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Comparison of Dietary Characteristics of Acute Coronary Syndrome Patients with Normal Subjects

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Abstract

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The importance of nutrition for the prevention and treatment of coronary heart disease (CHD) has been reported in a large number of studies at the levels of single nutrients, foods, and dietary patterns. However, the association between nutrition and the risk of acute coronary syndrome (ACS) has been less studied. In addition, the studies conducted in Korean subjects are limited. In this study, 91 ACS patients and 63 normal subjects without hypertension, dyslipidemia, diabetes, or the history of cardiovascular disease (CVD) were included. Socio-demographic, lifestyle, and anthropometric characteristics were determined. To compare the differences in dietary nutrient intake between ACS and normal groups, food frequency questionnaire (FFQ) and 2-day 24-hour recall were used. We also examined the differences in food intake between two groups and associations between

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food intake and the risk of ACS based on grouping of food items listed in FFQ and the intake levels of each food group. The ACS group was significantly older and had higher proportion of male subjects than the normal group. The income level and the percentage of the married were significantly lower in ACS group. The proportion of current smoker and subjects not doing regular exercise were significantly higher in ACS group than normal group. ACS patients had significantly higher waist circumference and there was a significant association between abdominal obesity determined by waist circumference and ACS. Overall, no significant difference in nutrient intake between the ACS and normal group was found from the FFQ and 2-day 24-hour recall among female subjects. However, significant differences in several nutrients intakes were found between male ACS patients and male normal subjects. FFQ analysis results showed that ACS group had significantly higher energy, carbohydrate and protein intakes than the normal group. Cholesterol and unsaturated fatty acids intakes were also significantly higher in the ACS group than the normal group. For dietary intakes of mineral and vitamins, the ACS group consumed significantly higher amount of phosphorus, sodium, iron from animal-source, selenium, vitamin E, vitamin K, vitamin B_6, vitamin B_{12}, and niacin compared with the normal group. According to the results from 2-day 24-hour recall, ACS group had significantly higher intakes of fat and protein from plant sources, fiber, calcium from plant source, vitamin E, vitamin B_{12},

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and folate, and lower animal-source fat intake than the normal group. ACS's sodium intake was also significantly higher than normal group's intake level. The overall correlation between the FFQ and 2-day 24-hour recall was relatively low (r = 0.163 ~ 0.364). When total amount of intake and the number of servings consumed per day were compared for food groups, ACS patients consumed significantly more sweets, fish, and rice/rice cakes/grains groups compared to the normal people. There were associations between the risk of developing ACS and the intakes of sweets, fish, and fruits group. The intake of sugar-sweetened beverages (SSB) group tended to show association with the risk of ACS. In conclusion, based on the data assessed by FFQ, the ACS patients' diets were characterized by higher intakes of total energy, carbohydrate, protein, cholesterol, phosphorus, sodium, and heme iron at the nutrient level and by higher consumption of sweets, fish, and rice/rice cakes/grains at the food group level compared to normal subjects. In sweets, fish, and fruits groups, significant associations between consumption level and ACS risk were found. Specifically, sweets and fish consumption had positive associations with ACS which suggest harmful effects of their consumption on the risk of ACS. On the other hand, fruits consumption showed an inverse association with ACS, which suggests a protective effect of fruits intake on ACS. However, dietary intakes assessed by 24-hour recall showed lack of significant correlation with the dietary intake results from FFQ, which suggested that there might have been dietary

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changes in ACS patients after the diagnosis of disease.

KEY WORDS: Acute coronary syndrome, nutrient intake, food intake, sweets, fish

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List of Abbreviations

ABW, adjusted body weight

ACS, acute coronary syndrome

ALT, alanine aminotransferase

AMI, acute myocardial infarction

AST, aspartate aminotransferase

BMI, body mass index

CCR2, C-C chemokine receptor type 2

CHD,coronary heart disease

CK,creatine kinase

CK-MB, creatine kinase - MB

CRP, C-reactive protein

CVD, cardiovascular disease

DHA, docosahexaenoic acid

ECG,electrocardiogram

EPA, eicosapentaenoic acid

FFQ, food frequency questionnaire

IBW, ideal body weight

IHD, ischemic heart disease

KDRIs, dietary reference intakes for Koreans

MCP-1, monocyte chemoattractant protein-1

M-CSF, macrophage colony-stimulating factor

MI, myocardialinfaction

MMPs, matrix metalloproteinases

NSTEACS, non-ST elevation acute coronary syndrome

NSTEMI, non-ST elevation myocardial infarction

OR, odds ratio

ROS, reactive oxygen species

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SSB, sugar-sweetened beverages

STEMI, ST elevation myocardial infarction

TG, triglyceride

UA, unstable angina

VCAM-1, vascular cell adhesion molecule-1

vWF, von Willebrand factor

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I. Introduction

1. Background

Acute coronary syndrome

Heart disease is the leading cause of death for people in the United States (Hoyert & Xu, 2012). Cardiovascular disease (CVD) is one of the four major causes of death in Korea as well. From 2000 to 2010, the relative rate of death attributable to all CVDs increased by 22.8%; from 38.2 per 100,000 to 46.9 per 100,000, respectively (Statistics Korea, 2010). Among many types of CVDs, acute coronary syndrome (ACS), which is the complication of coronary heart disease (CHD), is one of the greatest concerns these days because of its higher risk for cardiac death or ischemic complication. In the United States, more than 11 million people were hospitalized for ACS in 2010 (Go et al., 2013). In Korea, 42% of CVD death was attributed to acute myocardial infarction (AMI), a type of ACS (Statistics Korea, 2010).

ACS refers to a group of clinical symptoms caused by obstruction of coronary arteries. It can be subdivided into 3 categories- ST segment elevation myocardial infarction (STEMI), non-ST segment elevation myocardial infarction (NSTEMI), and unstable angina (UA) - according to the existence of myocardial damage and the degree of occlusion. Based on the appearance of 12-lead electrocardiogram (ECG), ACS is categorized

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into STEMI and non-ST elevation ACS (NSTEACS). NSTEACS encompasses both UA and NSTEMI, which can be determined by the detection of myocardial biomarkers, such as troponins (Morrow et al., 2007). (**Figure 1**)

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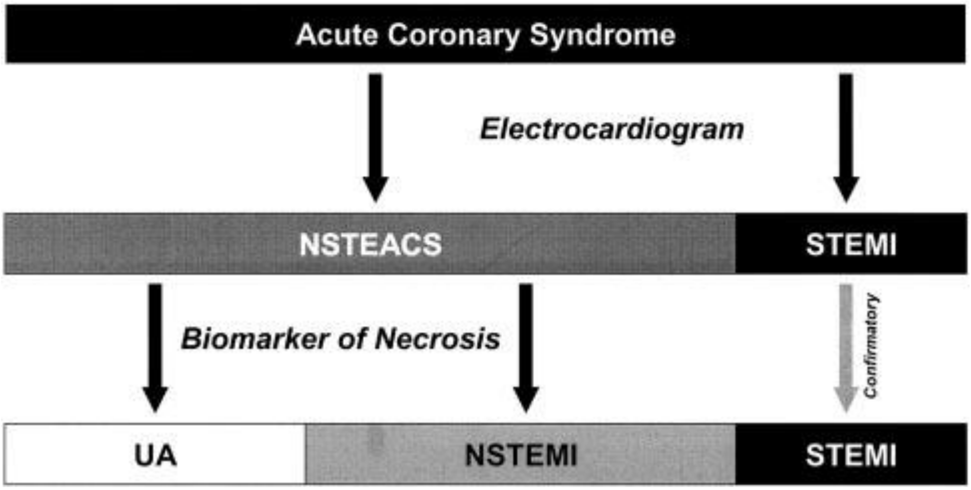

Figure 1. Categorization of acute coronary syndromes[1] (Morrow et al., 2007)

[1]NSTEACS, non-ST elevation acute coronary syndrome; NSTEMI, non-ST elevation myocardial infarction; STEMI, ST elevation myocardial infarction; UA, unstable angina

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Pathophysiology of acute coronary syndrome

Although ACS is a complex syndrome with a heterogeneous etiology (Morrow et al., 2007), the most common cause of ACS is the disruption of coronary atherosclerotic plaque. The serial events in the occurrence of ACS are 1) rupture or erosion of atherosclerotic plaque, 2) exposure of tissue factor and other prothrombotic substances in atheroma core to the blood flow, 3) activation of platelets and the start of coagulation cascade, and 4) thrombus formation in coronary arteries (Cimmino et al., 2012).

Atherosclerotic plaque

The formation of atherosclerotic plaque is considered to be the outcome of inflammatory responses, not the simple result of cholesterol storage. Initiated by inflammatory responses, blood cells, such as monocytes, begin to adhere to the endothelium of the arteries with the help of vascular cell adhesion molecule-1 (VCAM-1). Then, monocytes adhered to the endothelium migrate into the arterial intima and transform into macrophages. The migration requires a chemoattractant gradient and the interaction of monocyte attractant protein-1 (MCP-1) with its receptor C-C chemokine receptor type 2 (CCR2) seems to participate in this process. Macrophages begin to ingest lipoproteins by expressing scavenger receptors that bind lipoprotein particles. The lipid-laden macrophages called foam cells

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accumulate within the intima to form a plaque. The foam cell is a hallmark of the arterial lesion because it serves many functions related to atherosclerosis, secreting pro-inflammatory cytokines and producing matrix metalloproteinases (MMPs) which cause the thrombotic complications (Libby, 2002). (**Figure 2**)

Plaque disruption

The atherosclerotic plaque becomes evident when it attains enough volume to obstruct blood circulation, causing stable angina or it is abruptly disrupted and form a clot at the site, resulting in ACS. Disrupted plaques progress through following several mechanisms; 1) erosion of the epithelial monolayer, producing a thrombus by exposure of collagen, von Willebrand factor (vWF), and other prothrombotic substances, 2) intraplaque hemorrhage, and 3) a tear of a plaque's fibrous cap which can permit the plaque core to meet coagulation factors in the blood (Kleinschmidt, 2006).

