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■ **Original Article**

Relationship between Coffee Consumption and Metabolic Syndrome in Korean Adults: Data from the 2013– 2014 Korea National Health and Nutrition Examination Survey

Hyekyung Shin, John A. Linton*, Yujin Kwon, Yohan Jung, Bitna Oh, Sinae Oh

Department of Family Medicine, Severance Hospital, Yonsei University College of Medicine, Seoul, Korea

Background: The gradually increasing demand for coffee worldwide has prompted increased interest in the relationship between coffee and health issues as well as a need for research on metabolic syndrome in adults.

Methods: Data from 3,321 subjects (1,268 men and 2,053 women) enrolled in the 2013–2014 Korean National Health and Nutrition Examination Survey were analyzed. The subjects were divided into three groups according to their daily coffee consumption. The odds ratios (ORs) and 95% confidence intervals (95% CIs) for metabolic syndrome in the coffee-drinking groups were calculated using multiple logistic regression analysis by adjusting for confounding variables.

Results: The prevalence of metabolic syndrome was 15.5%, 10.7%, and 9.7% in men and 3.0%, 7.1%, and 6.5% in women according to their coffee consumption (less than one, one or two, or more than three cups of coffee per day), respectively. Compared with the non-coffee consumption group, the ORs (95% CIs) for metabolic syndrome in the group that consumed more than three cups of coffee was 0.638 (0.328–1.244) for men and 1.344 (0.627–2.881) for women after adjusting for age, body mass index, household income, education, smoking, alcohol, regular exercise, and daily caloric intake.

Conclusion: The OR of metabolic syndrome was not statistically significant in both men and women.

Keywords: Coffee; Metabolic Syndrome; Waist Circumference; Korea

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INTRODUCTION

With the skyrocketing consumption of coffee since the 2000s,[1] coffee has become more popular than rice, exceeding its status as a favorite food.[2] The 2014 Korea National Health and Nutrition Examination Survey (KNHANES) reported an average adult consumption of approximately 12 cups of coffee per week, replacing rice (6.5 times per week) and kimchi (10.8 times a week) as the most-consumed food.[3] The International Coffee Organization announced in its 2014 report that the global coffee consumption had increased by 2.5%, from 147.88 million tons in the previous year to 150.16 million tons, and that South Korea consumed 1.91 million tons of coffee in 2014, a 2.0% increase from 1.76 million tons in 2013, and was ranked 14th in global coffee consumption.[4]

As the per capita coffee consumption has continued to increase in South Korea, there has been increased interest in the relationship between coffee consumption, nutritional issues, and disease, which has prompted research on these topics. Previous studies reported coffee consumption to be associated with increased blood pressure[5] and closely related to increased cholesterol levels.[6] Coffee consumption is also related to cardiovascular diseases.[6-8] Combined, these findings suggest that coffee consumption is closely related to metabolic syndrome, which is associated with a variety of adult disease including diabetes and cardiovascular diseases as well as hypertension and hyperlipidemia. There are, however, some recent reports suggesting the opposite. In a meta-analysis, Steffen et al.[9] reported that coffee consumption was not associated with increased blood pressure. Similarly, Donahue et al.[10] suggested that coffee consumption was not related to blood lipid levels.[11] In addition, several researchers investigated the association between coffee and cardiovascular diseases and found no relationship, or reported that coffee reduced the risk of cardiovascular disease.[12-14] A research team from Harvard University recently reported that coffee contributed to longer lifespan by lowering risk of death due to heart disease, Parkinson's disease, or dementia.[15] Several studies in South Korea on the relationship between coffee consumption and blood cholesterol level,[16] liver inflammation,[17] and osteoporosis[18] have reported different findings. Therefore, there is a need to analyze the combined results of individual research on the relationship between coffee and blood pressure, blood glucose, and cholesterol. It is also necessary to analyze their relationships using recent data since no clear relationships have been established between coffee and disease. Therefore, this study aimed to analyze the relationship between coffee consumption and metabolic syndrome in Korean men and women according to the components that define metabolic syndrome.

METHODS

1. Subjects

The KNHANES is a large-scale national health project that has been implemented in 192 areas around the nation annually since 1998 to identify factors related to the health issues of the public and to identify health indicators to be reflected in health policies.

The present study analyzed original data of the 2013–2014 KNHANES. Our study included 10,039 men and women aged 20 years or older. We excluded 6,718 participants because they met at least one of the following criteria: missing data, a history of cancer, renal, or rheumatologic disease. Those who had taken a hypertensive drug, lipid-lowering drugs, or received diabetes treatments were also excluded. After these exclusions, 3,321 participants (1,268 males and 2,053 females) were included in our final analysis.

