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Diet quality and its association with type 2 diabetes and major cardiometabolic risk factors among adults in China

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Abstract *Aim:* We examined the association between diet quality and diabetes and major cardiometabolic risks among adults in China.
Methods and Results: We developed the China Dietary Guideline Index (CDGI) based on the 2007 Chinese dietary guidelines and tailored the Alternate Healthy Eating Index 2010 (which we call the tAHEI) to assess diet quality. Our analysis linked the dietary intake and covariates measured in 2006 with CM risk factors measured in 2009. We used diet data the longitudinal China Health and Nutrition Survey 2006 collected in 3 consecutive 24-h recalls from 4440 adults aged 18 to 65 to calculate both the tAHEI and the CDGI scores. We performed multivariable logistic regressions to analyze the association of each 2006 score with diabetes, abdominal obesity, elevated blood pressure, and lipid-related cardiometabolic risk factors in 2009.

After we adjusted for potential confounders, adults in the top quintile compared with the bottom quintile of the tAHEI scores showed 36% lower odds of high low-density lipoprotein cholesterol (LDL-C) (odds ratio [OR] 0.64; 95% confidence interval [CI] 0.46, 0.90] in men and 33% lower odds (OR 0.67; 95% CI 0.49, 0.91) in women, while the CDGI scores showed 35% lower odds of high LDL-C (OR 0.65; 95% CI 0.46, 0.92) in men only. Further, the CDGI scores indicated 55% lower odds of diabetes in the top versus the bottom quintile (OR 0.45; 95% CI 0.23, 0.87) in men only, whereas a null association was observed for the tAHEI scores for both sexes. Both index scores showed null associations with other cardiometabolic risk factors.
Conclusions: Chinese diets that scored high on both the CDGI and the tAHEI showed similarly negative associations with high LDL-C risk, whereas only CDGI score was negatively related to diabetes risk in men.

Abbreviations used: AHEI, Alternative Healthy Eating Index; BMI, body mass index; BP, blood pressure; CDG, Chinese dietary guidelines; CDGI, China Dietary Guideline Index; CFGP, Chinese Food Guide Pagoda; CHNS, China Health and Nutrition Survey; CI, confidence interval; CM, cardiometabolic; d, day; DBP, diastolic blood pressure; DHA, docosahexenoic acid; EPA, eicosapntemacnioc acid; FCT, food composition table; FFQ, food frequency questionnaire; FNDDS, Food and Nutrient Database for Dietary Studies; g, gram; HbA1c, hemoglobin A1c; HDL-C, high-density lipoprotein cholesterol; HEP, Healthy Eating Pyramid; IDF, International Diabetes Federation; kcal, kilocalories; L, liter; LDL-C, low-density lipoprotein cholesterol; MET, metabolic equivalent of task; mg, milligram; mmHg, millimeters of mercury; mmol/L, millimoles per liter; oz, ounce; OR, odds ratio; PA, physical activity; PUFA, polyunsaturated fatty acid; Q, quintile; SBP, systolic blood pressure; SSB, sugar-sweetened beverage; TAG, triacylglycerol; tAHEI, tailored Alternative Healthy Eating Index; TEI, total energy intake; TG, triglycerides; USDA, United States Department of Agriculture; WC, waist circumference; y, year; μg, microgram.

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Introduction

The rising epidemic of obesity and diabetes and associated cardiometabolic (CM) risk factors have been public health concerns worldwide in the past three decades [1]. This is especially pertinent for Asian countries, given that they have faced very rapid socioeconomic and nutrition transitions [2–5] and that Asians tend to have higher CM risks at lower body mass index (BMI) levels [6] and at younger ages relative to Western populations [7]. Studies have shown that approximately 85.0% of Chinese adults aged 40 and older [8] and 33.2% of nonoverweight Chinese adults had high levels of at least one CM risk factor in 2009 [4].