Thrombus formation

Platelet activation begins when exposed tissue factors bind to the receptors on the surface of platelet. It induces transformation of the receptors where a thrombus formation can initiate (Rajagopal & Bhatt, 2004). With the help of plasminogen-activating inhibitor-1, thrombi can

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form larger and damaging occlusions.

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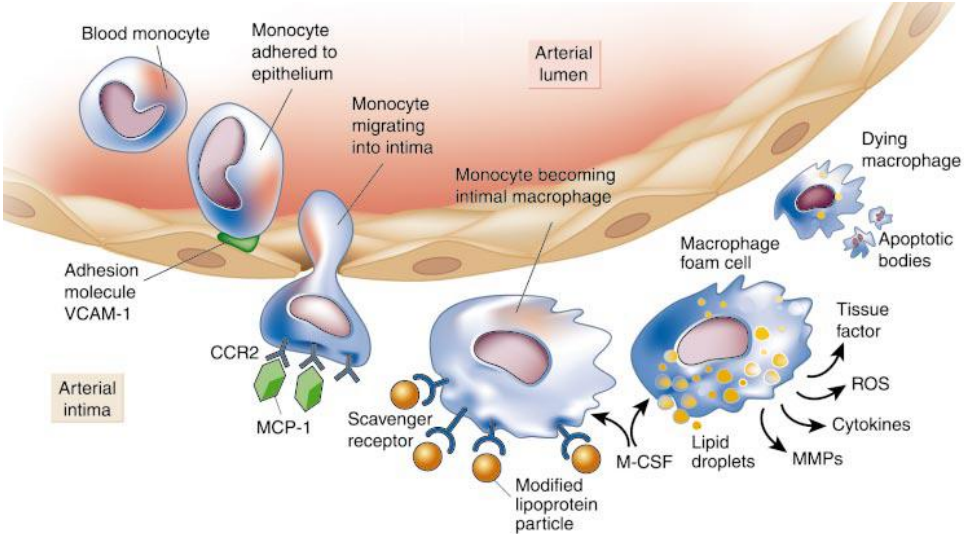

Figure 2. Role of mononuclear phagocytes in the development of atherogenesis[1](Libby, 2002).

[1]CCR2, C-C chemokine receptor type 2; MCP-1, monocyte chemoattractant protein-1; M-CSF, macrophage colony-stimulating factor; MMPs, matrix metalloproteinases; ROS, reactive oxygen species; VCAM-1, vascular cell adhesion molecule-1

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Diet and Acute coronary syndrome

Many epidemiologic studies have identified factors associated with the risk of atherosclerotic CVD. These factors can be subdivided into 2 categories according to the verification (**Table 2**); 1) risk factors which have been proven to be casual and 2) risk markers which have associations with CVD but for whom a cause and effect association should be proven (S. Yusuf et al., 2001). Among them, the importance of interventions to modify dietary factor has been emphasized because they are cost-effective means for prevention and treatment of CHD (Kastorini et al., 2011; Nishida et al., 2004; WHO & Consultation, 2003). In this respect, the effects of nutrition - single nutrients, foods, and dietary patterns - on CHD risk have been asserted by many studies.

Nutrients : dietary fats

Most of the studies which investigated the relationship between nutrients and CVD have focused on dietary fats. The interest in the effect of dietary fats on CVD emerged from animal studies in 1930s and subsequent studies about association between fat intake, cholesterol and CHD were conducted. Until 1990s, primary focus of studies and governmental recommendations was the limitation of total intake of dietary fat to prevent the development of CVD (Bhupathiraju & Tucker, 2011). However, it was revealed that intake

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Table 1. Proven and putative risk markers for CVD (S. Yusuf et al., 2001)

Risk factors that are causally linked:

1. Tobacco consumption
2. Elevated LDL
3. Low HDL
4. High blood pressure
5. Elevated glucose
6. Physical inactivity*
7. Obesity*
8. Diet*

Risk markers that show associations:

1. Low socioeconomoic status*
2. Elevated prothrombotic factors: fibrinogen, PAI-1
3. Markers of infection or inflammation
4. Elevated homocysteine
5. Elevated lipoprotein(a)
6. Psychological factors (depression, anger proneness, hostility, stress, actual life-events) and breakdown in social structures (loss of social support and cohesion)*

* Predisposing risk factors: A predisposing risk factor is presumed to work, at least in part, through an impact on other risk factors that act directly. For example, obesity ralses blood pressure, causes dyslipidemia, and increases blood glucose. It is likely that some of the predisposing risk factors also have direct effects.

PAI indicates plasminogen activator inhibitor

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of total fat was not significantly associated with the mortality of CHD by a 2009 meta-analysis (Skeaff & Miller, 2009). Since then, the focus has been shifted to the role of a particular type of fat, such as saturated fat and n-3 fatty acids. It was reported that intakes of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) were inversely associated with the risk of MI or nonfatal coronary events in the Japan Public Health Center-Based study (Iso et al., 2006). Another study also reported that higher plasma concentration of n-3 fatty acids showed lower risk of nonfatal MI (Sun et al., 2008). Recently, the association between higher intake of n-3 fatty acids and lower incidence of acute coronary syndrome, as well as the incidence of CVD, was reported (Joensen et al., 2010).

Foods

Fish consumption

Fish, the primary source of n-3 fatty acids, was also reported to be associated with lower mortality. A meta-analysis study which analyzed 11 cohort studies reported that CHD mortality can be reduced by consuming fish more than once per week. In this study, moderate (2-4 times per week) and higher frequency (≥ 5 times per week) of fish consumption reduced CHD risk by 23% and 38%, respectively (He et al., 2004a). The Zutphen study reported that fatty but not lean fish consumption lowered sudden

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coronary death risk, although there is no significant dose-response relationship between EPA+DHA intake and the risk of CHD death (Streppel et al., 2008). As for the effect of fish consumption on the risk of development of ACS, a Danish follow-up study with 57,053 men and women indicated that a modest intake of fatty fish was related with a lower risk in men (Bjerregaard et al., 2010).

Fruits and vegetables

With a large number of studies conducted, the effect of fruits and vegetables consumption on CVD risk has been revealed to be protective. A study reported that increasing consumption of fruits and vegetables up to 600 g per day could reduce the global burden of ischemic heart disease (IHD) and ischemic stroke by 31% and 19%, respectively(Lock et al., 2005). A meta-analysis of 9 studies showed an inverse association between consumption of fruits and vegetables and CHD risk; 4% decrease of CHD risk for each additional portion per day of fruits and vegetables, and 7% for fruits consumption. Also, the protective effect of fruit and vegetables intake seems to be dose-related, having proportionally increased benefit by the number of servings (Nikolić et al., 2008). In the CARDIO2000 case-control study, high consumption of fruits (≥ 5 servings per day) and vegetables (≥ 3 days per week) had lower relative risk of developing acute coronary

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syndrome by 72% and 70%, respectively (Panagiotakos et al., 2003).

Dietary patterns

Although traditional approach in nutritional epidemiology has been conducted by single nutrient- and food-specific analysis, the holistic approach of dietary pattern is considered to be more appropriate. Considering the fact that people consume a variety of foods as a complex meal, pattern analysis can provide more comprehensive understanding of association between the diet and disease.

Mediterranean dietary pattern

The interest in the Mediterranean dietary pattern firstly emerged in the Seven Countries Study which found that Mediterranean people had the lowest incidence of chronic diseases and higher life expectancy compared to others parts of the world (Keys, 1980). This dietary pattern is primarily characterized by high consumption of oleic acid, n-3 fatty acids, fibers and B-group vitamins, encouraging 1) daily consumption of fruits, vegetables, whole grain cereals, and low-fat dairy products,2) weekly consumption of fish, poultry, nuts, and legumes, 3) monthly consumption of red meat, and 4) a moderate daily consumption of alcohol with meals (Kastorini et al., 2011). In a recent meta-analysis of 514,816 participants from 8 studies, greater

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adherence to the Mediterranean diet (two-point increase) was associated with a 9% lower mortality from CVD (Sofi et al., 2008). Also in ATTICA study, a 1/55-unit increase in Mediterranean diet score could reduce the incidence of CVD by 6% (Panagiotakos et al., 2008). The protective effect of the Mediterranean diet was found both in the primary and secondary prevention of acute coronary syndrome, with the association between greater diet scores and lower likelihood of coronary events (Chrysohoou et al., 2010; Demosthenes B Panagiotakos et al., 2005).

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2. Objective of the study

In development of CHD, the influence of dietary factor as well as traditional risk factors of CHD such as smoking, hypertension, dyslipidemia has recently been emphasized by previous epidemiological studies. In these studies, associations between the risk of CHD and single nutrients, foods, and dietary patterns have been reported. However, studies which investigated direct associations between the risk of ACS and dietary intakes and which conducted in Korean subjects are limited.