2. General Information and Body Measurements

Information about age and coffee consumption was obtained from the health surveys, and body measurements including weight were obtained from the physical examinations. Data about coffee consumption and drinking methods were acquired from the survey on the frequency of food consumption among the nutrition survey items. We used the 'mean frequency of coffee consumption' category from the survey and selected subjects who responded that they consumed coffee with 'almost no sugar added' and 'almost no cream added.' Coffee consumption was defined as drinking coffee without sugar and cream. Data about drinking, smoking, and physical activity were acquired from the items included in the health behavior survey. Heavy alcohol use was defined as the consumption of seven alcoholic beverages in one sitting for men, or five for women. Ever smoker was defined as having ever smoked more than 100 cigarettes. Regular exercise was defined as over 30 minutes of light intensity exercise, for example walking, more than five days per week. Daily nutrient intake was analyzed according to daily caloric intake based on the food intake surveys. Blood pressure and biochemical indicators were based on the measurements and test findings from the physical examination.

3. Definition of Metabolic Syndrome

The prevalence of metabolic syndrome was determined based on National Cholesterol Education Program adult treatment program III and the Korean Society for the Study of Obesity criteria.

According to these guidelines, metabolic syndrome is defined as the presence of three or more of the following criteria: (1) abdominal obesity: waist circumference (WC) >90 cm (men) or >85 cm (women); (2) blood pressure: systolic blood pressure (SBP) >130 mm Hg, diastolic blood pressure (DBP) >85 mm Hg; (3) fasting serum glucose (FSG) level: ≥100 mg/dL or under treatment for diabetes; (4) triglyceride (TG) concentration: ≥150 mg/dL; and (5) high-density lipoprotein (HDL) cholesterol level: <40 mg/dL (men) and <50 mg/dL (women).

4. Data Processing and Analysis

In this study, IBM SPSS Statistics for Windows ver. 23.0 (IBM Corp., Armonk, NY, USA) was used for statistical analysis with each finding tested for statistical significance based on 95% confidence intervals (CIs). Continuous variables were analyzing using weighted one-way analysis of variance. Categorical variables were analyzed by weighted chi-square tests. Multiple logistic regression analysis was performed to in-

Table 1. General characteristics according to coffee consumption in Korean adult men and women

Characteristic	Coffee consumption (glasses)			P-value*
	<1	1–2	≥3	
Men				
Unweighted N	164	595	509	
Age (y)	37.6±1.0	40.6±0.6	42.7±0.5	<0.001
Body mass index (kg/m²)	24.8±0.3	24.1±0.1	24.3±0.2	0.161
WC (cm)	84.6±0.9	83.3±0.4	83.4±0.4	0.352
Systolic blood pressure (mm Hg)	116.5±1.0	117.4±0.6	117.3±0.7	0.805
Diastolic blood pressure (mm Hg)	77.4±0.9	78.6±0.5	78.9±0.6	0.321
Triglyceride (mg/dL)	155.7±12.6	154.4±5.4	167.5±7.3	0.844
HDLC (mg/dL)	48.5±0.9	49.7±0.5	48.8±0.5	0.481
Fasting plasma glucose (mg/dL)	97.2±1.6	96.8±0.8	97.8±0.8	1.000
Calorie intake (kcal/d)	2,372.3±89.5	2,334.2±42.1	2,548.4±45.8	0.146
Regular exercise (%)	42.8±3.9	41.1±2.2	38.5±2.5	0.574
Household income (%)				0.230
<25th percentile	10.1±2.4	8.0±1.3	6.2±1.1	
25–50th percentile	22.9±3.4	22.5±1.9	28.3±2.3	
50–75th percentile	33.4±3.4	34.8±2.2	31.0±2.0	
>75th percentile	33.6±4.1	34.7±2.3	34.4±2.6	
Education (%)				0.180
Elementary school	2.6±1.1	5.2±0.9	5.2±1.1	
Middle school	5.7±1.9	6.2±1.0	8.7±1.4	
High school	45.9±4.5	37.2±2.4	41.2±2.5	
College	45.8±4.6	51.4±2.5	44.9±2.6	
Ever smoked (%)	42.7±3.8	32.7±2.1	16.9±1.6	<0.001
Heavy alcohol (%)	50.7±4.4	51.7±2.2	55.9±2.6	0.385
Metabolic syndrome (%)	15.5±2.9	10.7±1.3	9.7±1.5	0.137
Women				
Unweighted N	311	1,208	534	
Age (y)	38.6±0.9	41.2±0.4	42.5±0.6	<0.001
Body mass index (kg/m²)	21.7±0.2	22.7±0.1	22.9±0.1	<0.001
WC (cm)	73.4±0.5	75.3±0.3	75.9±0.4	<0.001
Systolic blood pressure (mm Hg)	107.7±0.8	109.6±0.5	109.4±0.6	0.062
Diastolic blood pressure (mm Hg)	70.8±0.6	71.9±0.3	71.6±0.4	0.157
Triglyceride (mg/dL)	93.7±3.9	98.1±2.3	103.3±3.4	0.123
HDLC (mg/dL)	58.7±0.9	57.5±0.4	58.4±0.7	0.463
Fasting plasma glucose (mg/dL)	89.9±0.5	93.2±0.6	92.8±0.5	<0.001
Calorie intake (kcal/d)	1,868.2±40.0	1,940.5±22.4	2,102.6±43.9	<0.001
Regular exercise (%)	42.7±3.1	37.1±1.6	33.3±1.8	0.059
Household income (%)				0.203
<25th percentile	11.8±1.4	10.3±0.7	9.9±0.9	
25–50th percentile	26.5±2.0	23.9±1.1	27.8±1.5	
50–75th percentile	30.4±2.1	31.2±1.2	30.7±1.4	
>75 percentile	31.4±2.3	34.6±1.4	30.3±1.4	
Education (%)				0.026
Elementary school	15.1±1.5	15.5±0.9	15.0±1.2	
Middle school	8.3±1.1	9.9±0.7	9.6±0.9	
High school	39.4±2.2	33.8±1.2	39.7±1.5	
College	37.2±2.3	40.8±1.3	35.6±1.5	
Ever smoker (%)	11.5±2.3	9.1±0.9	12.2±1.8	0.215
Heavy alcohol (%)	18.8±3.0	16.8±1.3	20.8±2.0	0.282
Metabolic syndrome (%)	3.0±0.9	7.1±0.8	6.5±1.1	0.030