Chinese adults' diets have declined in intake of coarse grains and increased in intake of edible oils and animal-source foods over the past 2 decades [9]. Many studies have suggested that index-based dietary patterns capture the overall complexity of the diet to measure the overall diet quality [10–14]. The Alternative Healthy Eating Index 2010 (AHEI 2010), developed from the best and latest global evidence on relationships between foods and nutrients and diseases [15], is based on the recommendations of the Harvard Healthy Eating Pyramid (HEP), a popular healthy diet guide that used global scientific evidence on diet–disease relationships [16–18]. The Nurses' Health Study and the Health Professionals Follow-up Study found that adults with higher AHEI 2010 scores had 31% and 33% lower odds of coronary heart disease and diabetes, respectively [19]. The British Whitehall II prospective cohort study found higher odds of reversing metabolic syndrome [20] and reduced risk of mortality [21] associated with higher AHEI 2010 scores. Two recent studies showed a significant association between AHEI 2010 scores and insulin resistance in Chinese adults aged 18–65 [22] and hip fracture risk among Chinese adults in Singapore [23], which validated the health benefits of Chinese diets with high AHEI 2010 scores. China developed the Chinese dietary guidelines (CDG) [24], a food-based national policy, in 2007. However, little is known about the association between adherence to the CDG and CM risk factors in Chinese adults. The present study constructed the China Dietary Guideline Index (CDGI) from the recommendations of the 2007 CDG. We tailored the AHEI 2010 to match the Chinese diet and named our index the tailored Alternative Healthy Eating Index (tAHEI). Our analysis linked the dietary intake and covariates measured in 2006 with CM risk factors measured in 2009. We used data the China Health and Nutrition Survey (CHNS) collected to calculate CDGI and tAHEI scores among Chinese adults aged 18 to 65. Using 3 years of CHNS data, we examined the association between diet quality as assessed by those scores with the risks of type 2 diabetes, prediabetes, abdominal obesity, elevated blood pressure (BP), and lipid-related CM risk factors in 2009.

Methods

Study population

We derived all data used in this study from the CHNS, an ongoing longitudinal study. Initiated in 1989, the CHNS focuses on relationships between the social and economic transformation in China and the resulting effects on the health and nutritional status of the Chinese population [25]. The CHNS originally included 8 provinces and used a multistage, random cluster process to select communities for the sample. In each community the survey randomly selected 20 households and surveyed all individuals in each household for all the data in each wave. The sampling procedure has been described in detail elsewhere [9,25]. The CHNS has completed 9 rounds (1989, 1991, 1993, 1997, 2000, 2004, 2006, 2009, and 2011). It collected fasting blood samples for the first time in 2009.

Our analysis linked the dietary intake and covariates measured in 2006 with the CM risk factors measured in 2009. Of 5089 eligible subjects aged 18 to 65 who had complete diet data in 2006 and CM risk factor data in 2009, we excluded those with implausible energy intakes ($n = 38$; for men <1000 or >6000 kilocalories per day [kcal/d], for women <800 or >5000 kcal/d); pregnant or lactating women ($n = 70$); those with missing covariates ($n = 102$); those previously diagnosed by a doctor with diabetes, stroke, or myocardial infarction ($n = 88$); and those with missing BMI or waist circumference (WC) measurements ($n = 351$). Our final sample was 4440 (2062 males and 2378 females).

The protocol of the CHNS was approved by the institutional review committees of the University of North Carolina at Chapel Hill and the National Institute of Nutrition and Food Safety, Chinese Center for Disease Control and Prevention. All subjects gave written informed consent for their participation in the protocols.

Dietary measurement

The CHNS 2006 collected dietary data using 3 consecutive 24-h recalls for each individual and weighed all foods in the household inventory over the same period. Details of the collection method are described elsewhere [5,9]. We linked dietary intake data to the China Food Composition Table (FCT) [26]. We additionally linked all Chinese foods to the United States Department of Agriculture (USDA) Food and Nutrient Database for Dietary Studies (FNDDS) [27] and the USDA National Nutrient Database for Standard Reference [28] to estimate fatty acid composition, which is unavailable from the China FCT. We used the 3-day average of total energy intake (TEI), nutrients, and foods/food groups to calculate the CDGI and tAHEI scores in the analyses.

Construction of the CDGI

The goal of the CDG is to prevent both undernutrition and chronic diseases [24]. This guide provides 10 qualitative recommendations covering diet, physical activity (PA), alcohol consumption, healthy weight, and food safety. The Chinese Food Guide Pagoda (CFGP) presents 6 energy requirement–specific quantitative recommendations for intake of relevant foods [24]. We referred to the China Nutrition Society dietary intake recommendations [29] to

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