with dyslipidemia.

MATERIALS AND METHODS

Data source and participants

This study was based on three-year data obtained from the 6th–7th KNHANES survey, conducted from 2015 to 2017 by the Korea Centers for Disease Control and Prevention. The KNHANES is an annual surveillance system that uses a representative national sample consisting of three surveys—a health interview survey, health examination survey, and nutrition survey—to assess the collective health and nutritional status of the Korean population. The health interview survey includes information regarding housing characteristics, socioeconomic status, and physical activity. The health examination survey contains data on anthropometric measurements and laboratory tests. Data on dietary behaviors, dietary supplement use, food consumption frequency, and food intake are obtained using the nutrition survey. The Institutional Review Board (IRB) of the Korea Centers for Disease Control reviews and approves the KNHANES survey annually. The present study protocol was approved by the IRB of Yeungnam University (IRB File number: 2017-09-004).

The 2015–2017 KNHANES included 23,657 participants; in the present study, participants were excluded if they did not have dyslipidemia or had missing data regarding dyslipidemia or lipid-lowering drug use. Furthermore, participants were excluded if they were younger than

20 years, were pregnant, or had a daily calorie intake below 500 kcal or over 5,000 kcal. The final sample comprised 2,590 participants (748 in 2015, 838 in 2016, and 1,004 in 2017).

Variables and measurements

Participants received the diagnosis of dyslipidemia from a physician attached to the health interview survey. Participants with dyslipidemia were categorized as either users or nonusers of lipid-lowering drugs. Sociodemographic characteristics such as age, sex, education level, and marital status were obtained from the health interview survey. Obesity was defined as a BMI (calculated as kg/m^2) of ≥25 kg/m^2, which is the cutoff for adults in Asian and Pacific regions.[26] Systolic and diastolic blood pressure values were measured after a resting period. Blood samples were collected from the antecubital vein after an 8-h fast. TC, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), triglycerides (TG), and fasting blood glucose were measured using an enzymatic method (Hitachi Automatic Analyzer 7600, Hitachi, Japan). Diet and food intake were assessed using a one-day 24-h recall method in the KNHANES. The dietary questionnaire was administered during face-to-face interviews and solicited information concerning the type, amount, and frequency of foods and drinks consumed during the previous day.

Statistical analysis

KNHANES data from the Korea National Statistical Office were used to define the standard population. Data were analyzed using SPSS (version 23.0; IBM Corp, Armonk, New York, USA). The results were computed following the survey procedure by using individual weight, colony extraction, and variance estimation layer variables. The differences in categorical variables (general characteristics) were compared using chi-square tests. To identify differences in the continuous variables (anthropometric and biochemical data and nutrient intake) used in the study, data were analyzed using a t test with a general linear model. General linear models were used to estimate the trends in anthropometric and biochemical parameters among Korean adults with dyslipidemia after adjustment for age group, education level, marital status, self-reported health status, hypertension diagnosis, diabetes diagnosis, and alcohol intake. Trends in nutrient and food intake were adjusted for age group, education level, marital status, self-reported health status, hypertension diagnosis, diabetes diagnosis, alcohol intake, and energy intake. Multiple logistic regression analysis was performed to estimate the odds ratios (ORs) and 95% confidence intervals (CIs) for blood cholesterol control status according to general characteristics and across quartiles of sugar-, nut-, fruit-, and vegetable intake, for which the highest quartile was set as the reference. The significance for all analyses was set at $p<0.05$.

RESULTS

The general characteristics of users and nonusers of lipid-lowering drugs among Korean adults with dyslipidemia are shown in Table 1. Among a total of 2,590 participants with dyslipidemia, 1,734 reported taking lipid-lowering drugs, and 856 reported not taking them. In the 2015–2017 KNHANES, the number of users increased from 492 to 672. Significant differences were found between users and nonusers in terms of age group, education level, marital status, self-reported health status, hypertension diagnosis, diabetes diagnosis, and alcohol intake ($p<0.05$).

