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High carbohydrate intake was inversely associated with high-density lipoprotein cholesterol among Korean adults

Hanui Choi[a], SuJin Song[a], Jihye Kim[b], Jayong Chung[c], Jihyun Yoon[a], Hee-Young Paik[a], YoonJu Song[d,*]

[a]Department of Food and Nutrition/Research, Institute of Human Ecology, Seoul National University, Seoul, Korea
[b]Department of Food and Nutrition, Daegu University, Gyeongsan, Gyeongbuk, Korea
[c]Department of Food and Nutrition, KyungHee University, Seoul, Korea
[d]School of Human Ecology, Catholic University of Korea, Gyeongi-do, Korea

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Abstract

The traditional Asian diet, which is characterized as being high in carbohydrate with an abundance of vegetables, may be beneficial for preventing metabolic syndrome abnormalities within the Asian population. However, the prevalence of metabolic syndrome is increasing in Asian countries. This study explored the association between dietary carbohydrates and low high-density lipoprotein cholesterol (HDL-C) prevalence, one of the abnormalities of metabolic syndrome in Korean adults. We used the data from the Fourth Korea National Health and Nutrition Examination Survey and evaluated a total of 9947 Korean adults older 20 years. To measure carbohydrate quality and quantity, total carbohydrate intake (g/d), percentage of energy from carbohydrate, glycemic index, and glycemic load were divided into quintiles. Mean levels of HDL-C significantly decreased across the quintiles for all types of dietary carbohydrate intake except glycemic index after adjusting for potential variables in both men and women. Odds ratios for having low HDL-C in the highest quintile were 1.66 (95% confidence interval, 1.24-2.22) for total carbohydrate, 1.34 (1.02-1.75) for percentage of energy from carbohydrate, and 1.54 (1.17-2.03) for glycemic load in men as compared with the second quintile as a reference. Odds ratio for low HDL-C was 1.38 (1.12-1.71) for percentage of energy from carbohydrate in women. In conclusion, our study indicates that low HDL-C is associated with high carbohydrate intake without regard to energy or fat intake. Further studies would be necessary to optimize carbohydrate intake quantitatively on dyslipidemia for Asian population.

Keywords: Dietary carbohydrates; Glycemic index; Glycemic load; HDL-C; Korean

Abbreviations: BMI, body mass index; HDL-C, high-density lipoprotein cholesterol; KNHANES, Korea National Health and Nutrition Examination Survey.

1. Introduction

The prevalence of metabolic syndrome is increasing in Asian countries [1]. Recently, Lim et al [2] reported a significant secular trend of metabolic syndrome for 10 years in Korea. The study also indicated that the prevalence of low high-density lipoprotein cholesterol (HDL-C) had the most significant increase, followed by abdominal obesity and hypertriglyceridemia. Low levels of HDL-C are a major risk factor for cardiovascular events [3]. The association between dietary carbohydrate and HDL-C has been reported in previous studies [4-9]. In addition, the quality of carbohydrate, characterized by the glycemic index, is associated with a low level of HDL-C. However, only a few studies have been performed in Asian countries where a high-carbohydrate diet is common.

* Corresponding author. School of Human Ecology, Catholic University of Korea, 43-1 Jibongro Wonmigu, Bucheonsi, Gyeongido 420-743 South Korea. Tel.: +82 2 2164 4681; fax: +82 2 2164 4310.
E-mail address: yjsong@catholic.ac.kr (Y. Song).

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The Asian diet is characterized by high rice intake and low fat as compared with the Western diet. According to the recent Korea National Health and Nutrition Examination Survey (KNHANES) [10], carbohydrate intake as a percent of total energy was 65.2% for men and 68.3% for women; whereas in the United States, carbohydrate intake was 47.9% for men and 50.5% for women in the 2007 to 2008 National Health and Nutrition Examination Survey [11]. In addition, the portion of the Korean population whose carbohydrate intake was above 70% was more than half, with 61.7% of the men and 68.5% of the women in the Third KNHANES [9]. This suggests that Asian and Western populations have very different aspects of carbohydrate intake.