Therefore, to make a suggestion about the role of dietary intakes in development of ACS, we aimed to compare dietary intakes of ACS patients with normal people at the levels of overall nutrients and foods intake.

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II. SUBJECTS AND METHODS

1. Subjects

The study was conducted from December 2011 to March 2013 at Ewha Womans University Medical Center. We collected ACS patients diagnosed with ACS and normal subjects who visited the health promotion center for medical checkup during this period. Diagnosis of ACS was based on the symptoms of traditional chest pain, abnormal electrocardiogram, intravascular ultrasound/cardiac CT, the elevation of cardiac enzymes (troponin T, CK-MB), and echocardiography. Most of ACS patients were enrolled within 1-2 weeks after the diagnosis.

One hundred seventy six subjects (94 ACS patients and 82 normal subjects) older than 18 and younger than 70 years of age were recruited. Three ACS patients and 13 normal subjects did not completed dietary assessment, and 6 normal subjects were excluded based on exclusion criteria. As a result, one hundred fifty four subjects were included in the study; 91 ACS patients (72 men and 19 women) and 63 normal subjects (40 men and 23 women) were included. The exclusion criteria for normal subjects were 1) hypertension (systolic blood pressure higher than 140 mmHg), 2) dyslipidemia (TG higher than 200 mg/dL or total cholesterol higher than 230 mg/dL), 3) diabetes mellitus (fasting blood glucose higher than 126 mg/dL) and 4) the history of cardiovascular diseases.

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The protocol was approved by the Ewha Womans University Mokdong Hospital Institutional Review Board (ECT 12-01-10), and written informed consent was obtained from all subjects.

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2. Assessment of dietary intake of subjects

Dietary intake of all subjects was assessed by food frequency questionnaire (FFQ; food frequency questionnaire for Korean genome and epidemiology study, Korea Centers for Disease Control and Prevention) and 2-day 24-hour recall by the trained interviewer. As for FFQ, subjects were asked to record estimated intake based on their diets during past 1 year before the diagnosis of ACS.A 24-hour recall was performed on the day of enrollment and the second one-day 24-hour recall was collected by a telephone interview within 2-3 weeks.

The FFQ includes 103 food items, 9 categories of frequency of food intake and 3 categories of portion size. The validation and reproducibility of this FFQ was evaluated for Korean adults. An analysis of nutrient intake from FFQ was done using Can-Pro version 4.0 (Computer Aided Nutritional Analysis Program, The Korean Nutrition Society, 2011) based on the recipe from Korean genome and epidemiology study. The 9 categories of frequency were converted into 0, 0.033, 0.083, 0.214, 0.5, 0.786, 1, 2 and 3 times per day respectively and the 3 categories of portion size were changed into 0.5, 1 and 1.5 respectively based on the relative amount of each portion size. An analysis of dietary intake collected by 2-day 24-hour recall was done using Can-Pro version 4.0. The average of 2-day intake was used as an intake of each subject.

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Comparison of food intakes of ACS and normal groups was performed by grouping similar food items together. One hundred three food items of the FFQ were categorized to 22 groups based on the similarity of nutrient profiles (**Table 2**). Specifically, ramen was separated from other kinds of noodles because of its high level of saturated fat and sodium contents. Pork belly (samgyeopsal) was also classified into a different group from other types of meats because of its high fat content. As salted vegetables, especially kimchi, are characterized by their high level of sodium and several substances resulted from fermentation, we calculated their consumption separately from other vegetable items. The consumption level of each food group was also calculated as the number of servings consumed per day. Serving size was based on the serving size of each food item used in the database of FFQ.

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Table 2. Grouping of food items for the comparison of food intake[1]

Food groups	Food items in the group
Rice/rice cakes/grains	cooked rice, cooked rice with beans/ mixed cereals, rice cake, rice-cake soup, cornflakes, grains
Noodles	chopped noodle/fine noodle/Udon, Jajangmyeon/Champon, Naengmyeon/Soba (buckwheat-noodle),
Ramen	Ramen
Breads/snacks	bread, red bean-stuffed bread, other kinds of bread, cake, cookie/cracker
Potatoes/sweet - potatoes/starches	potato, sweet potato, Japchae, Muk
Sweets	sweets/chocolate, jam/honey/margarine, sugars, cream
Legumes	soybean, Doenjang/Cheonggukjang, tofu, soy milk
Nuts	peanut/almond/pine nut
Vegetables	radish, Chinese cabbage, spinach, lettuce, sesame leaf, ssam/salad, other green vegetables, bell-flower roots (Doraji), bean sprouts, bracken, red pepper leaf, leek, cucumber, carrot, hot pepper, young pumpkin, pumpkin/sweet pumpkin, Oyster mushroom, other kinds of mushroom
Salted vegetables	cabbage kimchi, radish kimchi, Nabakkimchi/Donchimi, other kinds of kimchi, pickled vegetables
Fruits	strawberry, oriental melon/melon, watermelon, peach/plum, banana, persimmon/dried persimmon,

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	mandarine, pear, apple, orange, grape, tomato
Pork belly (Samgyeopsal)	Samgyeopsal
Meats	dumpling, grilled pork, boiled pork, organ meat, beef, dogmeat, chicken, beef soups
Processed meats	ham, sausage
Eggs	egg, quail egg
Fish	Sashimi, mackerel/mackerel pike/sausel, hairtail, eel,croaker/snapper/flatfish, pollack, squid/octopus, anchovy, canned tuna, shellfish (clam)/whelk, oyster, crab/seasoned raw crab, shrimp, fish paste (eomuk)
Seaweeds	dried laver, sea mustard/kelp
Dairy products	milk, yogurt, ice cream, cheese
Sugar-sweetened beverages (SSB)	coffee mix, soft drinks, other kinds of beverages
Beverages w/o sugar	coffee without sugars/cream, tea
Fast foods	pizza/hamburger
Salted fish	salted fish

[1]Food grouping was based on the similarity of nutrients profiles or culinary usage among food items.

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3. Assessment of general and anthropometric characteristics of subjects

All subjects were asked to record their socio-demographic factors including education level, income, and marital status on questionnaire. Lifestyle characteristics such as smoking, exercise, drinking and sleep patterns were determined by questionnaire and interview. Smoking habit was divided into 4 categories; never-smoker, ex-smoker (no smoking for more than one year), current smoker (less than 1 pack per day), and heavy smoker (more than 1 pack per day). The exercise level was classified into 4 groups according to the frequency of exercise per week; none, light (1-2 times per week, more than 30 minutes per each time), moderate (3-5 times per week, more than 30 minutes per each time) and intense (6-7 times per week, more than 30 minutes per each time). The alcohol intake was determined by the amount of alcohol consumed per week. It was calculated based on alcohol unit per type of drinks (Korean food exchange lists for diabetes 3th edition, Korean Diabetes Association, 2010). One alcohol unit is measured as 8 g of pure alcohol. Sleep patterns were divided into 3 categories; without insomnia, insomnia type 1 (less than 4 hours of sleep), insomnia type 2 (more than 4 hours of sleep with symptoms of insomnia).

Height and body weight were measured using height-weight auto-measuring instrument (Dong Sahn Jenix Co., Korea). Body mass index

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(BMI) was calculated from the height and body weight. Waist circumference was measured at a point located between the iliac crest and the lowest rib. Obesity was defined by the criteria of Korean Society for the Study of Obesity; underweight < 18.5 kg/m^2, normal weight 18.5 – 22.9 kg/m^2, overweight 23.0 – 24.9 kg/m^2, obesity ≥ 25.0 kg/m^2. Central obesity was also defined according to the criteria of Korean Society for the Study of Obesity; waist circumference ≥ 90 cm in men, ≥ 85 cm in women. Blood pressure was measured using an automatic blood pressure monitor (Jawon Medical, Korea) after subjects rested for more than 10 minutes.

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4. Statistical analysis

All statistical analyses were performed with SPSS software (version 20.0; SPSS Inc., Chicago, IL) and significance was set at $P< 0.05$.

Categorical variables such as socio-demographic and lifestyle characteristics were tested by Chi-square test to examine the difference between ACS and normal groups. A student *t* test was used to test differences in anthropometric and dietary intakes between the two groups. A Mann-Whitney U test was used for variables that were not normally distributed. Pearson correlations were used to determine associations between dietary intakes assessed by FFQs and 2-day 24-hour recalls.

To examine the associations of obesity/central obesity and consumption level of each food group with the risk of ACS, multivariate logistic regression analysis adjusted for age and sex was used.

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III. RESULTS

1. General characteristics of subjects

The socio-demographic characteristics of subjects are shown in **Table 3**. The mean age of the ACS group was 53.3 ± 1.1 years and that of normal group was 49.0 ± 0.8 years (P < 0.01). The proportion of males in the subject groups was 79.1% in the ACS group and 63.5% in the normal group (P < 0.05). The distribution of income level was different between the ACS group and normal group (P< 0.01). The ACS patients were more likely to live in a low income household than normal subjects did. As for marital status, the percentage of married subjects was higher in the normal group than in the ACS group (P < 0.01).

The lifestyle characteristics of subjects are shown in **Table 4**. More ACS patients were smokers and ACS group had significantly higher percentage (35.2% and 14.3%, respectively) of heavy smokers (P< 0.01) than normal group. Compared with normal subjects, more ACS patients had sedentary lifestyle (64.8% and 44.4%, respectively; P < 0.01). However, the amount of alcohol consumption and sleep pattern distribution did not differ between the ACS group and normal group.

