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Dairy Product Intake Is Inversely Associated with Metabolic Syndrome in Korean Adults: Anseong and Ansan Cohort of the Korean Genome and Epidemiology Study

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The objective of this study was to examine the relationship between dairy product intake and the incidence of metabolic syndrome (MetS) and its components among middle-aged Koreans. We examined 7,240 adults aged 40-69 yr without MetS at baseline over a 45.5-month follow-up period. They were taken from the Anseong and Ansan cohort of the Korean Genome and Epidemiology Study. Dairy product intake including milk, yogurt, and cheese was assessed with food frequency questionnaire. At the follow-up, the incidence of MetS was 17.1%. The incidences of MetS components were as follows: low HDL cholesterol (16.2%), abdominal obesity (14.0%), hypertriglyceridemia (13.8%), hyperglycemia (13.3%), and hypertension (13.1%). Adjusting for potential confounders, dairy product consumption frequency was inversely associated with the risk of MetS and abdominal obesity. Hazard ratio (HR) (95% confidence interval) for dairy product consumption more than 7 times/week compared to never was 0.75 (0.64-0.88, *P* for trend < 0.001) for MetS and 0.73 (0.61-0.88, *P* for trend < 0.001) for abdominal obesity. HR for milk intake was 0.79 for MetS and 0.82 for abdominal obesity. The results of this study suggest that daily intake of dairy products protects against the development of MetS, particularly abdominal obesity, in middle-aged Koreans.

Key Words: Obesity, Abdominal; Dairy Products; Metabolic Syndrome; Milk

INTRODUCTION

Obesity has become a global public health concern in recent decades. The prevalence of diet-related chronic diseases, including obesity and metabolic syndrome (MetS), are increasing worldwide (1). In accordance with lifestyle changes following economic development, the leading causes of death in Korea are cancer, cardiovascular disease, diabetes, and liver disease (2). The prevalence of obesity, hypertension, and other adverse cardiometabolic outcomes has increased among Koreans. According to the Korea National Health and Nutrition Examination Survey (KNHANES), the prevalence of obesity among adults was more than doubled from 20.5% in 1995 to 30.9% in 2009 (3, 4). The prevalence of MetS in adults has increased primarily as a result of changes in lifestyle and diet, such as automobile use and fast food consumption (4). Obesity and MetS have become primary targets for public health intervention owing to the rapid change in mortality and chronic disease prevalence among Koreans.

Several cross-sectional and prospective studies have investigated the association between dairy product consumption and the risk of cardiometabolic disease. However, the results were inconsistent and varied among population groups (5, 6). A review of 10 cross-sectional studies and 3 prospective studies of the relationship between dairy product consumption and MetS suggested a protective effect of dairy product consumption on MetS, but the evidence was inconclusive (7). The effects of dairy product consumption on obesity have been extensively explored. A recent meta-analysis suggested a protective effect of dairy product consumption on obesity; however, the effect was small (6). In general, dairy product consumption in Asia is much lower than in Western countries. There is little evidence that increasing dairy product consumption has protective effects against obesity and MetS in Asians.

The present study hypothesized that dairy product intake is inversely related to the development of MetS and MetS components in middle-aged Korean adults living in urban and rural communities.

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MATERIALS AND METHODS

Study population

Raw data of the Anseong and Ansan cohort of the Korean Genome and Epidemiology Study (KoGES) was obtained with the support of the Korea National Institute of Health, which represents rural and urban communities in Korea. The baseline survey for the KoGES, a prospective community study, was conducted between May 2001 and February 2003 and included 10,038 adults aged 40-69 yr. Of these subjects, 76.6% were followed up in the 2005-2006 survey. The present study excluded individuals who had MetS at the baseline or who did not complete the nutritional survey; thus, a total of 7,240 participants were included in our study. The average follow-up period was 45.5 months with an interquartile range of 44.4-47.1 months. Detailed information on the Anseong and Ansan cohort has been previously published (8).