Anthropometric data and blood lipid concentrations of users and nonusers are shown in Table 2. In terms of the anthropometric data, the mean age of users (61.8 ± 0.4 years) was significantly higher than that of nonusers (55.0 ± 0.5 years). No significant difference in body weight, waist circumference, or BMI was observed between users and nonusers. When the changes in BMI were analyzed on the basis of sex (Figure 1), BMI significantly decreased in men among nonusers; however, no significant change was observed among women. However, among both men and women in 2017, the average BMI of nonusers represented overweight and that of users represented obesity. In terms of blood lipid concentrations, the TC, TG, and LDL-C of users were significantly lower than those of nonusers. From 2015 to 2017, the blood TG concentration significantly decreased in users. Multiple logistic regression analysis showed a significant association between hypertension and diabetes diagnosis and the control status of blood cholesterol among lipid-lowering drug users after adjustment for age group, education level, marital status, self-reported health status, hypertension diagnosis, diabetes diagnosis, and alcohol intake (Table 3). No significant increase in risk (blood cholesterol over 200mg/dL) was observed across research year and BMI.

The nutrient intake of users and nonusers is shown in Table 4. From 2015 to 2017, the intakes of energy, carbohydrates, vitamin A, and vitamin C decreased significantly among users, whereas the intakes of fat, saturated fatty acids, mono-unsaturated fatty acids, poly-unsaturated fatty acids, n-3 fatty acids, dietary fiber, and calcium increased significantly. In nonusers, the intakes of protein, saturated fatty acids, dietary fiber, n-3 fatty acids, and calcium increased significantly, and intakes of cholesterol, carbohydrates, vitamin A, and vitamin C decreased significantly. No significant difference in nutrient intake was observed between users and nonusers. An analysis of the changes in the proportion of energy intake from fat on the basis of sex (Figure 2) revealed that the intake rate among women increased significantly in users, whereas no significant change was noted among men. However, when both men and women were considered, the rate of energy intake from fat tended to increase in both users and nonusers.

The overall yearly food intake of users and nonusers is shown in Table 5. From 2015 to 2017, the total intake of food and eggs decreased significantly in users, whereas the intakes of vegetables and fish increased significantly. In nonusers, the intakes of meat, alcohol, and beverages increased significantly, whereas the egg intake decreased significantly. No significant difference in overall food intake was noted between users and nonusers, except in terms of nut intake. We further evaluated the relationship between food intake and blood cholesterol control status (Table 6). As expected, among the lipid-lowering drug nonusers, the blood lipid control status was negatively associated with sugar intake [OR (95% CI) = 0.48 (0.30–0.78)] after adjustment for age group, education level, marital status, self-reported health status, hypertension diagnosis, diabetes diagnosis, alcohol intake, and energy intake. However, no association between the intakes of nuts, fruits, and vegetables and the blood cholesterol control status was observed in users and nonusers of lipid-lowering drugs.

DISCUSSION

For dyslipidemia management, controlling blood lipid concentrations by using a combination of pharmacotherapy and lifestyle changes such as weight control and diet modification is crucial.[10,11] The present study evaluated anthropometric data, blood lipid concentrations, and nutrient and food intake of Korean adults with dyslipidemia and compared users and nonusers of lipid-lowering drugs using data from the 6th–7th KNHANES (2015–2017).

Among the anthropometric indicators, no significant difference was observed in terms of body weight, waist circumference, or BMI between users (24.9 kg/m^2) and nonusers (25.2 kg/m2). Moreover, the multiple logistic regression analysis revealed no significant increase in risk across research year and with respect to BMI. However, in both men and women, the average BMI of nonusers represented overweight and that of users represented obesity in 2017. In a previous study that investigated adults with dyslipidemia using data from the 2010–2013 KNHANES, the BMI of users (25.3 kg/m^2) was higher than that of nonusers (24.8 kg/m^2).[21] These results indicate that weight management in patients with dyslipidemia is necessary, especially among lipid-lowering drug users.

As mentioned earlier, controlling blood lipid concentrations is crucial in the management of dyslipidemia.[10,11] In the present study, the TC, TG, and LDL-C concentrations of users were significantly lower than those of nonusers, and the blood concentrations of TG in users significantly decreased from 2015 to 2017. In a study that used data from the NHANES, the decrease in TC, LDL-C, and TG concentrations was significantly greater among statin users than nonusers (p<0.05 for the difference in trends).[20] These results indicate that lipid-lowering drug users experience more effective management of blood lipid levels than nonusers. It is predicted that the management of patients with dyslipidemia who do not take lipid-lowering drugs is important. Therefore, maximizing the therapeutic effect of lipid-lowering drugs is necessary and could be achieved by encouraging active participation of patients in drug therapy and strengthening the patients' understanding of statins, the drugs primarily used to treat dyslipidemia.

