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Communication

Anti-inflammatory Dietary Inflammatory Index scores are associated with healthier scores on other dietary indices

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ABSTRACT

Dietary components are important determinants of systemic inflammation, a risk factor for most chronic diseases. The Dietary Inflammatory Index (DII) was developed to assess dietary inflammatory potential. It was hypothesized that anti-inflammatory DII scores would be associated with "healthier" scores on other dietary indices. The Energy Balance Study is an observational study focusing on energy intake and expenditure in young adults; only baseline data were used for this analysis (n = 430). The DII, as well as the Healthy Eating Index-2010 (HEI-2010), the Alternative Healthy Eating Index (AHEI), and the Dietary Approaches to Stop Hypertension Index (DASH) were calculated based on one to three 24-hour dietary recalls. General linear models were used to estimate least square means of the AHEI, HEI-2010, and DASH according to DII quartiles. Those with higher (ie, more proinflammatory) DII scores were more likely to be males, have less than a completed college education, and be younger. In addition, those with higher scores for cognitive restraint for eating or drive for thinness had lower (ie, anti-inflammatory) DII scores. Linear regression analyses indicated that as the DII increased, the AHEI, HEI-2010, and DASH dietary indices decreased (ie, became more unhealthy, all $P < .01$). The DII is a novel tool that characterizes the inflammatory potential of diet and is grounded in the peer-reviewed literature on diet and inflammation. Findings from the Energy Balance Study indicate that the DII is associated with other dietary indices, but has the added advantage of specifically measuring dietary inflammatory potential, a risk factor for chronic disease.

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Abbreviations: AHEI, Alternative Healthy Eating Index; BMI, body mass index; DII, Dietary Inflammatory Index; DASH, Dietary Approaches to Stop Hypertension; EDI, Eating Disorder Inventory; HEI-2010, Healthy Eating Index-2010; IL, interleukin; TFEQ, Three-Factor Eating Questionnaire; WHR, waist-to-hip ratio.

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1. Introduction

Diet is a strong moderator of chronic, systemic inflammation [1]. For example, "unhealthy" dietary patterns (eg, Western-style diets high in fats, refined carbohydrates, and protein) are typically associated with higher levels of inflammation, whereas "healthier" diets (eg, Mediterranean diets high in fruits, vegetables, and fish) are associated with lower levels of inflammation [1]. This is disconcerting considering that chronic inflammation, which can occur as a result of repeated injuries or stressors on the body, including poor diet, is associated with most major chronic disorders (eg, cardiovascular disease, cancer, and diabetes) [2,3].

Typically, dietary quality indices are based on a priori dietary guideline definitions (eg, Healthy Eating Index [HEI]) [3]. The Dietary Inflammatory Index (DII) is a relatively new dietary index that is based on peer-reviewed research focusing on diet and inflammation and is standardized to world average dietary intake [4]. The DII was validated against inflammatory biomarkers in previous research [5–7]. The DII also has been associated with other outcomes including, but not limited to, cancer, anthropometric measures, and asthma [8–10]. Based on the fact that healthier diets incorporate many foods that contain anti-inflammatory constituents, it is not surprising that more anti-inflammatory DII scores were observed with various types of vegetarian diets in a randomized control trial [11] or with healthier diets in a simulation analysis compared with a fast food diet [12].

However, to date, no DII analysis has examined the relationship between the DII and other established and commonly used dietary indices such as the HEI-2010, the Alternative Healthy Eating Index (AHEI), and the Dietary Approaches to Stop Hypertension (DASH) [13–15]. Therefore, this analysis addressed the hypothesis that more anti-inflammatory (ie, lower) DII scores would be associated with healthier (ie, higher) scores on the HEI-2010, AHEI, and DASH indices using data collected from the Energy Balance observational study (University of South Carolina, Columbia, SC, USA), including 24-hour recalls (24HRs) [16].

2. Methods and materials

2.1. Study design

The Energy Balance Study, which is a prospective cohort (follow-up visits occurred every 3 months), was designed to examine the impact of energy expenditure and intake on changes in body habitus in 430 young adults. Methodology for the Energy Balance Study has been described elsewhere [16]. In short, eligible participants were between 21 and 35 years of age, had a body mass index (BMI) of 20 to 35 kg/m^2, and lived in or near Columbia, South Carolina. Exclusions were applied at recruitment and included major acute or chronic health conditions, plans to move out of the study area within the first year of follow-up, or large changes in body composition prior to the study start date. Only baseline data were used for this cross-sectional analysis. The Energy Balance Study was approved by the institutional review board of the University of South Carolina, and all participants provided written informed consent.

2.2. Dietary data collection and indices

Dietary information was collected by telephone-administered 24HRs over a 14-day period. The Nutrient Data System for Research (version 2012; Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN, USA) was used to estimate average energy, nutrient, and individual food intakes from the 24HR. Dietary data from the 24HRs were used to calculate the HEI-2010, AHEI, DASH, and DII. The HEI-2010, AHEI, and DASH were created and scored in accordance with previous scoring guidelines [13–15].

The HEI-2010 was updated compared with the HEI-2005 based on recommendations in the 2010 Dietary Guidelines released by the USA Department of Agriculture. The HEI-2010 is made up of 9 adequacy components (total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, and fatty acids) and 3 moderation components (refined grains, sodium, and empty calories). Each component has standards for maximum scores and scores of zero. Values falling between zero and the maximum are scored proportionally [14]. The AHEI is composed of 9 components including servings of vegetables, fruits, nuts and soy protein, and alcohol; ratio of white to red meat; cereal fiber grams; percent of energy from trans-fat; ratio of polyunsaturated to saturated fat; and duration of multivitamin use. All components are proportionally scored on a scale of 0 to 10 based on minimum and maximum criteria [15]. It should be noted that duration of multivitamin use was not available within Energy Balance; therefore, this component was based on a "yes/no" response with 7.5 points for yes and 2.5 points for no. DASH index scores were calculated based on quintiles (scored 1-5) of servings per day for fruits, vegetables, nuts and legumes, whole grains, low-fat dairy, sodium, red and processed meats, and sweetened beverages; values were summed across these 8 components with sodium, meats and sweetened beverages being scored in reverse order [13]. Higher HEI-2010 (range, 0-100), AHEI (range, 2.5-97.5), and DASH (range, 8-40) scores indicate healthier diets.

Inflammatory effect scores derived from data reported in 1943 research articles examining the relationship between various dietary constituents (referred to as food parameters) and inflammation (interleukin [IL]-1β, IL-4, IL-6, IL-10, tumor necrosis factor α, and C-reactive protein) became the basis for the DII. Exposure estimates were scored relative to a "world" database (based on 11 populations from around the world including the United States, the United Kingdom, Bahrain, Mexico, Australia, South Korea, Taiwan, India, New Zealand, Japan, and Denmark) which consists of means and standard deviations for DII food parameters. The DII food parameters used to calculate DII scores within the Energy Balance Study included the following: carbohydrates; protein; fat; alcohol and fiber; cholesterol; saturated, monounsaturated, and polyunsaturated fatty acids; omega-3 and omega-6 fatty acids; trans-fat; niacin; thiamin; riboflavin; vitamins A, B_6, B_{12}, C, D, and E; iron; magnesium; zinc; selenium; folate; β-carotene; anthocyanidins; flavan-3-ols; flavones; flavonols;

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