Dietary assessment

A semi-quantitative food-frequency questionnaire (FFQ) that assessed intake of 110 commonly consumed food items and dietary habits was administered at baseline and at the follow-up interview. The questionnaire included nine categories of intake frequency ranging from "never" to "three times a day" and photographs illustrating three portion sizes for each item. The FFQ was developed based on dietary intake data from the KNHANES (9) and has been previously validated using dietary records taken over 3 days during each of the four seasons in 124 participants as described elsewhere (10). The amount and frequency of milk, yogurt, and cheese intake were summed to calculate dairy product intake. For example, the amount of each food item was categorized into three serving sizes, 1/2, 1 (standard), and 2 servings. For milk, 1/2 cup equals to 100 mL. For the analyses, food intake was recoded into serving categories considering both frequencies and the amount. Intake frequency was regrouped into five categories from none to more than 7 times per week for the statistical analyses. The frequency of milk intake was analyzed separately from the other dairy products.

Clinical assessment

The definition of MetS was based on the modified National Cholesterol Education Program, Adult Treatment Panel III (NCEP-ATP III) criteria (11) with the exception of abdominal obesity. We defined abdominal obesity according to the Korean Society for the Study of Obesity (KSSO) criteria; the cut-off value for waist circumferences was ≥ 90 cm for men and ≥ 85 cm for women (12).

We defined MetS as the presence of three or more of the following five components: abdominal obesity, waist circumference of > 90 cm for men and > 85 cm for women; elevated blood pressure, > 130/85 mmHg; increased triglycerides, > 150 mg/dL; low high-density lipoprotein (HDL) cholesterol, < 40 mg/dL in men and < 50 mg/dL in women; and elevated blood glucose levels, fasting blood glucose > 100 mg/dL.

The details of the clinical assessment are described elsewhere (13). Briefly, blood pressure was measured by trained health professionals using a conventional mercury sphygmomanometer. The participants sat in a chair and following a 5-min rest period, three blood pressure readings were taken with a 30-sec interval between each reading. The average of the three values was used in the analysis. The 8-hr fasting blood samples were collected in EDTA-containing tubes and separated serum was stored at -70°C until analysis was performed. The samples were analyzed for each parameter at two clinical laboratories using an autoanalyzer (ADVIA 1650, Bayer Diagnostics, Tarrytown, NY, USA). Reliability of the serological parameters was checked with three years of quality control data as explained elsewhere (14).

Statistical analysis

Data were analyzed using Stata statistical software (Ver. 11, College Station, TX, USA). Baseline characteristics are expressed as mean ± standard deviation or percentage. Differences between measurements and groups were assessed using an analysis of variance (ANOVA) and Pearson chi-square tests. Age- and sex-adjusted and multivariate Cox proportional hazard models were used to examine the association between dairy product and milk intake and MetS components. An additional multivariate model including age, sex, physical activity, alcohol consumption, total energy intake, smoking status, education, and income as covariates was used. The proportional hazards assumption was graphically assessed using log-log plots and statistically assessed on the basis of Schoenfeld residuals (15). No major violations of the proportional hazard assumption were detected. A two-sided P value < 0.05 was considered statistically significant.

Ethics statement

The present study was approved by the institutional review board of the Dongguk University Ilsan Hospital (#2010-1-64), Goyang, Korea. Informed consent was waived by the board.

RESULTS

The mean age of participants at baseline was 51.5 yr and 49.9% were women. When we classified the participants into 5 groups based on the frequency of dairy product intake, the group with participants consuming greater amount of dairy products were more likely to be women, be more educated, have higher income, drink less alcohol, and smoke less (Tables 1, 2).