Regarding dietary carbohydrate and HDL-C in the Asian population, Nakashima et al [12] reported that glycemic load was inversely associated with HDL-C in 3855 Japanese adults. Radhika et al [13] reported that both total carbohydrate and glycemic load were inversely associated with HDL-C, with glycemic load having a more significant association, in 2000 South Indian adults. Furthermore, Kim et al [14] also observed a significant association between glycemic load and low HDL-C prevalence in 910 Korean adults in rural areas. However, those studies reported a meaningful association between carbohydrate and HDL-C but limited to quantitative level of carbohydrate intake that would benefit for having a desirable HDL-C level.

Thus, this study aimed to explore the association between all types of dietary carbohydrate and HDL-C from nationally representative data in Korean population and to provide information on the definition of a desirable level of carbohydrate intake for reduced risks of low HDL-C.

2. Methods and materials

2.1. Study population

The study was based on the data from the Fourth KNHANES, a cross-sectional and nationally representative survey conducted by the Korean Ministry of Health and Welfare in 2007 to 2009. Details of the surveys have been described previously [15]. Briefly, we used a stratified, multistage probability sampling design that consisted of 3 sections: the Health Interview Survey, the Health Examination Survey, and the Nutrition Survey. We limited the analyses to participants 20 years or older who attended both the health examination and the nutrition surveys. In total, 13 832 participants were included in our analyses.

We excluded those who had been diagnosed as having hypertension or hyperlipidemia and reported taking medication for hypertension or hyperlipidemia (n = 3331). Those who had been diagnosed as having diabetes mellitus and reported taking medication or treatment with insulin were also excluded (n = 418) because they were assumed to have changed their dietary behavior. Subjects with implausible energy intake (<2092 kJ/d or >20920 kJ/d) were excluded (n = 136). Thus, a total of 9947 participants (3899 men, 6048 women) were eligible for further analysis. The study protocol was approved by the Ministry of Health and Welfare in Korea. All subjects in the studies participated voluntarily, and informed consent was obtained from them.

2.2. Health examination

Height, body weight, and waist circumference were measured by well-trained examiners. Body mass index (BMI; in kilograms per meter squared) was calculated from the measured height and weight of the participants. The cutoff points of overweight and obesity were defined by the International Obesity Task Force for Asian adults in the Asian and Pacific regions [16]. We classified the participants into 4 categories: underweight (<18.5 kg/m^2), normal (≥18.5 and <23 kg/m^2), overweight (≥23 and <25 kg/m^2), and obese (≥25 kg/m^2) based on their BMI.

Blood samples were drawn after a 12-hour overnight fasting and prepared to yield serum samples. Fasting blood glucose and lipids were measured enzymatically in a central laboratory. Serum triglyceride, HDL-C, and fasting blood glucose were measured with an ADVIA 1650 automatic analyzer (Siemens, Washington, DC, USA) in 2007 and with Hitachi automatic analyzer 7600 (Hitachi, Tokyo, Japan) in 2008 and 2009. Regarding HDL-C, converted HDL-C concentrations were used due to a different analyzer in 2007 to 2009 and were calculated based on the true value of HDL-C drawn from the Lipid Standardization Program of the US Centers for Disease Control and Prevention [17].

In this study, lipid abnormalities were chosen as the indicators for dyslipidemia. The criteria of dyslipidemia were based on the National Cholesterol Education Program Adult Treatment Panel III [18]. The cutoff point for elevated serum triglycerides was set according to the “High” level and that of low HDL-C was derived from the clinical identification of metabolic syndrome: (1) hypertriglyceridemia as triglycerides 200 mg/dL or greater, (2) low HDL-C as HDL-C less than 40 mg/dL for men and less than 50 mg/dL for women.

2.3. Dietary assessment and calculation of glycemic load

We used the dietary intake data from 24-hour recalls in the KNHANES. Participants reported all food and beverages consumed for the previous 24 hours.

The glycemic indices of the foods were calculated individually from the 24-hour recall data using previously validated methods [19], international tables [20,21], and published data for Asian foods [22-24]. When a glycemic index value was not available for a food item, we used the value of the most similar food item. When several glycemic index values were available for a food item, the mean value was used. Food items with very low carbohydrate content were ignored because their glycemic index values cannot be accurately measured.

Foods appearing in the 24-hour recalls consisted of 3045 items that were coded as a first code and then classified