In a study that used data from the 1999–2010 NHANES, the calorie intake of statin users was significantly lower than that of nonusers, but the calorie and fat intakes increased among statin users over time; BMI also increased relatively quickly among them.[20] However, in a study based on the KNHANES, no significant difference was observed between users and nonusers in terms of the trend of calorie intake.[21] The SENIOR project reported that statin users exhibited more favorable lipid profiles than nonusers, but users had significantly lower micronutrient intake.[22] In the present study, no significant difference in nutrient intake was observed between users and nonusers. From 2015 to 2017, the energy and carbohydrate intakes of users decreased significantly, and their fat intake increased significantly.

The National Cholesterol Education Program guidelines for healthy American adults recommends an intake of 50%–60% of calories from carbohydrates, 15% from protein, and 25%–35% from fats (≤7% of calories from saturated fatty acids, up to 10% from poly-unsaturated fatty acids, and up to 20% from mono-unsaturated fatty acids).[27] In general, fat intake in Korea is lower than the typical intake in Western countries. However, a wide variation in fat intake has been reported among individuals, with an increased fat intake reported in recent years. In the 2015 Korean guidelines for the management of dyslipidemia, rather than limiting the amount of total fat intake for the treatment of dyslipidemia, limiting the intake of saturated fatty acids was recommended.[3] In the present study in both users and nonusers, saturated fatty acid intake increased significantly, and intakes of vitamins A and C decreased significantly. However, the intakes of n-3 fatty acids and dietary fiber increased significantly in both users and nonusers.

Soluble dietary fiber is effective for improving blood cholesterol and triglyceride concentrations.[28] The 2015 Korean guidelines recommend that monosaccharide intake be reduced and consumption of mixed grains, marine algae, and vegetables that contain large amounts of soluble dietary fiber be increased for the management of dyslipidemia.[3] As mentioned earlier, it is helpful to have a diet that includes a higher proportion of whole grains along with foods such as vegetables, beans, fish, fruit, and dairy products.[3] In the present study, vegetable and fish intakes in lipid-lowering drug users increased significantly during the study period. The nutritional status of Korean patients with dyslipidemia was found to vary depending on individual nutrient and food intakes. In the multiple logistic regression analysis, among the lipid-lowering drug nonusers, blood lipid control status was negatively associated with sugar intake [OR (95% CI) = 0.48 (0.30–0.78)] after adjustment for age group, education level, marital status, self-reported health status, hypertension diagnosis, diabetes diagnosis, alcohol intake, and energy intake. For lipid-lowering drug users and nonusers, however, no association was observed between the intakes of nuts, fruits, and vegetables and blood cholesterol control status. Therefore, nutrition education is required for both lipid-lowering drug users and nonusers to ensure the appropriate intake of individual nutrients and foods.

This study has several limitations. First, nutrient intake data were obtained through self-reported questionnaires from the KNHANES, and the questionnaire used in the KNHANES examined only whether patients were taking lipid-lowering drugs generally rather than obtaining specific drug information. Second, the study followed an iterative cross-sectional design. Further studies are warranted to address these limitations.

In summary, the present study identified key nutrients for blood lipid management in lipid-lowering drug users and nonusers. The results indicate that changes in lifestyle and nutrient intake of patients with dyslipidemia are required and that the importance of appropriate nutrient intake should be emphasized in addition to providing education about lipid-lowering drugs. Furthermore, nutrition-related education concerning the adequate intake of individual nutrients for blood lipid management is necessary for both lipid-lowering drug users and nonusers.

CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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Table 1. General characteristics of participants