During the average follow-up period of 45.5 months, the incidence of MetS was 17.1%. Lower HDL cholesterol (16.2%) was the most common MetS components followed by abdominal

Table 1. Characteristics of participants according to the frequency of dairy product consumption at baseline

Parameters	Frequency of Dairy product intake (times/week)					
	None	1	2-3	4-6	≥ 7	*P* value
No. of subjects	1,446	1,022	1,070	1,282	2,420	
Age, mean (SD) (yr)	53.4 (9.4)	51.7 (8.9)	49.9 (8.4)	49.5 (8.0)	51.0 (8.6)	< 0.001
Female (%)	43.3	47.2	48.7	48.7	56.2	< 0.001
Body mass index, mean (SD) (kg/m^2)	23.8 (3.0)	23.8 (2.9)	24.1 (3.0)	23.9 (2.7)	23.8 (2.8)	0.061
Education level (%)						< 0.001
Elementary school graduate	40.8	36.8	24.4	20.3	24.8	
Middle school graduate	22.0	24.3	24.0	24.2	23.3	
High school graduate	28.6	26.3	35.7	38.1	36.1	
College graduate or higher	8.6	12.6	15.9	17.5	15.8	
Income level (KRW/mo.) (%)						< 0.001
< 1 million	44.5	39.6	28.5	23.2	26.3	
1 million-1.99 million	27.8	30.7	32.5	31.4	31.0	
2 million-2.99 million	14.4	16.6	19.5	23.5	20.7	
> 3 million	13.3	13.1	19.5	22.0	22.0	
Physical activity, mean (SD) (METs/day)	1,707.7 (1,120.0)	1,636.0 (1,116.1)	1,469.7 (1,031.4)	1,416.8 (964.0)	1,470.3 (986.9)	< 0.001
Alcohol consumption, mean (SD) (g/day)	20.5 (46.2)	16.3 (40.0)	20.4 (51.9)	15.3 (37.6)	16.0 (44.7)	0.001
Smoking, mean (SD) (pack-year)	8.4 (15.6)	7.3 (15.3)	6.2 (13.9)	5.4 (12.1)	4.7 (11.5)	< 0.001
Component of metabolic syndrome* (%)						
Abdominal obesity	26.7	27.8	26.3	20.5	25.4	< 0.001
High blood pressure	24.4	22.1	17.5	18.1	19.5	< 0.001
High fasting blood glucose	5.6	6.7	6.9	5.8	6.5	0.618
High triglyceride	29.9	28.6	27.7	28.2	24.8	0.008
Low HDL Cholesterol	39.5	46.1	44.5	45.3	43.8	0.006

*Abdominal obesity, waist circumference of > 90 cm for men and > 85 cm for women; high blood pressure, systolic/diastolic blood pressure > 130/85 mmHg; high fasting blood glucose, fasting blood glucose > 100 mg/dL; high triglyceride, triglyceride > 150 mg/dL; low high-density lipoprotein (HDL) cholesterol, HDL cholesterol < 40 mg/dL in men and < 50 mg/dL in women. KRW/mo., Korean Won/month; MET, Metabolic Equivalent.

Table 2. Characteristic of participants according to the frequency of milk consumption at baseline

