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Association between Dietary Glycemic Index and Knee Osteoarthritis: The Korean National Health and Nutrition Examination Survey 2010-2012

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ABSTRACT

Background Obesity and metabolic abnormalities are important risk factors for knee osteoarthritis (KOA). Recent epidemiologic studies have found that a high glycemic index (GI) and glycemic load (GL) diet are associated with a higher risk for metabolic complications and cardiovascular mortality.

Objective We aimed to examine the association between dietary GI, dietary GL, and KOA among Korean adults.

Design This was a cross-sectional study that analyzed data obtained from the Korean National Health and Nutrition Examination Survey 2010-2012.

Participants/setting A total of 9,203 participants (5,275 women) aged ≥50 years were included.

Main outcome measures KOA was defined as the presence of radiographic features of Kellgren-Lawrence grade ≥2. Chronic knee pain was defined as the presence of knee pain for more than 30 days during the past 3 months. Dietary information was collected using a single 24-hour recall method.

Statistical analyses performed The association between the quintiles of dietary GI and dietary GL and knee conditions was analyzed using a multinomial logistic regression analysis adjusting for age, physical activity, obesity, hypertension and diabetes, serum low-density lipoprotein, and total energy intake.

Results Among the women, the association between dietary GI and symptomatic KOA was: quintile 1: 1.00 (reference); quintile 2: 1.29 (95% CI 0.87 to 1.92); quintile 3: 1.59 (95% CI 1.11 to 2.28); quintile 4: 1.74 (95% CI 1.21 to 2.51); and quintile 5: 1.77 (95% CI 1.20 to 2.60) (P=0.001). Chronic knee pain without KOA was associated with dietary GI; however, this association was not linear across quintiles. There was no significant association between dietary GI and asymptomatic KOA. Among the men, no significant association was found between dietary GI and any knee conditions. There was no significant association between dietary GL and KOA in both men and women.

Conclusions There was a significant positive association between dietary GI and symptomatic KOA in women.

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KNEE OSTEOARTHRITIS (KOA) IS AN ARTICULAR DISorder with a high prevalence in elderly people and is associated with a substantial burden on both individuals and society.[1] KOA is defined according to classification criteria based on the clinical and radiographic features of the disease and is currently understood to be a late/end stage of various pathogenic pathways originating from different etiologic factors (eg, aging, trauma, and obesity).[2] Among these factors, metabolic abnormalities, for which therapeutic and preventive interventions are available, has been a primary research focus. Since the association between radiographic KOA and each metabolic risk factor was shown,[3] epidemiologic studies have demonstrated associations between metabolic abnormalities and KOA radiographic changes,[4] KOA symptoms,[5,6] impaired physical function,[6] and total knee replacement[7]; this led to the concept of metabolic KOA.[8]

Diet is an important modifiable risk factor for metabolic complications, and several studies have investigated diet and nutrition in relation to KOA. Interventional studies have primarily focused on the effect of dietary intervention to restrict total energy intake and reduce weight; such reports have demonstrated effects in structural, symptomatic, and functional improvement in KOA.[9] Although reducing weight by restricting macronutrients is achievable, it is difficult to maintain for many people[9] and results in negative effects (eg, loss of muscle mass).[10] Based on the limitations of the calorie-centered approach to weight loss and the findings of

both experimental and clinical research, an alternative model of obesity has been proposed that stresses diet quality, especially carbohydrate quality.[11]

The physiologic effects of isoenergetic carbohydrates differ between specific foods or meals, and this difference can be quantified using the glycemic index (GI), a measure of carbohydrate quality. GI is the incremental area under the glucose response curve following the ingestion of a standard amount of a test food compared to a control food (eg, glucose),[12] which is influenced by factors such as ingredients, moisture contents, and cooking methods. As a related concept, glycemic load (GL), which quantifies the overall (both qualitative and quantitative) glycemic effects of a food, represents the product of the total amount of carbohydrate and the GI of the food.[13] The GI and carbohydrate content of individual food items are used to predict the glycemic response of mixed meals, which is the concept of dietary GI.[14,15] The physiologic response after ingestion of a meal with a high GI is characterized by early (approximately 0 to 2 hours after consuming a high-GI meal) postprandial hyperglycemia and hyperinsulinemia, middle (2 to 4 hours) postprandial hypoglycemia, and late (4 to 6 hours) postprandial hyperglycemia, as well as high free fatty acid levels due to high counter-regulatory hormonal response.[16] Recent epidemiologic studies have reported that a high proportion of energy from carbohydrate, which is mostly from refined carbohydrate with high GI, such as rice in Asian diets, was associated with mortality and metabolic symdrome.[17,18] Studies that focused on dietary GI have shown associations with an elevated risk of developing metabolic complications (eg, type 2 diabetes,[19,20] coronary heart disease,[21,22] and mortality[23-25]), suggesting the possibility that poor dietary carbohydrate quality may also have negative effects on KOA.