As for traditional risk factors, 24.2% of ACS patients had hypertension, 19.8% had diabetes, and 20% had dyslipidemia (13.2% were hypertriglyercidemic and 9.9% were hypercholesterolemic).

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Table 3. Socio-demographic characteristics of subjects

characteristics	ACS (n = 91)	Normal (n = 63)	*P* - value
Sex[1]			< 0.05
Men [n (%)]	72 (79.1)[2]	40 (63.5)	
Women [n (%)]	19 (20.9)	23 (36.5)	
Age (year)[1,3]	53.3± 10.2[4]	49.0 ± 6.5	< 0.01
≤ 30s	6 (6.6)	6 (9.5)	< 0.01
40s	23 (25.3)	27 (42.9)	
50s	39 (42.9)	28 (44.4)	
≥ 60s	23 (25.3)	2 (3.2)	
Education[1]			0.07
≤ Elementary	6 (6.6)	0 (0)	
Middle	16 (17.6)	4 (6.3)	
High	27 (29.7)	19 (30.2)	
Undergraduate	29 (31.9)	26 (41.3)	
≥ Graduate	5 (5.5)	6 (9.5)	
No response	8 (8.8)	8 (12.7)	
Income (10,000 won/month)			< 0.01
< 200	26 (28.6)	3 (4.8)	
< 300	17 (18.7)	1 (1.6)	
< 400	14 (15.4)	10 (15.9)	
< 500	9 (9.9)	7 (11.1)	
< 700	6 (6.6)	11 (17.5)	
< 1000	5 (5.5)	14 (22.2)	
≥ 1000	4 (4.4)	9 (14.3)	
No response	10 (11.0)	8 (12.7)	
Marriage			< 0.01
Married	62 (68.1)	55 (87.3)	
Separated	14 (15.4)	1 (1.6)	
Never-married	6 (6.6)	1 (1.6)	
No response	9 (9.9)	6 (9.5)	

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[1]Chi-square test was used to determine the significant difference between two groups.

[2]Percentage of subjects in each group. Percentages may not add up to 100% due to rounding.

[3]Independent *t* test was used to determine the significant difference between two groups.

[4]Data are reported as mean ± SD.

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Table 4. Lifestyle characteristics of subjects

characteristics	ACS (n = 91)	Normal (n = 63)	*P* - value
Smoking[1]			< 0.01
Never-smoker	21 (23.1)[2]	26 (41.3)	
Ex-smoker	24 (26.4)	11 (17.5)	
Current smoker	13 (14.3)	7 (11.1)	
Heavy smoker	32 (35.2)	9 (14.3)	
No response	1 (1.1)	10 (15.9)	
Exercise			< 0.01
No exercise	59 (64.8)	28 (44.4)	
Light	17 (18.7)	9 (14.3)	
Moderate	11 (12.1)	18 (28.6)	
Intense	4 (4.4)	8 (12.7)	
Alcohol drinking (g/wk)[3]	144.8 ± 220.7[4]	109.3 ± 160.4	0.28
Sleep patterns[1]			0.30
No insomnia	63 (69.2)[2]	50 (79.4)	
Insomnia 1	2 (2.2)	0 (0)	
Insomnia 2	26 (28.6)	13 (20.6)	

[1]Chi-square test was used to determine the significant difference between two groups.

[2]Percentage of subjects in each group. Percentages may not add up to 100% due to rounding.

[3]Independent *t* test was used to determine the significant difference between two groups.

[4]Data are reported as mean ± SD.

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2. Anthropometric characteristics of subjects

The anthropometric and clinical characteristics of subjects are presented in **Table 5**. The mean heights of the ACS and normal groups were similar for both men and women. Weight and BMI were also similar between the two groups for both men and women. For men, waist circumference was significantly larger in the ACS group ($P < 0.01$). For women, ACS group tended to have greater waist circumference ($P = 0.095$).

Central obesity determined by waist circumference had the odds ratio of 2.930 for developing ACS (95% CI 2.263 to 6.793). While there was no relation between obesity determined by BMI and ACS, we observed an association between central obesity and the incidence of ACS (**Table 6**).

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Table 5. Anthropometric characteristics of subjects

characteristics	ACS (n = 91)	Normal (n = 63)	*P* - value
Height (cm)			
Men	169.6 ± 5.3	170.8 ± 6.0	0.30
Women	157.7 ± 4.3	157.4 ± 4.8	0.84
Weight (kg)			
Men	70.9 ± 11.0	69.6 ± 12.6	0.57
Women	61.9 ± 9.4	58.4 ± 10.2	0.26
BMI (kg/m^2)			
Men	24.6 ± 3.4	23.7 ± 3.0	0.17
Women	24.8 ± 3.7	23.5 ± 3.8	0.28
Waist circumference (cm)			
Men	88.2 ± 8.3	83.1 ± 8.1	< 0.01
Women	82.9 ± 10.6	77.8 ± 8.8	0.10

Data are presented as means ± SD.

ALT, Alanine transferase; AST, Aspartate transaminase ; BP, blood pressure; CK, Creatine kinase; CK-MB, Creatine kinase-MB; CRP, C-reactive protein; LDL:HDL cholesterol, ratio of LDL to HDL cholesterols; Total:HDL cholesterol, ratio of total to HDL cholesterols

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Table 6. Odds ratios for ACS according to categories of obesity and central obesity[1]

Obesity	N			risk of ACS	*P* -value
	total	ACS	Normal	OR (95% CI)	
Obesity[2]					0.16
under- / normal weight	59	31	28	1	
overweight	40	24	16	1.096 (0.460 – 2.607)	
obesity	55	36	19	1.787 (0.806 – 3.960)	
Central obesity[3]					< 0.05
normal	114	61	53	1	
central obesity	40	30	10	2.930 (1.263 – 6.793)	

[1]The model includes the categories of obesity and central obesity as independent variables. Adjusted for age and sex.

[2]Obesity by the criteria of Korean Society for the Study of Obesity (underweight < 18.5 kg/m^2, normal weight 18.5 – 22.9 kg/m^2, overweight 23.0 – 24.9 kg/m^2, obesity ≥ 25.0 kg/m^2)

[3]Central obesity by the criteria of Korean Society for the Study of Obesity (waist circumference ≥ 90 cm in men, ≥ 85 cm in women)

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3. Comparison of nutrient intakes of ACS and normal groups

3.1 Comparison of nutrient intakes of ACS and normal groups assessed with a FFQ

Overall, among female subjects, no significant difference in nutrient intake between the ACS and normal group was found from the assessment using FFQ. However, differences in the several nutrient intakes were found between two groups among male subjects.

Energy, macronutrients, cholesterol, and fatty acids intakes assessed by the FFQ are shown in **Table 7**. ACS group had significantly higher carbohydrates and protein intakes than the normal group. Energy intake was significantly higher in the ACS group as well. Intakes of cholesterol, monounsaturated and polyunsaturated fatty acids were also significantly higher in the ACS group than normal group. Fiber intake was not significantly different between two groups, but tended to be higher in the ACS group than normal group.

Dietary intakes of minerals and vitamins estimated by FFQ are presented in **Table 8**. The ACS patients consumed significantly more phosphorus, sodium, iron, and selenium compared with normal subjects. Subjects of both groups consumed excessive amount of phosphorus and sodium according to Dietary Reference Intakes for Koreans (KDRIs).

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Vitamin E, vitamin K, vitamin B_6, vitamin B_{12} and niacin intakes were significantly higher in the ACS group than normal group. Intakes of vitamin D and folate tended to be different between two groups, with higher intakes of ACS group.

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Table 7. Comparison of energy, macronutrients, cholesterol, and fatty acid intakes assessed with a FFQ

nutrients	ACS (n = 91)	Normal (n = 61)	*P* - value
Subjects			
Men [n (%)]	72 (79.1)	38 (62.3)	
Women [n (%)]	19 (20.9)	23 (37.7)	
Energy (kcal)			
Men	2083.48 ± 523.48	1847.34 ± 565.07	< 0.05
Women	1997.97 ± 451.18	1866.75 ± 562.68	0.42
Carbohydrate (g)			
Men	373.90 ± 92.34	333.62 ± 101.34	< 0.05
Women	371.42 ± 82.96	339.34 ± 110.07	0.30
Fat (g)			
Men	39.29 ± 17.30	34.81 ± 16.63	0.19
Women	31.64 ± 22.06	33.15 ± 14.94	0.31
plant fat (g)			
Men	17.88 ± 8.66	14.64 ± 8.20	< 0.05
Women	13.62 ± 5.74	14.82 ± 5.73	0.22
animal fat (g)			
Men	21.41 ± 12.20	20.18 ± 11.50	0.61
Women	18.03 ± 19.18	18.34 ± 11.70	0.26
Protein (g)			
Men	77.93 ± 24.38	66.80 ± 22.72	< 0.05
Women	73.88 ± 24.88	70.55 ± 24.72	0.67
plant protein (g)			
Men	45.67 ± 12.75	39.59 ± 13.35	< 0.05
Women	44.11 ± 10.20	42.92 ± 12.43	0.74

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animal protein (g)			
Men	32.26 ± 18.08	27.21 ± 14.82	0.14
Women	29.78 ± 21.50	27.62 ± 16.72	0.72
Fiber (g)			
Men	19.28 ± 6.36	17.33 ± 7.85	0.06
Women	21.86 ± 5.01	22.21 ± 10.35	0.90
Cholesterol (mg)			
Men	250.05 ± 128.87	200.20 ± 140.45	< 0.05
Women	206.36 ± 128.23	215.98 ± 142.45	0.75
Total FA (g)			
Men	21.86 ± 11.00	18.98 ± 9.16	0.25
Women	17.65 ± 15.51	17.52 ± 8.05	0.40
SFA (g)			
Men	9.88 ± 5.19	8.26 ± 4.24	0.16
Women	8.50 ± 6.74	8.71 ± 5.46	0.68
MUFA (g)			
Men	10.48 ± 5.73	8.42 ± 3.98	< 0.05
Women	9.24 ± 7.76	10.00 ± 6.62	0.55
PUFA (g)			
Men	5.41 ± 2.85	3.94 ± 1.45	< 0.05
Women	4.39 ± 2.87	4.57 ± 2.31	0.52

Data are presented as means ± SD.