Parameters	Frequency of milk intake (times/week)					
	None	1	2-3	4-6	≥ 7	*P* value
No. of subjects	2,658	985	1,068	937	1,592	
Age, mean (SD) (yr)	52.7 (9.2)	50.5 (8.4)	49.2 (7.9)	49.6 (8.2)	51.2 (8.6)	< 0.001
Female (%)	47.9	42.8	47.4	52.6	57.7	< 0.001
Body mass index, mean (SD) (kg/m^2)	23.8 (3.0)	23.9 (2.8)	24.0 (2.8)	24.0 (2.8)	23.7 (2.8)	0.014
Education level (%)						< 0.001
Elementary school graduate	38.4	26.3	19.6	19.7	25.9	
Middle school graduate	21.5	26.6	22.4	25.1	24.5	
High school graduate	29.3	33.5	38.6	37.3	35.0	
College graduate or higher	10.9	13.7	19.4	17.8	14.5	
Income level (KRW/mo.) (%)						< 0.001
< 1 million	39.1	33.9	22.4	23.1	28.7	
1 million-1.99 million	28.9	32.9	30.7	32.5	30.9	
2 million-2.99 million	15.5	18.5	23.3	24.8	19.8	
> 3 million	16.5	14.7	23.7	19.6	20.7	
Physical activity, mean (SD) (METs/day)	1,601.7 (1,081.2)	1,599.6 (1,081.2)	1,358.2 (932.7)	1,431.0 (959.6)	1,541.1 (1,032.8)	< 0.001
Alcohol consumption, mean (SD) (g/day)	17.8 (43.6)	19.6 (49.7)	19.1 (44.9)	15.4 (40.5)	15.8 (44.0)	0.082
Smoking, mean (SD) (pack-year)	7.3 (15.2)	7.1 (14.1)	5.5 (12.3)	4.9 (11.8)	4.7 (11.4)	< 0.001
Component of metabolic syndrome* (%)						
Abdominal obesity	26.8	25.8	20.8	24.2	25.9	0.003
High blood pressure	22.9	19.5	18.4	17.0	19.8	< 0.001
High fasting blood glucose	5.8	7.2	5.7	6.1	7.0	0.312
High triglyceride	28.9	29.0	28.8	26.7	23.2	0.001
Low HDL Cholesterol	43.5	45.5	43.5	43.0	43.1	0.783

*Abdominal obesity, waist circumference of > 90 cm for men and > 85 cm for women; high blood pressure, systolic/diastolic blood pressure > 130/85 mmHg; high fasting blood glucose, fasting blood glucose > 100 mg/dL; high triglyceride, triglyceride > 150 mg/dL; low high-density lipoprotein (HDL) cholesterol, HDL cholesterol < 40 mg/dL in men and < 50 mg/dL in women.

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obesity (14.0%), hypertriglycerides (13.8%), high fasting blood glucose levels (13.3%), and high blood pressure (13.1%). According to the age- and sex-adjusted model, the risk of MetS was inversely associated with dairy product consumption (*P* for trend < 0.001, Table 3). In this model, the risk of MetS was significantly decreased in participants who consumed dairy products two to three times per week with a hazard ratio (HR) of 0.82 (95% confidence interval [CI], 0.68-0.99) as compared with those who never consumed dairy products. For participants who consumed dairy products seven or more times a week, the HR was 0.72 (95% CI, 0.62-0.84). Using the multivariate model, the HR for MetS for participants who consumed dairy products seven or more times a week was 0.75 (95% CI, 0.64-0.88), which was slightly higher than the HR of the age- and sex-adjusted model. The trend test in the multivariate model was statistically significant across the frequency of dairy product consumption (*P* < 0.001, Table 3). Analyses of the individual MetS components revealed that only abdominal obesity showed an inverse relationship with the frequency of dairy product consumption. The consumption of dairy products seven or more times per week was associated

Table 3. Hazard ratios (HRs) for the association between dairy product consumption and incident metabolic syndrome