	Total (n=2,590)	Drug non-user (n=856)	Drug user (n=1,734)	*p*-value
Year (%/n)				
2015	28.9 (748)	29.9 (256)	28.4 (492)	0.350
2016	32.4 (838)	31.3 (268)	32.9 (570)	
2017	38.8 (1,004)	38.8 (332)	38.8 (672)	
Sex (%)				
Male	36.3	37.5	35.6	0.257
Female	63.7	62.5	64.4	
Age group, years (%)				
20–44	7.4	14.4	4.0	<0.001
45–64	46.7	52.2	43.9	
>65	45.9	33.4	52.1	
Educational attainment (%)				
<High school	54.0	45.6	58.1	<0.001
High school	25.6	28.8	24.1	
>High school	20.4	25.6	17.8	
Marital status (%)				
Married	73.9	76.5	72.6	0.001
Single	3.4	4.6	2.8	
Other	22.7	18.9	24.6	
Self-reported health status (%)				
Good	15.5	17.3	14.7	0.001
Intermediate	50.7	54.9	48.6	
Bad	33.8	27.9	36.7	
Body mass index (%)				
<22.9	27.5	32.4	15.2	0.116
23.0–24.9	26.3	25.6	26.7	
>25.0	46.1	42.0	48.2	
Hypertension diagnosis (%)				
No	43.2	61.4	34.2	<0.001
Yes	56.8	38.6	65.8	
Diabetes diagnosis (%)				
No	74.6	84.6	69.7	<0.001
Yes	25.4	15.4	30.3	
Alcohol intake (%)				
≥Once a month	66.5	61.2	69.1	<0.001
<Once a month	33.5	38.8	30.9	
Smoking status (%)				
Non-smoker	65.5	64.9	65.8	0.100
Current smoker	11.9	13.1	11.3	
Past smoker	22.7	22.1	23.0	

Table 2. Anthropometric data and blood lipid of lipid-lowering drug users and nonusers

	2015 Mean±standard error	2016 Mean±standard error	2017 Mean±standard error	*p*-value for trend†	Total Mean±standard error	*p*-value for group comparison‡
Drug non-user (n=856)						
Age	53.7±1.0	55.5±1.0	55.5±0.8	0.169	55.0±0.5	0.001
Body weight	66.6±1.3	66.3±1.0	65.3±0.7	0.600	66.0±0.6	0.405
Waist size	86.1±0.8	85.7±0.8	84.6±0.6	0.381	85.4±0.4	0.231
Body mass index	25.2±0.3	25.0±0.3	24.5±0.2	0.281	24.9±0.1	0.395
Fasting blood sugar	105.0±2.2	107.8±2.4	105.6±1.5	0.643	106.1±1.2	0.303
Total cholesterol	219.9±2.7	219.2±3.2	221.3±2.9	0.629	220.2±1.7	<0.001
Triglyceride	184.7±11.5	182.1±7.5	208.9±15.1	0.214	193.5±7.3	0.018
LDL-cholesterol	136.7±2.4	127.9±4.6	127.9±4.3	0.278	132.8±1.9	<0.001
Drug user (n=1,734)						
Age	61.1±0.8	60.8±0.5	63.3±0.6	0.002	61.8±0.4	-
Body weight	65.1±0.8	65.7±0.7	64.8±0.5	0.607	65.2±0.4	-
Waist size	87.0±0.5	87.0±0.5	86.7±0.4	0.775	86.9±0.3	-
Body mass index	25.2±0.2	25.1±0.2	25.3±0.1	0.591	25.2±0.1	-
Fasting blood sugar	111.1±1.9	111.9±1.8	112.1±1.4	0.545	111.7±1.0	-
Total cholesterol	170.7±1.8	168.9±1.6	167.4±1.4	0.635	168.9±0.9	-
Triglyceride	158.3±12.5	159.9±7.2	140.0±5.0	0.037	152.0±4.7	-
LDL-cholesterol	93.0±1.5	96.8±2.7	88.7±3.5	0.359	93.1±1.2	-

†The trend in the study period was analyzed using general linear models in complex sample analysis after adjustment for age group, education level, marital status, self-reported health status, hypertension diagnosis, diabetes diagnosis, and alcohol intake (p-value; trend from 2015 to 2017).
‡Comparisons between lipid-lowering drug users and nonusers were performed using general linear models in complex sample analysis (using pooled samples across the study period) after adjustment for age group, education level, marital status, self-reported health status, hypertension diagnosis, diabetes diagnosis, and alcohol intake.

Table 3. Multiple logistic regression results showing adjusted ORs and 95% CIs† of blood cholesterol control status in lipid-lowering drug users and nonusers

	Drug user		Drug non-user	
	OR	95% CI	OR	95% CI
Blood cholesterol over 200 mg/dL				
Research year				
2015	1.060	0.690–1.627	0.904	0.563–1.451
2016	1.234	0.843–1.805	1.104	0.682–1.787
2017	1.000		1.000	
Body mass index				
<22.9	1.213	0.839–1.754	0.939	0.619–1.423
23.0–24.9	.818	0.554–1.208	0.804	0.522–1.239
>25.0	1.000		1.000	
Hypertension diagnosis				
No	1.847	1.326–2.573	1.326	0.883–1.993
Yes	1.000		1.000	
Diabetes diagnosis				
No	1.570	1.092–2.256	3.401	2.112–5.478
Yes	1.000		1.000	

OR: odds ratio; CI: confidence interval.