All data except regular exerciser, ever smoker, heavy alcohol, household income, education, and metabolic syndrome are presented as mean±SE and P-values were calculated using general linear models. Regular exerciser, ever smoker, heavy alcohol, household income, education, and metabolic syndrome are presented as %±SE and P-values were calculated by chi-square test. Regular exercise: ≥30 minutes of light-intensity physical activity ≥5 days a week. Ever smoked: those who had ever smoked more than 100 cigarettes. Heavy alcohol: men or women who drank seven or five alcoholic beverages in one sitting, respectively.

WC, waist circumference; HDLC, high-density lipoprotein cholesterol; SE, standard error.

*P-values from continuous and categorical variables were analyzed by weighted one-way analysis of variance and chi-square test, respectively.

vestigate the association between metabolic syndrome and coffee consumption. The odds ratios (ORs) and 95% CIs were determined after adjusting for confounding variables such as age, body mass index (BMI), household income, education, smoking, alcohol consumption, regular exercise, and daily caloric intake.

RESULTS

1. General Characteristics

Table 1 shows the general subject characteristics. The subjects included 1,268 adult men and 2,053 women aged 20 years or older. There were 12.9%, 47.0%, and 40.1% of men and 15.1%, 58.9%, and 26.0% of women consumed less than one cup, one or two cups, and more than three cups of coffee daily, respectively. The highest percentage of participants drank one or two cups of coffee per day. The mean ages of the

subjects according to coffee consumption were 37.6±1.0, 40.6±0.6, and 42.7±0.5 years (P<0.001) in men and 38.6±0.9, 41.2±0.4, and 42.5±0.6 years (P<0.001) in women according to increasing coffee consumption. The daily caloric intakes were 2,372.3±89.5, 2,334.2±42.1, and 2,548.4±45.8 kcal/d (P=0.146) in men and 1,868.2±40.0, 1,940.5±22.4, and 2,102.6±43.9 kcal/d (P<0.001) in women according to increasing coffee consumption. In men, age and ever smoking showed a significant change (all P-value <0.001). In women, age, BMI, WC, FSG, and daily calorie intake showed a significant change. The prevalence of metabolic syndrome was 15.5%, 10.7%, and 9.7% in men and 3.0%, 7.1%, and 6.5% in women, respectively (P=0.137 and P=0.030, respectively) according to increasing coffee consumption; the relationship was significant in women.