Frequency of dairy product intake (times/week)	None	1	2-3	4-6	≥ 7	*P* for trend
Metabolic syndrome, No. (No. of cases)	1,446 (307)	1,022 (193)	1,070 (174)	1,282 (199)	2,420 (367)	
Model 1	1	0.93 (0.78-1.12)	0.82 (0.68-0.99)	0.80 (0.67-0.96)	0.72 (0.62-0.84)	< 0.001
Model 2	1	0.94 (0.78-1.13)	0.84 (0.70-1.02)	0.83 (0.69-1.00)	0.75 (0.64-0.88)	< 0.001
Components of metabolic syndrome						
Abdominal obesity, No. (No. of cases)	1,214 (231)	854 (154)	912 (167)	1,144 (162)	2,098 (302)	
Model 1	1	0.99 (0.80-1.21)	1.03 (0.84-1.26)	0.80 (0.65-0.98)	0.72 (0.61-0.86)	< 0.001
Model 2	1	0.92 (0.50-1.14)	1.05 (0.85-1.28)	0.82 (0.67-1.01)	0.73 (0.61-0.88)	< 0.001
High blood pressure, No. (No. of cases)	1,073 (209)	778 (149)	862 (145)	1,027 (149)	1,903 (296)	
Model 1	1	1.07 (0.87-1.32)	0.98 (0.79-1.21)	0.87 (0.71-1.08)	0.92 (0.77-1.10)	0.143
Model 2	1	1.11 (0.90-1.38)	1.03 (0.83-1.28)	0.95 (0.76-1.18)	0.97 (0.80-1.16)	0.380
High fasting blood glucose, No. (No. of cases)	1,122 (228)	787 (148)	861 (127)	1,038 (157)	1,937 (300)	
Model 1	1	0.98 (0.79-1.21)	0.81 (0.64-1.01)	0.85 (0.69-1.06)	0.89 (0.74-1.06)	0.134
Model 2	1	1.01 (0.81-1.26)	0.83 (0.66-1.04)	0.90 (0.72-1.12)	0.91 (0.75-1.10)	0.268
High triglyceride, No. (No. of cases)	1,004 (226)	723 (139)	756 (132)	912 (178)	1,805 (327)	
Model 1	1	0.86 (0.69-1.06)	0.76 (0.61-0.94)	0.89 (0.73-1.09)	0.81 (0.68-0.96)	0.058
Model 2	1	0.86 (0.69-1.07)	0.78 (0.62-0.97)	0.92 (0.75-1.13)	0.85 (0.71-1.02)	0.224
Low HDL Cholesterol, No. (No. of cases)	865 (273)	544 (163)	576 (149)	685 (191)	1,340 (394)	
Model 1	1	1.02 (0.84-1.23)	0.75 (0.62-0.92)	0.89 (0.74-1.08)	0.91 (0.78-1.06)	0.185
Model 2	1	1.01 (0.83-1.23)	0.79 (0.64 ,0.97)	0.92 (0.76-1.12)	0.95 (0.81-1.13)	0.572

Model 1; adjusted for age (continuous), sex (category). Model 2; adjusted for age (continuous), sex (category), physical activity (continuous), daily alcohol consumption (continuous), smoking pack-year (continuous), income (category), education (category), total energy intake (continuous).

Table 4. Hazard ratios (HRs) for the association between milk intake and incident metabolic syndrome

Variables	Frequency of milk intake (times/week)					*P* for trend
	None	1	2-3	4-6	≥ 7	
Metabolic syndrome, No. (No. of cases)	2,658 (524)	985 (171)	1,068 (157)	937 (142)	1,592 (246)	
Model 1	1	0.90 (0.75-1.07)	0.84 (0.70-1.01)	0.80 (0.66-0.97)	0.77 (0.66-0.90)	< 0.001
Model 2	1	0.92 (0.77-1.19)	0.88 (0.73-1.06)	0.83 (0.69-1.01)	0.79 (0.67-0.92)	0.002
Components of metabolic syndrome						
Abdominal obesity, No. (No. of cases)	2,243 (402)	831 (145)	953 (145)	816 (116)	1,379 (208)	
Model 1	1	1.01 (0.84-1.23)	0.96 (0.79-1.16)	0.84 (0.68-1.03)	0.81 (0.68-0.95)	0.005
Model 2	1	1.01 (0.83-1.22)	1.03 (0.85-1.25)	0.88 (0.71-1.09)	0.82 (0.68-0.97)	0.019
High blood pressure, No. (No. of cases)	2,006 (380)	777 (139)	853 (118)	763 (112)	1,244 (199)	
Model 1	1	1.01 (0.84-1.24)	0.86 (0.70-1.06)	0.92 (0.74-1.13)	0.94 (0.79-1.12)	0.294
Model 2	1	1.05 (0.86-1.28)	0.92 (0.75-1.14)	0.94 (0.76-1.17)	0.96 (0.80-1.14)	0.448
High fasting blood glucose, No. (No. of cases)	2,479 (391)	900 (135)	1000 (119)	868 (121)	1,458 (194)	
Model 1	1	0.97 (0.79-1.19)	0.80 (0.65-0.99)	0.98 (0.79-1.21)	0.94 (0.78-1.12)	0.414
Model 2	1	0.98 (0.79-1.20)	0.82 (0.66 ,1.02)	0.98 (0.79-1.22)	0.94 (0.78-1.13)	0.447
High triglyceride, No. (No. of cases)	1,872 (380)	687 (145)	750 (125)	681 (129)	1,210 (223)	
Model 1	1	1.06 (0.88-1.29)	0.84 (0.69-1.03)	0.99 (0.81-1.21)	0.94 (0.79-1.10)	0.333
Model 2	1	1.06 (0.87-1.29)	0.86 (0.70-1.06)	1.02 (0.83-1.25)	0.97 (0.82-1.16)	0.680
Low HDL cholesterol, No. (No. of cases)	1,478 (439)	527 (154)	592 (155)	524 (157)	889 (265)	
Model 1	1	1.08 (0.90-1.30)	0.94 (0.79-1.14)	1.08 (0.90-1.30)	1.02 (0.87-1.19)	0.789
Model 2	1	1.10 (0.91-1.32)	0.99 (0.82-1.19)	1.16 (0.96-1.40)	1.07 (0.91-1.20)	0.313