†OR and 95% CI were analyzed using multiple logistic regression in complex sample analysis after adjustment for age group, education level, marital status, self-reported health status, hypertension diagnosis, diabetes diagnosis, and alcohol intake.

Table 4. Nutrient intake of lipid-lowering drug users and nonusers

	2015 Mean±SE	2016 Mean±SE	2017 Mean±SE	*p*-value for trend†	Total Mean±SE	*p*-value for group comparison‡
Drug non-user (n=856)						
Energy (Kcal)	2002.9±67.9	1971.2±80.4	1922.1±53.2	0.482	1960.9±38.5	0.457
Protein (g)	67.7±2.8	71.5±3.9	73.1±2.5	0.001	71.0±1.8	0.741
Fat (g)	43.0±2.7	43.5±2.6	43.6±2.0	0.394	43.4±1.4	0.803
Saturated fatty acid (g)	12.1±0.9	12.3±0.8	13.8±0.8	0.020	12.9±0.5	0.405
Mono-unsaturated fatty acid (g)	13.6±1.0	13.9±0.9	14.1±0.8	0.402	13.9±0.5	0.619
Poly-unsaturated fatty acid (g)	11.1±0.7	10.7±0.7	10.8±0.4	0.515	10.9±0.3	0.363
n-3 fatty acid (g)	1.7±0.1	1.6±0.1	2.0±0.1	0.001	1.8±0.1	0.179
n-6 fatty acid (g)	9.5±0.6	9.1±0.6	8.7±0.4	0.839	9.1±0.3	0.581
Cholesterol (mg)	256.8±25.8	281.0±21.3	220.7±13.7	0.030	250.1±11.6	0.671
Carbohydrate (g)	316.0±11.0	294.3±9.4	303.6±8.0	0.031	304.3±5.4	0.461
Dietary Fiber (g)	26.8±1.0	23.7±0.9	28.0±1.0	<0.001	26.3±0.6	0.556
Calcium (mg)	499.7±21.5	480.7±22.0	549.2±20.6	0.014	513.3±12.5	0.551
Sodium (mg)	3832.4±203.8	3845.5±218.3	3889.8±164.1	0.428	3859.2±111.7	0.734
Vitamin A (mg)	742.4±50.2	640.6±44.5	366.4±19.5	<0.001	561.3±23.2	0.053
Vitamin C (mg)	114.5±7.8	110.7±6.2	63.7±3.4	<0.001	93.1±3.5	0.144
Drug user (n=1,734)						
Energy (Kcal)	1867.7±52.2	1848.3±47.0	1677.5±35.7	0.003	1789.7±26.0	-
Protein (g)	62.8±2.3	63.6±1.9	62.7±2.0	<0.001	63.1±1.2	-
Fat (g)	34.8±1.5	36.8±1.8	35.0±1.4	<0.001	35.6±0.9	-
Saturated fatty acid (g)	9.4±0.5	10.1±0.6	10.8±0.4	<0.001	10.2±0.3	-
Mono-unsaturated fatty acid (g)	10.4±0.5	11.6±0.7	10.8±0.5	0.001	11.0±0.3	
Poly-unsaturated fatty acid (g)	9.6±0.4	9.8±0.5	9.5±0.4	0.003	9.6±0.2	
n-3 fatty acid (g)	1.6±0.1	1.8±0.1	1.9±0.1	<0.001	1.8±0.1	
n-6 fatty acid (g)	8.0±0.4	8.1±0.4	7.5± 0.3	0.151	7.8±0.2	
Cholesterol (mg)	204.3±12.9	226.7±15.1	176.5±11.7	0.172	201.7±7.9	-
Carbohydrate (g)	307.0±7.0	294.9±6.5	285.7±5.4	0.043	294.8±3.6	-
Dietary Fiber (g)	25.7±0.8	25.1±0.7	26.8±0.8	<0.001	25.9±0.4	-
Calcium (mg)	473.4±16.8	465.2 ±19.0	501.6 ±15.9	<0.001	481.0±10.0	-
Sodium (mg)	3543.2±145.2	3613.0±136.3	3233.4±110.2	0.497	3451.8±75.9	-
Vitamin A (mg)	692.5±42.8	720.6±59.6	341.1±33.4	<0.001	570.9±28.4	-
Vitamin C (mg)	113.2±6.2	126.0±7.8	61.6±2.7	<0.001	98.4±3.7	-

SE: standard error.

