RESEARCH
Original Research

A Randomized Trial on the Effects of 2010 Dietary Guidelines for Americans and Korean Diet Patterns on Cardiovascular Risk Factors in Overweight and Obese Adults

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ARTICLE INFORMATION

Article history:
Submitted 11 May 2014
Accepted 24 March 2015

Keywords:
Diet and dietary patterns
Dyslipidemia
Korean dietary pattern
2010 Dietary Guidelines for Americans
Overweight/obese

http://dx.doi.org/10.1016/j.jand.2015.03.023

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ABSTRACT

Background Dietary patterns that are considered healthy (eg, the Dietary Approaches to Stop Hypertension diet and Mediterranean diet) may be more successful in reducing typical cardiovascular disease risks compared to dietary patterns considered unhealthy (eg, energy-dense diets such as the typical American diet).

Objective This study assessed the effects of a Korean diet, the 2010 Dietary Guidelines for Americans (DGA), and a typical American diet on cardiometabolic risk factors, including lipid levels and blood pressure, in overweight, non-Asian individuals in the United States with elevated low-density lipoprotein cholesterol.

Design/intervention The study was a three-period crossover, controlled-feeding study from January 2012 to May 2012. Thirty-one subjects were randomly allocated to one of six possible sequential orders for consuming the three diets for 4 weeks, each separated by a 10-day break. Data analysis included 27 subjects on the Korean diet periods and 29 in the DGA and typical American diet periods. Subjects remained weight stable.

Main outcome measures Lipid profile, blood pressure, insulin, glucose, and 24-hour urinary sodium were determined at baseline and at the end of each diet period.

Statistical analyses performed The additive main effects multiplicative interactions model was used to test for a subject by diet interaction. Differences among diets were determined using a mixed-models procedure (PROC MIXED) with random intercept for each subject.

Results Total cholesterol and low-density lipoprotein cholesterol significantly decreased on Korean ($P<0.0001$ and $P<0.01$, respectively) and DGA ($P<0.01$ and $P<0.05$, respectively) diets, but not on the typical American diet. Although an unfavorable outcome, high-density lipoprotein cholesterol significantly decreased on all three diets (Korean: $P<0.0001$; DGA: $P<0.0001$; typical American: $P<0.05$). No diet had a significant effect on serum triglycerides, but a slight increase in triglycerides in the Korean and decrease in the DGA resulted in a significant difference between these two diets ($P<0.01$). All three diets caused modest decreases in systolic and diastolic blood pressure, which reached statistical significance for DGA only ($P<0.05$ and $P<0.01$, respectively). No diet had significant effect on fasting insulin, whereas fasting glucose decreased significantly on the Korean ($P<0.01$) and typical American ($P<0.05$) diets only. Urinary sodium output decreased significantly on DGA ($P<0.0001$).

Conclusions After a 4-week feeding period, Korean and DGA diet patterns resulted in positive changes in cardiovascular disease risk factors.
J Acad Nutr Diet. 2015;115:1083-1092.

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CARDIOVASCULAR DISEASE (CVD) REMAINS A LEADING cause of morbidity and mortality in the United States and worldwide.[1] Two widely recognized elements for prevention of CVD are smoking cessation and a healthy diet.[1] Interventions focusing on healthy dietary patterns have been successful in reducing typical CVD risks (such as hypertension and dyslipidemias)—for

example, the Dietary Approaches to Stop Hypertension (DASH)[2,3] and the Mediterranean diet patterns.[4,5] Similarly, the 2010 Dietary Guidelines for Americans (DGA) are based on an overall healthy dietary pattern.[6] The recent release of the 2015 DGA report again recommends the consumption of a healthy dietary pattern.[7] To our knowledge, the effectiveness of the DGA dietary pattern in reducing CVD risk factors has not yet been experimentally tested and reported.

Another dietary pattern culturally considered as "healthy," and only reported in one controlled study,[8] is a Korean-style diet. Even with the nutrition transition and rapid economic growth in Korea, the prevalence of obesity has remained relatively low compared to other Asian countries.[9] However, the prevalence of hypertension remains high.[10] The recommended Korean dietary pattern focuses on a traditional plant-based (primarily rice and soy) diet and a reduced (relative to typical Korean consumption) sodium content.[11] Another unique characteristic of the Korean diet is the inclusion of traditional fermented foods, such as kimchi (highly spiced, fermented-in-brine cabbage). According to some studies, fermented foods may elicit a beneficial effect on the intestinal microbiota[12] and on lipid profile and the immune response.[13] Furthermore, the Korean diet's potential health effects on non–Asian Americans remain unclear.