FA, fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; SFA, saturated fatty acids

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Table 8. Comparison of minerals and vitamins intakes assessed with a FFQ

nutrients	ACS (n = 91)	Normal (n = 61)	*P* - value
Subjects			
Men [n (%)]	72 (79.1)	38 (62.3)	
Women [n (%)]	19 (20.9)	23 (37.7)	
Calcium (mg)			
Men	465.67 ± 193.99	419.15 ± 227.59	0.16
Women	489.10 ± 135.31	462.17 ± 211.81	0.64
plant calcium (mg)			
Men	265.21 ± 115.83	244.70 ± 120.78	0.24
Women	286.52 ± 86.36	308.34 ± 150.74	0.58
animal calcium (mg)			
Men	200.46 ± 133.34	174.45 ± 172.31	0.12
Women	202.58 ± 107.89	153.83 ± 106.62	0.15
Phosphorus (mg)			
Men	1061.14 ± 326.92	898.12 ± 337.56	< 0.05
Women	1098.53 ± 277.80	1007.97 ± 351.75	0.37
Sodium (mg)			
Men	3001.19 ± 1269.48	2573.62 ± 1550.32	< 0.05
Women	2645.25 ± 1229.45	2510.36 ± 1138.78	0.71
Iron (mg)			
Men	13.58 ± 4.72	11.93 ± 4.44	< 0.05
Women	15.41 ± 3.41	14.62 ± 5.71	0.58
plant iron (mg)			
Men	10.51 ± 3.79	9.54 ± 3.78	0.13
Women	12.38 ± 3.02	12.03 ± 4.69	0.78

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animal iron (mg)			
Men	3.07 ± 1.64	2.40 ± 1.43	< 0.05
Women	3.03 ± 1.86	2.59 ± 1.56	0.40
Selenium (μg)			
Men	117.67 ± 33.66	95.91 ± 32.01	< 0.01
Women	106.29 ± 35.54	97.78 ± 32.16	0.42
Vitamin A (μg/RE)			
Men	547.48 ± 263.87	550.72 ± 321.01	0.93
Women	645.51 ± 285.44	694.80 ± 423.62	0.97
Vitamin D (μg)			
Men	4.42 ± 3.77	3.07 ± 2.01	0.05
Women	4.00 ± 2.55	2.67 ± 1.44	0.05
Vitamin E (mg)			
Men	9.53 ± 3.93	7.79 ± 3.26	< 0.05
Women	8.93 ± 2.61	8.93 ± 3.09	1.00
Vitamin K (μg)			
Men	177.77 ± 137.47	143.44 ± 110.15	< 0.05
Women	205.10 ± 91.57	225.80 ± 185.63	0.87
Vitamin C (mg)			
Men	79.75 ± 43.75	79.46 ± 48.73	0.89
Women	106.46 ± 36.36	115.71 ± 72.04	0.81
Niacin (mg)			
Men	16.91 ± 5.72	14.55 ± 4.95	< 0.05
Women	16.71 ± 6.05	16.32 ± 6.63	0.84
Vitamin B_6 (mg)			
Men	1.60 ± 0.44	1.43 ± 0.52	< 0.05
Women	1.70 ± 0.42	1.64 ± 0.61	0.72

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Folate (μg)			
Men	480.87 ± 166.99	422.53 ± 192.41	0.05
Women	532.88 ± 137.12	530.45 ± 205.12	0.97
Vitamin B_{12} (μg)			
Men	7.56 ± 4.15	5.40 ± 3.23	< 0.01
Women	8.00 ± 5.09	5.91 ± 3.38	0.14

Data are presented as means ± SD.

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3.2 Comparison of nutrient intakes of ACS and normal groups assessed with a 2-day 24-hour recall.

Overall, among female subjects, there was no significant difference in nutrient intake between the ACS group and normal group. However, among male subjects, differences in the several nutrient intakes were found between two groups.

Energy, macronutrients, cholesterol, and fatty acids estimated with 2-day 24-hour recall are shown in **Table 9**. Although energy intake was not different between the ACS and normal groups, carbohydrate intake tended to be higher in the ACS group than normal group. While intakes of fat and protein from plant sources, and fiber were significantly higher in the ACS group, animal fat intake was significantly higher in the normal group.

Dietary intakes of minerals and vitamins assessed by 2-day 24-hour recall are shown in **Table 10**. The ACS patients showed significantly higher intakes of calcium from plant source, vitamin E, vitamin K, vitamin B_{12}, and folate than normal subject. Sodium intake was also significantly higher in the ACS group than normal group. The levels of sodium intake in both groups were higher than the level recommended in KDRIs.

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Table 9. Comparison of energy, macronutrients, cholesterol, and fatty acid intakes assessed with a 2-day 24-hour recall

nutrients	ACS (n = 91)	Normal (n = 63)	*P* - value
Subjects			
Men [n (%)]	72 (79.1)	40 (63.5)	
Women [n (%)]	19 (20.9)	23 (36.5)	
Energy (kcal)			
Men	1734.28 ± 349.81	1714.91 ± 290.82	0.77
Women	1524.38 ± 177.10	1530.55 ± 309.97	0.94
Carbohydrate (g)			
Men	265.50 ± 50.71	246.88 ± 54.03	0.07
Women	244.50 ± 40.41	236.06 ± 54.48	0.58
Fat (g)			
Men	43.14 ± 18.05	47.71 ± 17.77	0.21
Women	34.90 ± 13.37	40.59 ± 14.64	0.20
plant fat (g)			
Men	23.54 ± 11.79	18.54 ± 9.37	< 0.05
Women	19.88 ± 8.55	23.64 ± 12.87	0.36
animal fat (g)			
Men	19.60 ± 13.26	29.17 ± 17.24	< 0.01
Women	15.02 ± 10.12	16.95 ± 9.27	0.53
Protein (g)			
Men	76.80 ± 21.54	76.22 ± 18.25	0.93
Women	67.73 ± 20.13	63.60 ± 14.61	0.45
plant protein (g)			
Men	37.28 ± 9.30	33.22 ± 9.75	< 0.05
Women	33.90 ± 6.38	33.94 ± 9.02	0.92

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animal protein (g)			
Men	39.52 ± 20.13	43.00 ± 18.84	0.37
Women	34.02 ± 19.18	29.66 ± 13.61	0.43
Fiber (g)			
Men	23.48 ± 6.74	20.31 ± 6.47	< 0.05
Women	24.94 ± 6.11	23.26 ± 7.24	0.43
Cholesterol (mg)			
Men	330.57 ± 183.55	304.47 ± 121.01	0.80
Women	282.07 ± 190.13	269.98 ± 151.16	0.82
Total FA (g)			
Men	24.44 ± 14.10	28.39 ± 22.62	0.65
Women	24.47 ± 18.23	21.62 ± 12.91	0.56
SFA (g)			
Men	8.61 ± 8.88	10.05 ± 9.26	0.18
Women	6.83 ± 5.92	6.60 ± 4.61	0.89
MUFA (g)			
Men	12.52 ± 11.90	12.30 ± 10.55	0.81
Women	9.68 ± 8.37	8.58 ± 6.24	0.63
PUFA (g)			
Men	10.09 ± 6.21	7.65 ± 4.22	0.05
Women	7.97 ± 5.29	7.85 ± 4.58	0.94

Data are presented as means ± SD.