†Trend for the study period was analyzed using general linear models in complex sample analysis adjusted for age group, education level, marital status, self-reported health status, hypertension diagnosis, diabetes diagnosis, and alcohol intake (p-value; trend from 2015 to 2017).

‡Comparisons between lipid-lowering drug users and nonusers were performed using general linear models in complex sample analysis (using pooled samples across the study period) after adjustment for age group, education level, marital status, self-reported health status, hypertension diagnosis, diabetes diagnosis, and alcohol intake.

Table 5. Food intake of lipid-lowering drug users and nonusers

	2015 Mean±SE	2016 Mean±SE	2017 Mean±SE	*p*-value for trend†	Total Mean±SE	*p*-value for group comparison‡
Drug non-user (n=856)						
Total food	1561.4±55.2	1661.3±86.1	1600.9±49.2	0.146	1608.5±37.1	0.762
Cereals (g)	299.9±15.0	279.9±11.6	291.1±10.5	0.302	290.1±7.1	0.614
Potatoes (g)	45.3±8.6	43.6±7.7	30.9±5.2	0.201	39.0± 4.1	0.543
Sugar (g)	10.7±1.4	10.5±1.8	12.0±1.5	0.357	11.2±0.9	0.345
Beans (g)	46.9±6.4	45.5±8.1	36.1±3.3	0.296	42.2±3.5	0.831
Nuts (g)	8.4±1.7	4.9±0.9	6.6±0.8	0.195	6.6±0.7	0.002
Vegetables (g)	361.0±17.2	328.7±17.7	348.5±14.0	0.198	345.9±9.4	0.913
Mushrooms (g)	7.3±1.7	5.8±1.2	6.5±1.3	0.894	6.5±0.8	0.794
Fruits (g)	232.1±20.1	212.7±20.3	192.3±16.4	0.158	210.2±10.8	0.186
Meat (g)	84.0±8.4	101.4±17.3	104.3±8.2	0.016	97.5±6.8	0.689
Eggs (g)	31.9±5.2	34.0±3.7	24.1±3.0	0.039	29.5±2.3	0.393
Fish (g)	95.8±13.2	97.0±13.5	120.1±9.2	0.169	105.8±6.8	0.729
Seaweeds (g)	24.4±4.9	27.3±6.0	27.8±4.8	0.813	26.7±3.0	0.138
Milk (g)	64.5±7.5	85.8±10.7	74.6±9.1	0.282	75.2±5.4	0.308
Oil (g)	6.9±0.7	6.9±0.8	7.0±0.5	0.458	7.0±0.4	0.076
Alcohol and beverages (g)	207.4±24.2	341.1±62.3	277.3±22.8	0.010	277.1±22.9	0.293
Drug user (n=1,734)						
Total food	1485.7±53.2	1512.4±42.7	1436.3±37.2	0.041	1476.6±25.0	-
Cereals (g)	293.8±8.8	272.9±8.1	263.5±6.3	0.190	275.1±4.4	-
Potatoes (g)	36.4±5.1	39.6±4.2	38.8±4.0	0.803	38.4±2.5	-
Sugar (g)	9.7±0.8	8.2±0.7	9.2±0.6	0.084	9.0±0.4	-
Beans (g)	41.1±3.6	37.0±3.3	42.7±3.5	0.425	40.3±2.0	-
Nuts (g)	9.9±1.4	11.8±2.2	9.1±1.3	0.827	10.3±1.0	-
Vegetables (g)	322.7±11.2	346.4±11.7	334.1±11.7	0.012	335.2±6.8	-
Mushrooms (g)	4.7±0.8	6.6±1.4	3.9±0.6	0.160	5.1±0.6	-
Fruits (g)	223.9±14.9	253.5±17.5	200.1±11.7	0.121	225.3±8.6	-
Meat (g)	74.5±8.9	73.4±6.4	76.2±6.3	0.302	74.7±4.1	-
Eggs (g)	23.5±2.2	28.7±2.4	18.3±1.6	0.014	23.4±1.2	-
Fish (g)	101.5±12.9	93.3±8.3	112.6±8.0	0.014	102.8±5.5	-
Seaweeds (g)	33.4±7.0	33.9±4.5	34.3±4.2	0.968	33.9±2.9	-
Milk (g)	80.2±8.5	66.1±7.2	79.8±5.7	0.147	75.1±4.0	-
Oil (g)	6.9±0.4	6.4±0.5	6.2±0.4	0.795	6.5±0.3	-
Alcohol and beverages (g)	193.7±26.5	201.6±18.5	176.3±15.2	0.713	190.0±11.4	-