To date, few observational studies have investigated the association between the amount of carbohydrate intake and KOA.[26,27] Although a prospective study revealed a positive association between carbohydrate intake and bone marrow edema in magnetic resonance imaging (MRI) of the knee, it had methodological issues (eg, a lack of adjustments for total energy intake).[27] In addition, there has been no study that addressed the association between dietary carbohydrate quality and KOA. Therefore, the purpose of this study was to examine the association between dietary GI, dietary GL, and KOA among Korean adults.

PATIENTS AND METHODS

Study Design and Participants

This study was a cross-sectional study that analyzed data obtained from participants of the Fifth Korean National Health and Nutrition Examination Survey conducted from January 2010 to December 2012. Plain radiographs of both knees were indicated for all participants aged 50 years and older, and those who underwent the radiographic examination were eligible for this study. The Korean National Health and Nutrition Examination Survey, for which the participants were selected by systematic sampling, is a South Korean nationwide health and nutrition survey of children, adolescents, and adults. Details of the sample selection process were reported in a previous study.[1] The overall participation rates were 81.9%, 80.4%, and 80.8% from 2010 through 2012, respectively. All participants provided written informed consent for both participation in the survey and use of their data for research purposes, and the survey was approved by the Institutional Review Board of the Korean Centers for Disease Control and Prevention, and the Statistics Korea.

Evaluation of Radiographic Features and KOA Symptoms

Bilateral anteroposterior, lateral (30-degree flexion), and weight-bearing anteroposterior plain radiographs of the knees were acquired using an SD3000 Synchro Stand (SYFM). The radiographic features of KOA were assessed using the Kellgren-Lawrence grade,[28] which is a grade for each case representing the highest concordant grade in both knees. In 2010 and 2011, the radiographic digital images were graded by two radiologists. The inter-rater agreement between the two radiologists was 57.4% and 64.0%, with an unweighted Cohen's kappa coefficient of 0.43 and 0.44 in 2010 and 2011, respectively. In 2012, one of the two radiologists read all images, and 5% of the images were read by another radiologist. The inter-rater agreement was 67.0%, and the linear-weight kappa was 0.74. KOA was defined as the presence of radiographic features of Kellgren-Lawrence grade $\geq$2. Data regarding knee pain were obtained through health interviewing. Chronic knee pain was defined as the presence of knee pain for more than 30 days during the past 3 months. Symptomatic KOA was defined as KOA accompanied by chronic knee pain.

Nutritional Survey and Derivation of Dietary GI and GL

Dietary information was obtained using a single 24-hour dietary recall method. Trained interviewers conducted face-to-face home interviews from 5 to 11 days after the health interview and health examination. The interviewers used supplementary materials, such as two-dimensional models of dishes/bowls (69 different kinds in 10 categories) and foods, measuring cups, measuring spoons, and rulers. Serving size of each food was recorded as volume and converted to weight using a database that included 860 conversion factors. The amount of carbohydrate, protein, and fat intake (g) from each food item were calculated using the seventh edition of the food composition table published by the Rural Development Administration in 2006.[29] Percentage of energy provided by carbohydrate, protein, and fat was calculated by dividing energy from the nutrients by total daily energy intake.

The GI of each food item was based on glucose with a GI of 100. The GI values of food items were derived from a previous study on the GI of common Korean foods.[30] The GI of 653 food items found to be ingested by the participants in the fourth Korean National Health and Nutrition Examination Survey was matched to the value of the same food items reported in previous domestic and international studies[13,31] for 149 (22.8%) food items; imputed from similar food items in calorie and carbohydrate contents, and recipe for 60 (9.2%) food items; and judged to be 0 due to very low carbohydrate content for 444 (68.0%) food items (eg, meat and its products, fish, eggs, mushrooms, seaweeds, oils, seasonings, and pure alcoholic beverages). Therefore, a total of 209 GI values were used and matched to secondary food codes of the nutritional survey.