FA, fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; SFA, saturated fatty acids

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Table 10. Comparison of minerals and vitamins intakes assessed with a 2-day 24-hour recall

nutrients	ACS (n = 91)	Normal (n = 63)	*P* - value
Subjects			
Men [n (%)]	72 (79.1)	40 (63.5)	
Women [n (%)]	19 (20.9)	23 (36.5)	
Calcium (mg)			
Men	563.24 ± 270.04	468.19 ± 151.57	0.10
Women	660.84 ± 626.24	458.82 ± 157.62	0.44
plant calcium (mg)			
Men	330.75 ± 122.98	262.63 ± 79.78	< 0.01
Women	322.48 ± 143.52	283.83 ± 113.48	0.34
animal calcium (mg)			
Men	232.49 ± 232.79	205.56 ± 135.30	0.92
Women	338.36 ± 572.98	174.99 ± 114.78	0.85
Phosphorus (mg)			
Men	1158.79 ± 309.01	1086.87 ± 250.89	0.21
Women	1133.63 ± 353.27	978.09 ± 236.18	0.18
Sodium (mg)			
Men	4889.98 ± 1369.45	4416.38 ± 1444.29	< 0.05
Women	4923.60 ± 1996.86	3993.98 ± 1375.40	0.08
Iron (mg)			
Men	17.33 ± 5.82	17.88 ± 13.06	0.29
Women	16.94 ± 8.52	14.09 ± 3.46	0.18
plant iron (mg)			
Men	11.95 ± 3.79	12.86 ± 13.03	0.21
Women	11.76 ± 3.98	10.32 ± 3.49	0.22

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animal iron (mg)			
Men	5.38 ± 4.45	5.02 ± 3.13	0.81
Women	5.17 ± 6.10	3.77 ± 1.79	0.60
Selenium (μg)			
Men	102.78 ± 39.66	94.20 ± 30.02	0.39
Women	90.74 ± 41.37	83.04 ± 29.47	0.49
Vitamin A (μg/RE)			
Men	875.56 ± 346.65	963.50 ± 548.71	0.79
Women	1027.78 ± 565.20	1117.76 ± 710.58	0.93
Vitamin D (μg)			
Men	3.85 ± 4.95	3.44 ± 4.43	0.60
Women	3.99 ± 4.96	2.33 ± 2.15	0.95
Vitamin E (mg)			
Men	16.67 ± 5.77	12.99 ± 5.01	< 0.01
Women	15.21 ± 4.56	15.52 ± 5.17	0.99
Vitamin K (μg)			
Men	272.64 ± 148.55	208.51 ± 114.83	< 0.05
Women	343.22 ± 336.34	275.32 ± 246.98	0.26
Vitamin C (mg)			
Men	107.31 ± 46.34	102.71 ± 75.24	0.24
Women	130.19 ± 55.72	119.52 ± 62.63	0.41
Niacin (mg)			
Men	17.42 ± 6.43	16.60 ± 4.79	0.78
Women	16.98 ± 6.45	13.68 ± 3.20	0.07
Vitamin B_6 (mg)			
Men	1.90 ± 0.64	1.70 ± 0.55	0.12
Women	1.73 ± 0.32	1.64 ± 0.49	0.48

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Folate (μg)			
Men	540.26 ± 151.22	473.63 ± 144.70	< 0.05
Women	558.96 ± 188.60	466.03 ± 134.36	0.07
Vitamin B_{12} (μg)			
Men	11.72 ± 8.66	7.52 ± 4.53	< 0.05
Women	13.06 ± 12.74	6.98 ± 4.20	0.13

Data are presented as means ± SD.

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3.3 Correlations between nutrient intakes assessed by FFQ and 2-day 24-hour recall

The correlation between the FFQ and 24-hour recall is presented in **Table 11**. The FFQ and 2-day 24-hour recall showed weak correlations for all nutrients with correlation coefficients ranged from 0.163 to 0.364.

Correlations between the dietary intakes were found in fiber, calcium from plant source, and vitamin C ($r > 0.3$). However, in the intakes of the other nutrients, correlations were relatively low. Specifically, correlations between intakes of carbohydrate, cholesterol, total fatty acids, saturated fatty acid and monosaturated fatty acid were much lower, with the coefficients around 0.1.

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Table 11. Correlation between FFQ and 24-hour recall[1]

	Correlation coefficient	*P* - value
Energy	r = 0.182	p < 0.05
Carbohydrate	r = 0.039	p = 0.64
Fat	r = 0.232	p < 0.01
plant fat	r = 0.225	p < 0.01
animal fat	r = 0.178	p < 0.05
Protein	r = 0.193	p < 0.05
plant protein	r = 0.284	p < 0.01
animal protein	r = 0.236	p < 0.01
Fiber	r = 0.334	p < 0.01
Cholesterol	r = 0.128	p = 0.12
Total fatty acids	r = 0.070	p = 0.39
Saturated fatty acids	r = 0.101	p = 0.22
Monounsaturated fatty acids	r = 0.135	p = 0.10
Polyunsaturated fatty acids	r = 0.281	p < 0.01
Calcium	r = 0.137	p = 0.09
plant calcium	r = 0.320	p < 0.01
animal calcium	r = 0.157	p = 0.05
Phosphorus	r = 0.163	p < 0.05
Sodium	r = 0.237	p < 0.01
Iron	r = 0.087	p = 0.29
plant iron	r = 0.110	p = 0.18
animal iron	r = 0.214	p < 0.01
Selenium	r = 0.059	p = 0.47
Vitamin A	r = 0.226	p < 0.01
Vitamin D	r = 0.226	p < 0.01

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Vitamin E	r = 0.153	p = 0.06
Vitamin K	r = 0.256	$p < 0.01$
Vitamin C	r = 0.364	$p < 0.01$
Niacin	r = 0.274	$p < 0.01$
Vitamin B_6	r = 0.203	$p < 0.05$
Folate	r = 0.229	$p < 0.01$
Vitamin B_{12}	r = 0.234	$p < 0.01$

[1]Correlation was determined by a Pearson correlation.

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4. Comparison of food intakes of ACS and normal groups

Comparison of food intakes of ACS and normal groups

To investigate the difference in food intakes between the ACS and normal groups, we calculated the total amounts of daily intake for each food group (**Table 12**). Overall, ACS patients consumed significantly more amount of rice/rice cakes/grains, sweets, and fish groups and tended to consume more potatoes/sweet potatoes/starches. However, in women, the intensity of significance of differences in food intakes for those food groups was weakened. Only in the fish group, ACS group had significantly higher intake compared to the normal group.

We compared the food intakes of ACS and normal groups at the serving size level based on the serving size of each food item according to the database from FFQ. Because each food group includes several food items with different average weights, analyses of food consumption considering serving size were also required. The mean servings of each food group consumed per day are presented in **Table 13**. Overall, the significant differences between ACS and normal groups were found in rice/rice cakes/grains, sweets, SSB and fish groups. Intake of potatoes/sweet potatoes/-starches tended to be different. In men, in sweets and fish groups, ACS patients showed significantly higher intakes than normal subjects. Also,

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Table 12. Comparison of the total amount (g) of each food group intake per day

food groups	ACS (n = 91)	Normal (n = 61)	*P* - value
Subjects			
Men [n (%)]	72 (79.1)	38 (62.3)	
Women [n (%)]	19 (20.9)	23 (37.7)	
Rice, rice cakes and grains			
Men	616.75 ± 172.21	533.32 ± 180.06	< 0.05
Women	557.47 ± 170.58	473.34 ± 207.39	0.17
Potatoes, sweet potatoes and starches			
Men	22.38 ± 23.30	15.17 ± 17.21	0.10
Women	48.96 ± 58.92	26.80 ± 24.07	0.14
Sweets			
Men	23.83 ± 16.91	9.47 ± 12.09	< 0.01
Women	11.47 ± 11.41	6.38 ± 5.60	0.09
Sugar-sweetened beverages			
Men	53.03 ± 93.62	117.82 ± 331.90	0.25
Women	47.55 ± 73.84	48.81 ± 66.80	0.95
Vegetables			
Men	111.18 ± 101.76	85.80 ± 76.79	0.18
Women	125.72 ± 67.15	180.91 ± 139.53	0.12
Fruits			
Men	161.49 ± 174.04	219.61 ± 288.15	0.19
Women	267.77 ± 240.59	298.24 ± 314.09	0.73
Fish			
Men	61.61 ± 49.32	36.26 ± 20.64	< 0.01
Women	72.37 ± 47.55	45.52 ± 30.07	< 0.05

Data are presented as means ± SD.

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Table 13. Mean servings consumed per day of each food group[1]

food groups	ACS (n = 91)	Normal (n = 61)	*P*-value
Subjects			
Men [n (%)]	72 (79.1)	38 (62.3)	
Women [n (%)]	19 (20.9)	23 (37.7)	
Rice/rice cake/grains	2.85 ± 0.82	2.47 ± 0.96	< 0.05
Men	2.90 ± 0.83	2.59 ± 0.92	0.07
Women	2.65 ± 0.80	2.27 ± 1.01	< 0.05
Potatoes/sweet potatoes/starches	0.56 ± 0.73	0.42 ± 0.45	0.20
Men	0.46 ± 0.49	0.34 ± 0.42	0.21
Women	0.92 ± 1.23	0.55 ± 0.48	0.19
Sweets	4.63 ± 3.70	1.75 ± 2.28	< 0.01
Men	5.21 ± 3.76	1.99 ± 2.67	< 0.01
Women	2.43 ± 2.56	1.34 ± 2.12	0.11
Sugar-sweetened beverages	3.09 ± 2.48	2.07 ± 2.48	< 0.05
Men	3.44 ± 2.57	2.43 ± 2.95	0.07
Women	1.78 ± 1.59	1.49 ± 1.28	0.52
Vegetables	3.25 ± 2.33	3.44 ± 3.01	0.66
Men	3.11 ± 2.38	2.47 ± 2.22	0.17
Women	3.77 ± 2.12	5.04 ± 3.48	0.17
Fruits	1.32 ± 1.32	1.69 ± 1.89	0.16
Men	1.18 ± 1.24	1.45 ± 1.68	0.35
Women	1.84 ± 1.53	2.09 ± 2.16	0.68
Fish	1.82 ± 1.32	1.13 ± 0.73	< 0.01
Men	1.69 ± 1.19	1.02 ± 0.66	< 0.01
Women	2.28 ± 1.70	1.32 ± 0.81	< 0.05

Data are presented as means ± SD.

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[1]the numbers of servings of each food group consumed per day were calculated based on the serving size of each item according to the database from FFQ.

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in SSB group, ACS patients tended to have higher intake compared to the normal subjects. In women, ACS group had higher level of food consumption in rice/rice cakes/grains and fish group compared to the normal group.