SE: standard error. †The trend in the study period was analyzed using general linear models in complex sample analysis after adjustment for age group, education level, marital status, self-reported health status, hypertension diagnosis, diabetes diagnosis, and alcohol intake (p-value; trend from 2015 to 2017). ‡Comparisons between lipid-lowering drug users and nonusers were performed using general linear models in complex sample analysis (using pooled samples across the study period) after adjustment for age group, education level, marital status, self-reported health status, hypertension diagnosis, diabetes diagnosis, and alcohol intake

Table 6. Multiple logistic regression results showing adjusted ORs and 95% CIs of blood cholesterol control status according to sugar-, nut-, vegetable-, and fruit intake

	Drug user		Drug non-user	
	OR	95% CI	OR	95% CI
Blood cholesterol over 200 mg/dL				
Sugar intake				
Quartile 1	1.165	0.726–1.868	0.616	0.351–1.080
Quartile 2	0.896	0.585–1.374	0.644	0.387–1.072
Quartile 3	0.914	0.582–1.435	0.480	0.298–0.775
Quartile 4	1.000		1.000	
Nuts intake				
Quartile 1	1.121	0.557–2.257	1.536	0.710–3.324
Quartile 2	1.148	0.593–2.220	1.339	0.642–2.792
Quartile 3	1.110	0.538–2.292	1.139	0.521–2.488
Quartile 4	1.000		1.000	
Vegetables intake				
Quartile 1	0.495	0.249–0.983	1.542	0.674–3.529
Quartile 2	0.502	0.239–1.055	1.153	0.476–2.795
Quartile 3	0.397	0.151–1.044	1.882	0.525–6.745
Quartile 4	1.000		1.000	
Fruits intake				
Quartile 1	0.697	0.308–1.578	1.183	0.471–2.971
Quartile 2	0.790	0.349–1.788	0.989	0.414–2.363
Quartile 3	0.776	0.294–2.048	0.978	0.363–2.635
Quartile 4	1.000		1.000	

OR: odds ratio; CI: confidence interval.

†OR and 95% CI were analyzed using multiple logistic regression in complex sample analysis after adjustment for age group, education level, marital status, self-reported health status, hypertension diagnosis, diabetes diagnosis, and alcohol intake.