Table 2. Odds ratios for metabolic syndrome according to coffee consumption in Korean adult men and women

Variable	Coffee consumption (glasses)					
	Men			Women		
	<1	1–2	≥3	<1	1–2	≥3
Metabolic syndrome						
Model 1	1.000	0.656 (0.399–1.077)	0.589 (0.345–1.005)	1.000	2.502 (1.313–4.771)	2.304 (1.121–4.734)
Model 2	1.000	0.831 (0.444–1.556)	0.623 (0.332–1.171)	1.000	1.501 (0.770–2.923)	1.300 (0.624–2.706)
Model 3	1.000	0.869 (0.450–1.676)	0.638 (0.328–1.244)	1.000	1.739 (0.869–3.480)	1.344 (0.627–2.881)
Metabolic syndrome components						
Triglyceride ≥150 mg/dL						
Model 1	1.000	1.012 (0.710–1.441)	1.252 (0.859–1.825)	1.000	1.241 (0.825–1.868)	1.190 (0.758–1.868)
Model 2	1.000	1.128 (0.757–1.682)	1.348 (0.883–2.058)	1.000	0.958 (0.619–1.485)	0.863 (0.544–1.369)
Model 3	1.000	1.016 (0.669–1.544)	1.175 (0.754–1.833)	1.000	0.992 (0.638–1.543)	0.766 (0.487–1.206)
High-density lipoprotein cholesterol <40 mg/dL in men, <50 mg/dL in women						
Model 1	1.000	0.695 (0.462–1.046)	0.794 (0.502–1.256)	1.000	1.174 (0.856–1.610)	0.943 (0.659–1.348)
Model 2	1.000	0.743 (0.480–1.151)	0.812 (0.507–1.300)	1.000	1.000 (0.726–1.378)	0.762 (0.530–1.096)
Model 3	1.000	0.765 (0.484–1.208)	0.810 (0.491–1.337)	1.000	1.009 (0.723–1.408)	0.738 (0.511–1.067)
Systolic blood pressure >130 mm Hg						
Model 1	1.000	0.886 (0.553–1.419)	0.973 (0.594–1.593)	1.000	1.664 (0.940–2.945)	1.654 (0.896–3.051)
Model 2	1.000	0.911 (0.546–1.522)	0.906 (0.532–1.546)	1.000	1.444 (0.747–2.792)	1.309 (0.662–2.587)
Model 3	1.000	0.894 (0.522–1.531)	0.944 (0.523–1.704)	1.000	1.546 (0.772–3.095)	1.419 (0.686–2.934)
Diastolic blood pressure >85 mm Hg						
Model 1	1.000	1.190 (0.798–1.774)	1.235 (0.804–1.897)	1.000	1.418 (0.835–2.410)	1.398 (0.785–2.485)
Model 2	1.000	1.360 (0.891–2.074)	1.309 (0.833–2.059)	1.000	1.210 (0.698–2.099)	1.145 (0.624–2.101)
Model 3	1.000	1.367 (0.887–2.107)	1.246 (0.776–2.000)	1.000	1.286 (0.724–2.287)	1.316 (0.695–2.492)
Fasting blood glucose ≥100 mg/dL						
Model 1	1.000	0.764 (0.493–1.185)	1.033 (0.661–1.616)	1.000	1.572 (1.001–2.470)	1.480 (0.878–2.495)
Model 2	1.000	0.701 (0.437–1.125)	0.859 (0.530–1.391)	1.000	1.204 (0.733–1.979)	1.056 (0.596–1.872)
Model 3	1.000	0.667 (0.410–1.083)	0.820 (0.501–1.343)	1.000	1.162 (0.688–1.962)	1.019 (0.567–1.833)
Waist circumference >90 cm (men), >85 cm (women)						
Model 1	1.000	0.500 (0.254–0.982)	0.526 (0.271–1.018)	1.000	1.614 (1.030–2.529)	1.594 (0.972–2.614)
Model 2	1.000	0.608 (0.190–1.947)	0.554 (0.160–1.920)	1.000	0.743 (0.383–1.442)	0.685 (0.339–1.383)
Model 3	1.000	0.545 (0.183–1.621)	0.462 (0.136–1.570)	1.000	0.707 (0.343–1.459)	0.647 (0.308–1.356)

Values are presented as odds ratio (95% confidence interval).
Model 1: unadjusted. Model 2: adjusted for age and BMI. Model 3: adjusted for age, BMI, household income, education, smoking, alcohol consumption, exercise status, and daily caloric intake.
BMI, body mass index.