Associations between food intake levels and risk of ACS

After adjusted for age, sex and total energy intake, we investigated the association between daily servings of each food group consumed and the incidence of ACS (**Table 14**). The incidence of ACS was higher with higher intakes of sweets and fish (OR 1.355, 95% CI 1.168 - 1.570 and OR 1.848, 95% CI 1.201 – 2.844). As for the servings of fruits consumed per day, there was a tendency of negative relation with the risk of ACS (OR 0.794, 95% CI 0.629 - 1.003). The consumption level of SSB calculated by servings consumed per day also tended to have a negative association with ACS (OR 1.163, 95% CI 0.978 – 1.384).

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Table 14. Odds ratios for ACS according to the servings consumed per day of each food group[1]

food groups	risk of ACS		*P* - value
	OR	95% CI	
Rice/rice cake/grains	1.133	0.708 - 1.813	0.60
Potatoes/sweet potatoes/starches	1.433	0.691 – 2.973	0.33
Sweets	1.355	1.168 – 1.570	< 0.01
Sugar-sweetened beverage	1.163	0.978 – 1.384	0.09
Vegetables	0.952	0.814 – 1.113	0.54
Fruits	0.794	0.629 – 1.003	0.05
Fish	1.848	1.201 – 2.844	< 0.01

[1]The model includes the mean servings of each food group as independent variables. Adjusted for age, sex, and energy intake.

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IV. Discussion

In this study, we examined the difference in nutrient and food intakes between ACS patients and normal people using FFQ and 24-hour recall, and associations of food consumption with the risk of developing ACS.

In men, waist circumference was significantly higher in the ACS group than normal group (P < 0.01), but, BMI was not significantly different between two groups. Central obesity defined by waist circumference was closely associated with the risk of ACS (P < 0.05), while obesity defined by BMI showed no relation with the risk of ACS (P for trend = 0.162). The APCS collaboration's study showed that waist circumference was more important predictor of CHD risk than BMI in Asia-Pacific populations (Collaboration, 2006) as well as European and North American populations (Rexrode et al., 1998). Another study also reported that waist-to-hip ratio and waist circumference had closer associations with MI risk worldwide even after an adjustment for other risk factors compared to BMI (Salim Yusuf et al., 2005). In the study conducted with Korean adults, it was also reported that an increase in waist circumference was accompanied by an increase in the number of cardiovascular risk factors (Park, 2001). Waist circumference can be more meaningful and simply measured risk factor for CHD, considering abdominal adiposity is linked to metabolic abnormalities

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such as hypertension, glucose intolerance, and diabetes mellitus (Rexrode et al., 1998).

An analysis of nutrient intake determined by FFQ showed that, in men, the ACS group consumed more carbohydrate and protein than the normal group resulting in a higher intake of total energy. Although studies with ACS patients are limited, previous studies with CHD patients also showed that CHD patients had higher carbohydrate intake compared to normal people (Zyriax et al., 2005). However, there have been contradictory results regarding the association between carbohydrate intake and CHD risk. A case-control study in Greece showed that a quintile-increase of carbohydrate intake lowered risk of CHD by 19% (Tzonou et al., 1993). On the other hand, in a prospective study with 75,521 women, total carbohydrate intake appeared to have a positive, but not significant association with CHD risk (Liu et al., 2000). The Nurses' Health Study results indicated that total carbohydrate intake was related with an increased risk of CHD (Halton et al., 2006). These conflicting results might be attributed to the fact that dietary intake of carbohydrate has an influence on the development of CHD through indirect mechanisms: contribution to total energy intake, obesity (abdominal obesity), and plasma lipid profiles (Reddy & Katan, 2004). Several studies have identified the effect of carbohydrate intake on HDL-cholesterol (Merchant et al., 2007; Siri-Tarino, 2011; Tucker, 2004), showing that

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decreased carbohydrate intake led to a decrease in the TC:HDL ratio (Siri-Tarino, 2011). The effect of a high-carbohydrate diet on HDL-cholesterol seems to be closely related to the development of CHD considering its influence on vascular function. Regarding cholesterol intake in this study, a significantly higher intake of ACS group was observed only in men. Many prospective studies since 1981 have shown the association between dietary cholesterol intake and CHD risk.

Results of dietary minerals and vitamins intakes determined by FFQ showed that phosphorus, sodium, and iron, especially animal-source iron intakes were higher in ACS group in men. The effects of high phosphorus, sodium, or heme iron intakes on CHD risk have been studied in the context of associations between processed meats and CHD. A harmful effect of high contents of sodium and phosphorus (rather than total or saturated fat content) in processed meats on CHD risk was reported (Micha et al., 2012). Heme iron from meats but not total dietary iron was found to have an association with elevated MI risk (Ascherio et al., 1994).

Nutrients intake assessed by 2-day 24-hour recall showed different appearance from dietary intake results assessed by FFQ. Significant differences in intakes of energy, carbohydrate, protein, and cholesterol were not found between the ACS and normal groups. Rather, in men, intake of animal fat was significantly lower in ACS group, and fiber intake was

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higher in ACS group. Also, intakes of calcium from plant source, vitamin E, vitamin K, vitamin B_{12}, and folate were higher in male of ACS subjects than normal male subjects. The tendency of higher calcium from plant source, vitamin K, and folate intakes in ACS group seemed to due to higher vegetables consumption of ACS group. This was contradictory to the dietary intake results from FFQ which indicated higher consumption of animal-source foods in ACS group. Plant-source nutrients such as fiber (Bazzano et al., 2003; Wolk et al., 1999) and folate (Tavani et al., 2004; Voutilainen et al., 2001) have been demonstrated to have inverse associations with risk of CHD or ACS. The unexpected findings from 24-hour recall in this study might result from self-directed changes in diet by ACS patients, because 24-hour recall was performed after the patients were diagnosed with ACS. The gap between the development of disease and assessments is a typical limitation of a case-control study (Yano et al., 1978). On the other hand, dietary intake assessed by FFQ might have been less influenced by the diagnosis of the ACS because subjects were asked to record their food consumption during the past one year. The possibility that ACS patients might have corrected their diets was also shown by the relatively low correlation ($r = 0.163 \sim 0.364$) between dietary intakes estimated by FFQ and 24-hour recall in this study compared with other studies (Jeon et al., 2011).

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We also analyzed the dietary intake by food group because food consumption pattern shows our daily meals more directly than nutrient intake pattern. Among overall food groups, consumption of sweets showed the most clear association with the risk of ACS (OR = 1.355, $P < 0.01$). ACS group consumed significantly higher amount of and more servings of sweets than the normal group. Our findings can be partly explained by the deteriorative effect of sugar on CVD which was the main food item included in the sweets group. Many short-term studies have indicated that sugar have an influence on CVD risk by increasing serum triglyceride level and decreasing serum HDL-cholesterol (Katan et al., 1997; Parks & Hellerstein, 2000). Although trials which linked sugars and CVD (or ACS) were rare, a recent report from the American Heart Association concluded that consumption of sugars should be limited because of its dose-dependent effect on serum triglyceride level (Howard & Wylie-Rosett, 2002).

A tendency for a positive association between SSB intake and ACS risk was found in the present study (OR = 1.163, $P = 0.09$). Although studies which investigated the direct association between SSB and ACS are limited, many epidemiological studies have shown associations of SSB intake with risk factors of CVD and CHD. It was reported that SSB intake, especially soft drink intake, had positive associations with weight gain (Schulze et al., 2004), insulin resistance (Janssens et al., 1999) and elevated blood pressure

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(Savoca et al., 2004). The findings indicating that SSB intake was associated with elevated risk of CHD were shown in the previous studies performed with US women and men (De Koning et al., 2012; Fung et al., 2009).

In this study, fish consumption showed a positive association with ACS (OR = 1.848, $P < 0.01$), which was contrary to the general belief on its protective role in CHD development. Regarding the association between fish intake and CHD, recent prospective studies have shown relationships between fish consumption and reduced CHD risk although earlier epidemiologic studies had conflicting results. In a meta-analysis of 11 cohort studies, He et al. (He et al., 2004b) found that moderate fish intake (2-4 times/week) was associated with 23% lower risk of CHD mortality (OR = 0.77, 95% CI 0.66 - 0.89) compared to low intake (never or < once/month) and higher intake (> 5 times/week) led to greater reduction of the risk (RR = 0.62, 95% CI 0.46 - 0.82) compared to low intake. The Zutphen study with 1373 men (Streppel et al., 2008) showed that fatty, but not lean, fish consumption resulted in 54% lower risk of (sudden) cardiac death suggesting that the benefit of fish intake for CHD was due to its n-3 PUFA content. Associations of fish consumption with ACS were also found. The Danish follow-up study with 57,053 middle-aged men and women also reported an inverse association between modest fatty fish intake and ACS,

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showing that the highest quintile had 33% lower risk of ACS compared to the lowest quintile in men (Bjerregaard et al., 2010). In the CARDIO2000 study (D. B. Panagiotakos et al., 2005), a relatively moderate consumption (< 150 g/week) showed 38% lower odds of developing ACS, while higher consumption levels (150–300 g/week and > 300 g/week) were not associated with ACS risk (OR 1.10 and 1.01 respectively, $P > 0.1$) . This result suggested that moderate level of fish consumption rather than high level has a protective association with the risk of ACS. A positive association between fish intake and ACS risk reported in our study, which is contradictory to the results in most of previous epidemiologic studies, can be explained in many ways. First, it might be related the fact there is no additional protection against CHD (or ACS) from eating fish over a certain level. In Marckmann's study (Marckmann & Grønbæk, 1999), a systematic review of prospective cohort studies, the benefit of fish consumption was limited to individuals at high risk of CHD and they benefited from increasing fish intake up to the optimum of 40-60 g per day. Also in the CARDIO2000 study (D. B. Panagiotakos et al., 2005), fish consumption over 150 g per week had no inverse association with ACS. In our study, mean amounts of total fish intake in ACS group were over 60 g per day both in men and women. The normal group also consumed around 30-40 g per day which had the most protective effect on CHD/ACS risk, meaning that

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they have benefited enough from eating fish even with lower consumption level. In addition, the positive association between fish intake and ACS might be influenced by an inclusion of shellfish into fish group in the present study. Inclusion of shellfish when calculating fish consumption has been inconsistent in previous studies which emphasized the benefit of fish intake. Results from the studies which investigated the association between shellfish consumption and risk of CHD are conflicting (e Silva et al., 1996; Matheson et al., 2009; Yuan et al., 2001). It might be caused by high cholesterol content of shellfish different from other kinds of fish.