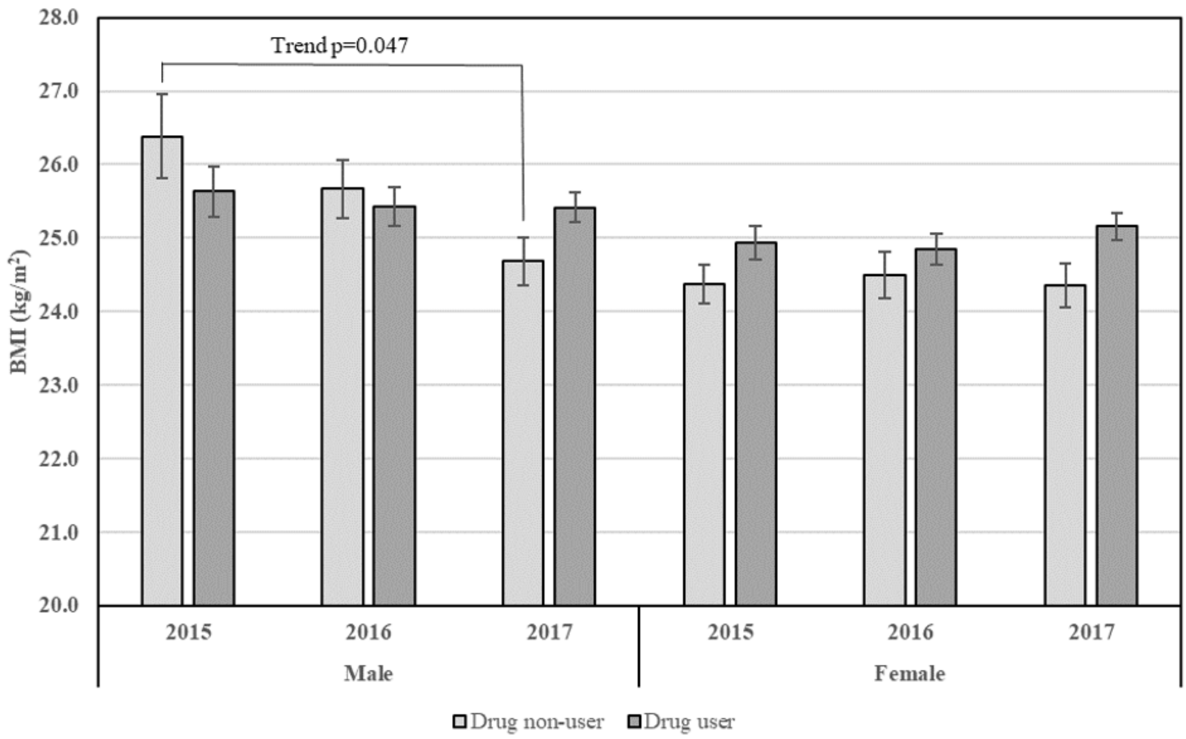

Figure 1. Changes in BMI in lipid-lowering drug users and nonusers.

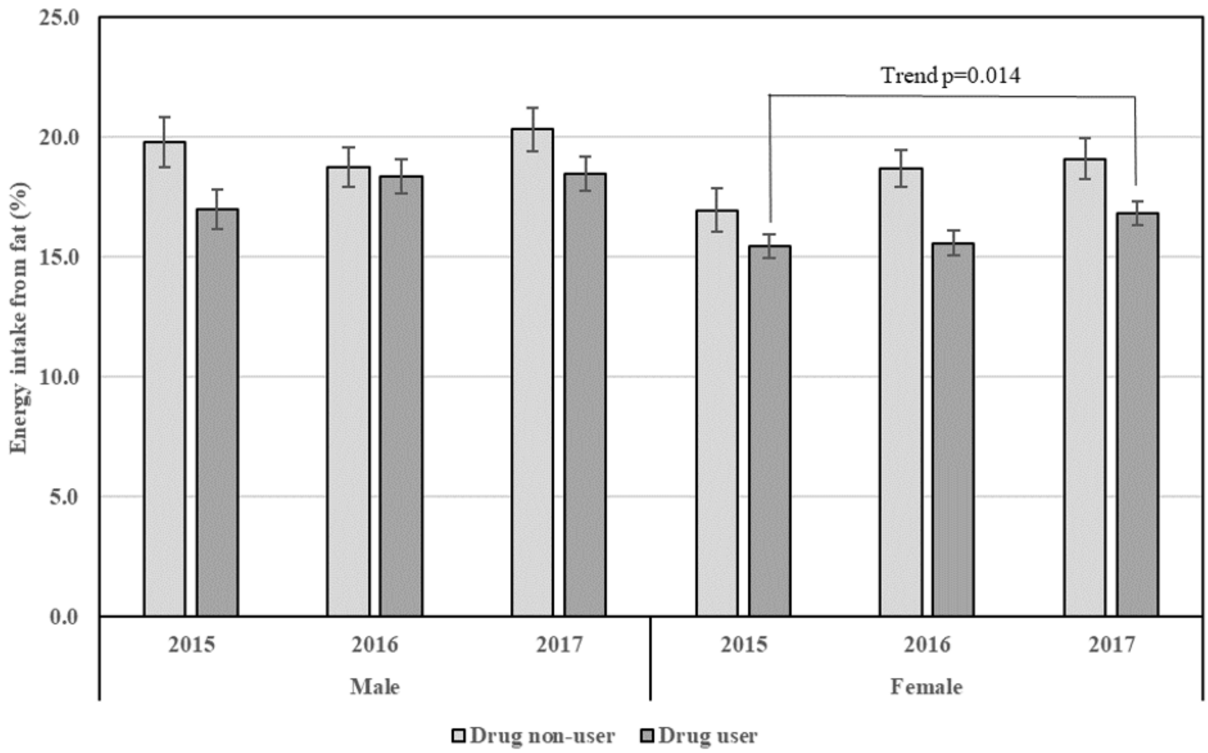

Figure 2. Changes in energy intake from fat in lipid-lowering drug users and nonusers.