Model 1; adjusted for age (continuous), sex (category). Model 2; adjusted for age (continuous), sex (category), physical activity (continuous), daily alcohol consumption (continuous), smoking pack-year (continuous), income (category), education (category), total energy intake (continuous).

with a decreased risk of abdominal obesity in both models (HR, 0.73; 95% CI, 0.61-0.88, *P* for trend < 0.001 with multivariate model). The age- and sex-adjusted model showed that participants who consumed dairy products seven or more times per week had a significantly lower risk of hypertriglyceridemia (HR, 0.81; 95% CI, 0.68-0.96) with marginal significance in the trend test. However, we found no significant association between dairy product intake and MetS components other than abdominal obesity in the multivariate-adjusted model.

A similar trend was observed for milk intake (Table 4). The multivariate model revealed that milk intake was inversely associated with the risk of abdominal obesity and MetS and showed a dose-response relationship such that the more frequently milk was consumed, the lower the risk of abdominal obesity and MetS was. The HR of the most frequent milk intake (> 7 times/week) compared to none was 0.79 (95% CI, 0.67-0.92) for MetS and 0.82 (95% CI, 0.68-0.97) for abdominal obesity. No associations with other components of MetS were observed.

DISCUSSION

Our community-based prospective study of 7,240 middle-aged men and women revealed an inverse association between dairy product consumption and the risk of abdominal obesity and MetS. Our results agreed with those of previous studies (6, 16-19). Literature reviews of the effects of dairy products on MetS and risk factors for cardiovascular disease suggest that dairy products play a role in the prevention of MetS development (16, 17). van Meijl et al. (16) reported that various cross-sectional studies support an inverse association between dairy product consumption and the prevalence of MetS in some, but not all, populations. Recently, Otsuka et al. (18) examined the association between the number of MetS components and dietary factors in community-dwelling middle-aged and elderly Japanese subjects. In this cross-sectional study, a low intake of calcium, milk, and dairy products was associated with a high number of MetS components after adjusting for possible confounders, particularly in women. Nevertheless, the authors concluded that the majority of epidemiological studies showed an association between dairy product consumption and a lower risk of MetS.