Fruits but not vegetables consumption showed a tendency of an inverse association with ACS risk in this study (OR = 0.794, $P = 0.05$). This inverse association is in accordance with results from previous studies. In many epidemiological studies (Dauchet et al., 2006; Hansen et al., 2010; Nikolić et al., 2008; Tucker et al., 2005), the protective effects of fruits and vegetables on CVD risk were evident and shown to be dose dependent. A meta-analysis of 9 studies showed that lower risk of CHD was related with each additional portion of fruit or vegetable intake by 4% (RR = 0.96, 95% CI 0.93 - 0.99) and especially by 7% (RR = 0.93, 95% CI 0.89 - 0.96) with additional portion of fruit intake (Dauchet et al., 2006). In Nikolić et al.'s case-control study (Nikolić et al., 2008), the benefit of fruits and vegetable intake for CHD increased proportionally with the number of servings

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consumed. However, less is known about the direct association between fruit or vegetable intakes and ACS risk.

As for rice/rice cake/grains group, the differences in total intake and the number of servings consumed were significant between ACS and normal groups, but an association with the risk of ACS was not observed. It seemed that the significance disappeared because of energy adjustment since higher consumption of rice/rice cake/grains group in ACS patients also led to their higher total energy intake. For the analyses of Korean diet in which most of its calories comes from carbohydrate sources, the independent effect of grains on CHD/ACS risk seemed to be difficult to be identified.

There are some limitations in this study. Although we tried to match the mean age and the sex ratio of the ACS and normal groups, the ACS group was older and had higher proportion of male subjects compared to the normal group. The fact that there was no significant difference in dietary intake between women in two groups could be due to the small number of female subjects in ACS group. However, the higher proportion of male subjects in the ACS group reflects the characteristic of ACS, which has the higher risk of development in the later age and in men. Also, the traditional limitation of a case-control study, the difference in the point in time between the development of disease and the dietary assessment, was inevitable. The

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influence of behavioral changes of ACS patients on dietary intake cannot be ignored.

In conclusion, compared to normal people, the nutrient intake of ACS patients can be characterized by high levels of carbohydrate, protein and cholesterol intakes which resulted in high energy intake. In the minerals and vitamins intakes, ACS patients showed higher intakes of phosphorus, sodium, heme iron contained highly in animal-source foods. Regarding food consumption, ACS patients had higher intakes of rice/rice cakes/grains, sweets, and fish groups compared to normal subjects, and associations between ACS risk and sweets, fish, and fruits groups were observed. Our overall findings suggest that high energy intake accompanied by high carbohydrate intake of ACS patients might have an influence on the development of ACS. At the level of food consumption, higher intakes of sweets and fish, and lower intakes of fruits compared to normal people (after adjusted for total energy intake) might have contributed to increased risk of ACS. In developing ACS, high-energy and high-carbohydrate diet of ACS group might have influenced lipid profile with increased total: HDL-cholesterol ratio and abdominal obesity, one of the main risk factors of CHD and ACS. Differences found in dietary intakes and lack of significant correlations in dietary intakes between FFQ and 24-hour recall data suggested that there might have been self-directed changes in diet of ACS

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patients after the diagnosis of disease.

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국문초록

급성관상동맥증후군 환자와 정상인의 식생활 특성 비교

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소지선

영양이 관상동맥질환의 예방과 치료에 미치는 영향에 관하여서는 단일 영양소, 음식, 그리고 식생활 패턴에 관한 연구들을 통해 그 중요성이 강조되어왔다. 그러나 급성으로 발생하는 급성관상동맥증후군과의 연관성에 대해서는 상대적으로 연구가 충분하지 않고, 한국인의 식이섭취에 대해 수행된 연구는 더욱이 부족한 실정이다. 본 연구에는 91명의 급성관상동맥증후군 환자들과 고혈압, 이상지질혈증, 당뇨 또는 주요 심혈관질환력을 가지지 않는 63명의 정상인이 포함되었다. 이들을 대상으로 사회인구학적 및 생활습관 관련 특성들과 신체계측지수들이 측정되었다. 급성관상동맥증후군 환자와 정상인간의 영양소 섭취 양상을 비교하기 위해 식품섭취빈도조사지와 이틀치의 24시간 회상법으로 식이조사를 수행하였다. 또한 식품섭취빈도조사지의 구성식품들을 각 식품군으로 분류하고 각 식품군에 대한 섭취수준을 조사 분석하여 두 군간에 식품 섭취 양

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상을 비교하고 식품 섭취 수준과 급성관상동맥증후군의 발병 위험간의 연관성을 알아보았다. 급성관상동맥증후군 환자군이 정상군에 비해 연령과 남성의 비율이 유의적으로 높았다. 소득수준은 유의적으로 낮은 쪽에 분포하였고 기혼자의 비율도 유의적으로 낮았다. 흡연자의 비율과 정기적인 운동을 하지 않는 사람의 비율도 환자군이 정상군보다 유의적으로 높았다. 또한, 환자군이 정상군에 비해 유의적으로 높은 허리둘레를 가지고 있었고 허리둘레에 따른 복부비만도와 급성관상동맥증후군 발병 위험간에도 연관성이 나타났다. 영양소 섭취 양상은 식품섭취빈도조사지와 24시간 회상법을 통한 분석에서 모두 여성 피험자들은 환자군과 정상군간에 영양소 섭취수준의 유의적인 차이가 없었으나, 남성 피험자들에서는 두 군간에 차이가 있었다. 식품섭취빈도조사지 분석 결과, 환자군이 정상군에 비해 전반적인 열량, 탄수화물, 단백질의 섭취가 유의적으로 높았다. 콜레스테롤과 불포화지방산의 섭취에 있어서도 환자군이 정상군보다 유의적으로 높았다. 무기질과 비타민 섭취에 있어서는 환자군이 정상군보다 인, 나트륨, 동물성 철, 셀레늄, 비타민 E, K, B_6, B_{12} 및 니아신의 섭취가 유의적으로 높았다. 24시간 회상법 분석 결과에서는 환자군이 정상군보다 동물성 지방의 섭취는 유의적으로 낮은 반면에 식물성 지방, 식물성 단백질, 식이섬유, 식물성 칼슘, 비타민 E, B_{12}, 엽산의 섭취는 유의적으로 높았다. 나트륨 섭취는 여전히 환자군이 정상군보다 유의적으로 높았다. 식품섭취빈도조사지와 이틀치의 24시간 회상법간의 상관관계는 전반적인 영양소들에서 상대적으로 낮게 나타났다 (r = 0.163

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~ 0.364). 식품 섭취 양상은 식품군별 하루 총 섭취량이나 하루 평균 1회 섭취분량 횟수로 비교했을 때 환자군이 정상군에 비해 당류, 어류 및 어류가공품류 그리고 밥/떡/선식류의 섭취가 유의적으로 높았다. 그 중 당류, 어류 및 어류가공품류, 과일류의 섭취는 급성관상동맥증후군 발병 위험과 유의적인 상관관계를 보였으며 당 함유 음료류의 경우에는 경향성을 보였다. 결론적으로, 급성관상동맥증후군 환자는 영양소 수준에서는 총 에너지, 탄수화물, 단백질, 콜레스테롤, 인, 나트륨, 동물성 철의 섭취가 높았고, 식품 수준에서는 당류, 어류 및 어류가공품류, 밥/떡/선식류의 섭취가 높았다. 특히, 당류 및 어류가공품류, 과일류에서는 섭취 수준과 급성관상동맥증후군 발병 위험간의 연관성도 나타났다. 구체적으로, 당류와 어류 및 어류가공품류의 섭취는 급성관상동맥증후군 위험에 대한 부정적인 영향을 예측해볼 수 있는 양적인 연관관계를 가지는 반면, 과일류는 발병 위험과 반대의 연관성을 가져 급성관상동맥증후군 발병에 대한 예방적 영향을 짐작해볼 수 있었다. 다만, 24시간 회상법의 분석결과는 앞의 식품섭취빈도조사지 분석결과와 상관관계가 낮게 나타났는데, 이는 환자군이 병을 진단받은 이후 스스로 식단에 변화를 주었을 가능성을 반영하는 것으로 보인다.

주요어: 급성관상동맥증후군, 영양소 섭취, 식품 섭취, 당류, 어류 및 어류가공품류

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