The objective of this study was to evaluate the effects of these two diet patterns, the Korean and the 2010 DGA, on cardiometabolic risk factors in non-Asian overweight and obese adults in the United States with dyslipidemia. A third comparison diet pattern, the typical American diet, was based on data from the National Health and Nutrition Examination Survey—What We Eat in America dietary intake data[14] to represent the typical pattern of intake of the US population.

METHODS

Subjects

Study participants were recruited from the local general population in Beltsville, MD, between October and November 2011 by print and web advertisements. Interested individuals (n=94) attended an information meeting at the US Department of Agriculture, Agricultural Research Service, Beltsville Human Nutrition Research Center, at which the details of the study were explained, and attendees were invited to try samples of Korean foods to be used in the study. Individuals who wished to participate in the study (n=87) were scheduled for a screening visit. Inclusion criteria consisted of a body mass index (calculated as kg/m^2) $\geq$25, serum low-density lipoprotein (LDL) cholesterol concentration $\geq$120 mg/dL ($\geq$3.11 mmol/L), not on cholesterol-lowering or blood pressure medications, and no aversion to Korean-style foods. Exclusion criteria included regular use of dietary supplements, pre- or probiotics, laxatives, fiber supplements, or antibiotics in the past 3 months. Also individuals with any condition requiring ongoing medical care and/or medication, including kidney, liver, gastrointestinal, or endocrine disorders; regular tobacco use within 6 months before the start of the study; history of eating disorders or other atypical dietary patterns; weight loss of 10% of body weight within the last 12 months; self-report of alcohol or substance abuse within the past 12 months; or blood donation during the 8-week period before the study were excluded from the study. Of the 87 individuals screened, 31 non–Asian American apparently healthy men and women (25 to 73 years of age) were eligible for and enrolled in the study. In order to test the Korean diet in individuals who were not typically consuming these types of foods, Asian Americans were not included in this study. The study protocol was approved by the John Hopkins University Bloomberg School of Public Health Institutional Review Board. All participants provided written informed consent at the start of the study.

Study Design

This was a 4-week, three-period, randomized, crossover, controlled-feeding study. Subjects were randomly assigned to start with one of the three dietary groups (Korean, DGA, or typical American) for 4 weeks by the study investigators. Participants were stratified by sex, body mass index, and baseline LDL cholesterol. Subjects were blinded (as much as possible) to the diet treatments. Each diet was separated by a 10-day interval (compliance break). Each testing day included measurements of height, weight, blood pressure (six measurements over 2 days), 24-hour urine collection, fecal sample, and fasting blood chemistry. Testing days were performed at the beginning of the study and at the end of each 4-week diet period. Controlled-feeding began in January 2012 and was completed in May 2012. In addition, at the end of each 4-week diet period, subjects completed a series of validated questionnaires via pen and paper: a 150-mm continuous hedonic scale to assess acceptability of each diet (four questions),[15] and a 100- mm Visual Analog Scale to assess gastrointestinal symptoms (four questions).[16]

Subjects consumed breakfast and dinner meals at the Beltsville Human Nutrition Research Center Monday through Friday under the observation of study staff. Lunch, evening snack, and weekend meals were packed and provided as a carry out. Subjects were instructed to eat all and only foods provided by the study. They were allowed to consume up to 16 oz coffee or tea per day. Diet soda and artificial sweeteners were limited to the amounts provided as part of the study meals. Dietary and herbal supplements, vitamins, and minerals were not allowed. Compliance was also monitored via daily questionnaires and by the study staff consistently engaged with the subjects regarding compliance. Subjects were weighed every weekday to ensure they remained weight stable throughout the study. In addition, subjects were instructed to maintain their regular physical activity throughout the study. Energy intake was adjusted as needed in 200-kcal increments in order to maintain subject's weight within <5% change from baseline.

Diets

The DGA and typical American diets were prepared at the Beltsville Human Nutrition Research Center research kitchen. The DGA menus were developed using a modified version of the US Department of Agriculture's 2010 DGA "Sample Menus for a 2000 Calorie Food Pattern."[17] The DGA diet included a dietary pattern low in sodium, saturated fat, and refined grains, and high in vegetables, fruit, whole grains, fiber, seafood, lean meat, legumes and nuts, and low-fat dairy. The DGA foods needed to be prepared from ingredients using healthy preparation methods, such as baking, and