In our previous study, both obesity and abdominal obesity were associated with dairy product consumption (19). The results of present study are consistent with those of previous studies (6, 20) suggesting a protective effect of dairy product consumption on obesity. Furthermore, a systematic review of prospective cohort studies concluded that dairy product consumption had a protective effect on the risk of obesity (6). Calcium, one of the many nutrients in dairy products, has been extensively investigated for its effect on weight loss. In a recent review of dairy product consumption and weight loss, Abargouei et al. (21) reported that epidemiological studies demonstrated low calcium intake was a risk factor for obesity in various population groups. The Coronary Artery Risk Development in Young Adults (CARDIA) study comprising 3,157 black and white adults aged 18 to 30 yr of age (22), found that the odds ratio for lowering the risk for obesity by adding one serving per day of dairy products was 0.82 (0.72-0.93) over the next 10 yr. A recent cross-sectional study on supplementary or dietary calcium intake and the risk of obesity in 8,127 Chinese men and women found an inverse relationship in women with a 14% reduction in abdominal obesity with the increase of each quartile of dietary calcium (23). Our finding of a significant inverse association between dairy product intake and abdominal obesity is consistent with these results.

A previous urban population-based cohort study with an average 12-yr follow-up period reported that a high intake of fermented milk, but not other dairy products including non-fermented milk or cheese, was associated with a decreased risk of cardiovascular disease (24). A study analyzing US National Health and Nutrition Examination Survey 1999-2004 data for adult population revealed an inverse association between whole milk, yogurt, calcium, and magnesium intake, and metabolic disorders (20). These investigators reported that the intake of one more daily serving of yogurt, but not other dairy products, lowered the risk of MetS by 60% (OR, 0.40; 95% CI, 0.18-0.89). Furthermore, the authors suggested that ethnic differences in dairy product consumption and nutrient intake from dairy products, such as magnesium or phosphorus, might explain variations in the effect of dairy products on MetS. Moreover, they suggested that because of the complexity of the effect of dairy products and their nutrient contents on health, MetS might not have been a useful endpoint for the study. Although some studies resulted in the positive effect of conjugated linoleic acid in dairy fat on protecting metabolic syndrome, low fat dairy product is recommended to reduce cardiovascular risks (16). Overall, different components of diary products act synergistically, showing beneficial effects on prevention of metabolic syndrome. In the present study of Korean adults, most of the dairy product consumed was whole milk and yogurt because low-fat milk is not popular. Thus, the lack of significant association between dairy product intake and the lipid related components of MetS in this population may be explained by the lack of variation in dairy products consumed.

Although dairy product consumption has rapidly increased over the last few decades in Asia, consumption in Western countries is at least twice that of East Asian countries (25). According to the 2008 KNHANES (26), less than 10% of adults aged 50-64 yr old reported milk consumption at dietary intake assessment using 24-h recall method. The average intake of dairy products of people aged 50-64 yr was 52.69 ± 4.16 g/day, which is lower than the average dairy product intake of all subjects (94.58 ±

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3.13 g/day). Thus, the results of the present study confirm the protective effect of dairy products against obesity and MetS in Asian population with low dairy product consumption. Furthermore, the prospective cohort data in our study supports the temporal causal-relationship between dairy product consumption and MetS.

The present study has several strengths. The large sample size in the community setting increased the generalizability of our results. Furthermore, the high response rate, comprehensive data collection through face-to-face interviews, inclusion of demographic and lifestyle factors, and the use of a validated FFQ all strengthened the results of our study. In the statistical analysis of this study, most well-known factors affecting MetS were included in the analysis as covariates, such as age, sex, physical activity, alcohol consumption, total energy intake, smoking status, education, and income . Due to the multicolinearity problem among dietary factors, we took parsimonious model for the statistical analysis by including total energy intake as one of the covariates. However, our follow-up period may have been a limitation. An average of 45.5 months follow-up period may not have been long enough to observe a dietary effect on components of MetS other than abdominal obesity. Thus, the possibility of a type 2 error existed and our study may lack enough power to detect other associations. However, the substantial incidence of abdominal obesity and MetS indicated sufficient statistical power to detect these differences. Future studies with greater statistical power are warranted to further examine the relationship between dairy product consumption and the risk of MetS components other than abdominal obesity.

Overall, the results of our study suggest that dairy product intake is an important dietary factor for lowering the risk of abdominal obesity and MetS in middle-aged Koreans.

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DISCLOSURE

The authors have no conflicts of interest to disclose.

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