2. Relationship between Daily Coffee Consumption and Metabolic Syndrome

Table 2 presents the relationships between daily coffee consumption and metabolic syndrome. The ORs of metabolic syndrome were not statistically significant except for model 1 in women. We analyzed the relationship between daily coffee consumption and each metabolic syndrome component individually. In men, WC was lower according to coffee consumption but the difference was not statistically significant. The ORs for TG and HDL cholesterol were not statistically significant in models 1, 2, and 3. SBP and DBP did not differ significantly; similarly, the differences in FSG were also not statistically significant. In women, the OR for WC was increased in model 1. After adjusting for confounding variables in models 2 and 3, the OR decreased but was still not statistically significant. After adjusting for confounding variables in models 2 and 3, the ORs for TG decreased and HDL cholesterol increased with increasing coffee consumption, but the differences were not statistically significant. There were no significant differences in SBP and DBP and FSG was unrelated to coffee consumption.

DISCUSSION

The present study examined the relationship between coffee consumption and metabolic syndrome among adult men and women in South Korea using data from the 2013–2014 KNHANES. After collecting data from these two years, we identified 3,321 men and women 20 years or older that met the requirements of the present study. The participants were divided into three groups according to daily coffee consumption; less than one cup, 1–2 cups, and more than three cups per day.

In an attempt to understand the relationships between coffee and the components of metabolic syndrome, the present study performed analyses based on the five diagnosis criteria of metabolic syndrome. Metabolic syndrome components such as WC, HDL cholesterol, TG, FSG, SBP, and DBP did not differ significantly according to coffee consumption in both men and women. After adjusting for social economic status, life habits, and daily caloric intake that might influence metabolic syndrome in addition to daily coffee consumption, the results did not change. Those findings may be explained by the components of coffee and their physiological functions inside the human body. Coffee contains various components in addition to caffeine that may also affect the physiology of the human body. Of them, chlorogenic acid (CGA), a polyphenol, controls oxidation of fat and prevents atherosclerosis, thus potentially slowing the progress of cardiovascular diseases.[19] Unsaturated fatty acid also has a beneficial effect on metabolic syndrome by regulating the expression of genes associated with fatty acid oxidation.[20] However, several studies have identified negative outcomes of coffee consumption. Coffee consumption has been reported to increase total cholesterol, low-density lipoprotein (LDL) cholesterol, and TG levels.[21] However, our present study showed that coffee consumption was not related to TG or LDL cholesterol levels. However, these previous studies on the relationship between coffee consumption and cholesterol and TG levels included a criterion of consumption of six cups of coffee per day.[21] Because only a small percentage of the population in South Korea reported drinking six or more cups of coffee per day, they would likely not have a significant impact on the findings of the present study. There were no significant relationships between coffee consumption and FSG levels in the present study. While the CGA in coffee reduces the absorption of glucose in the small intestine and increases insulin sensitivity, thus lowering the risk of type 2 diabetes, caffeine inhibits glucose metabolism and increases insulin resistance, thus raising blood glucose levels.[22] Those opposing effects make it difficult to identify consistent directionality. In addition, CGA also inhibits hydroxyhydroquinone (HHQ) produced during the roasting of coffee beans, thus lowering blood pressure.[9] There are opposing functions between HHQ and CGA in coffee, which make it impossible to find consistent correlations between coffee and blood pressure.

The present study used secondary data regarding coffee consumption and drinking methods; therefore, one limitation of the study is the lack of detailed information about the types of coffee that the respondents usually consumed, as well as the lack of information regarding coffee concentrations according to the ways that coffee was drunk and no reflection on the styles of making coffee. Moreover, it is hard to define coffee consumption using only the self-reported questionnaire. In addition to the rather low accuracy of information, the study was also limited in that it was difficult to control for many confounding variables that could influence metabolic syndrome and figure out the relationship by a cross-sectional study.

Compared with previous studies, however, the present study has several strengths, such as including data from the most recent survey, which reflects a large sample size that represents South Korea. In addition, the survey was a random survey that was not restricted to certain areas and included participants residing in cities as well as rural areas.

Several overseas papers have used a cohort study design because it is useful for evaluation of risk factors and the prevalence of disease; compared to a cross-sectional study design, this design is also appropriate to establish the relationships between coffee consumption and metabolic syndrome. In South Korea, there is a need for additional large-scale prospective studies to assess the relationship between coffee consumption and metabolic syndrome.

In conclusion, coffee consumption was not significantly associated with metabolic syndrome in Korean adults. Since coffee has become an established part of food culture, and has become a favorite food, the findings of this study are expected to help consumers make the right choices regarding coffee consumption and drinking methods, which may help to prevent metabolic syndrome associated with dietary habits, and thus prevent and manage chronic diseases such as cardiovascular diseases, hyperlipidemia, and diabetes.

CONFLICT OF INTEREST

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

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