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Healthy Eating Index 2005 and selected macronutrients are correlated with improved lung function in humans

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ABSTRACT

A number of dietary components have been associated with lung function. However, a comprehensive measure of a healthy diet has not been compared with lung function. Herein, we test the hypothesis that a healthy overall diet, as assessed by the Healthy Eating Index 2005 (HEI-2005), will be associated with increased lung function. This is an investigation using the Atherosclerosis Risk in Communities Research Materials obtained from the National Heart Lung Blood Institute. The study surveyed dietary habits of 15 567 American subjects from 4 communities in 1987 to 1990. Spirometric measures of lung function were also taken at entry to the study and a second time 3 years later. Based on food and nutritional data collected by food frequency questionnaire, an HEI-2005 score was calculated for each subject. This total score, together with its 12 components scores and associated macronutrient, was compared with lung function results by linear regression. Models were controlled for smoking behavior, demographics, and other important covariates. The HEI-2005 total scores were positively associated with forced expiratory volume in 1 second per forced vital capacity (FEV(1)/FVC) at visit 1 (β = .101 per increase in 1 quintile of HEI-2005) and visit 2 (β = .140), and FEV(1) as percentage of the predicted FEV(1) at visit 2 (β = .215) ($P < .05$). In addition, HEI-2005 component scores that represented high intakes of whole grains (β = .127 and .096); saturated fats (β = –.091); and solid fats, alcohol, and added sugar (β = –.109 and –.131) were significantly associated with FEV(1)/FVC at either visit 1 or visit 2. Intakes of total calories (β =–.082 at visit 1) and saturated fatty acids (β = –.085 at visit 2) were negatively associated with FEV(1)/FVC. Dietary polyunsaturated fatty acids (β = .085 and .116) and long-chain omega-3 fatty acids (β = .109 and .103), animal protein (β = .132 and .093), and dietary fiber (β = .129) were positively associated with lung health. An overall healthy diet is associated with higher lung function.

Abbreviations: ARIC, Atherosclerosis Risk in Communities; BMI, body mass index; COPD, chronic obstructive pulmonary disease; FEV(1), forced expiratory volume in 1 second; %FEV, forced expiratory volume in 1 second as a percentage of predicted FEV(1); %FEV(1), forced expiratory volume in 1 second as a percent of predicted expiratory volume in 1 second; FEV(1)/FVC, forced expiratory volume in 1 second as a percent of forced vital capacity; FVC, forced vital capacity; HEI, Healthy Eating Index; HEI-2005, Healthy Eating Index 2005; SoFAAS, solid fats alcohol, and added sugar.

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1. Introduction

The US Department of Agriculture establishes a food guide that converts the foods and nutrients recommended in the Dietary Guidelines for Americans and the Dietary Reference Intakes into actual food intakes [1]. The food guide formed the basis for the Food Guide Pyramid and more recent guides, which are used to advise Americans on healthy eating [1]. The Healthy Eating Index 2005 (HEI-2005) was created by workgroups of experts in the fields of nutrition, economics, and psychometrics to score diets based on the dietary recommendations published in the Dietary Guidelines for Americans in 2005 [2]. The HEI-2005 ranks diets high if the foods consumed provide essential nutrients in adequate amounts and also include lower amounts of foods that negatively affect health [2]. Many reports on the relations between diet and cardiovascular diseases or diet-related cancers have supported the recommendations of the Dietary Guidelines for increasing fruits and vegetables and reducing sodium and saturated fats, as verified by the HEI-2005 [3-5].

Data from the Centers for Disease Control and Prevention demonstrate that chronic lower respiratory disease was the third leading cause of death among Americans in 2010 [6]. Chronic obstructive pulmonary disease (COPD) is a slowly progressive disease affecting the airways and pulmonary parenchyma leading to dyspnea, chronic cough, and respiratory failure. Chronic obstructive pulmonary disease is the pathologic consequence of lung function decline and is monitored by spirometric measurements, including forced expiratory volume in 1 second (FEV(1)) and forced vital capacity (FVC). Chronic obstructive pulmonary disease is partially classified by a forced expiratory volume in 1 second as a percentage of FVC (FEV(1)/FVC) ratio of less than 0.70 and an FEV(1) less than 80% of that predicted by age, sex, ethnicity, and standing height [7]. Although the most notable risk factor for COPD is cigarette smoking, other factors including air pollution, persistent respiratory infections, genetic disorders, asthma, and dietary factors also contribute to lung function decline leading to COPD [8-11].

Previous reports have shown that dietary intake influences lung function. An inverse association has been shown between COPD and consumption of fruits and vegetables in a case-control study [12]. Whole grains and fiber have been shown to have an inverse association in both a cross-sectional study and a longitudinal follow-up study of 16 years [13,14]. A cross-sectional study has shown that docosahexaenoic acid may be protective [15,16]. Overall dietary patterns rich in fruits, vegetables, and fish have been linked to improved lung function in longitudinal studies in both men and women [17,18].

The Healthy Eating Index (HEI) is derived from the Dietary Recommendations for Americans, which is largely focused on preventing vascular diseases with recommendations on salt intake, saturated fat intake, and excess sugar intake. The HEI-2005 is built around these largely vascular oriented recommendations [2]. Others have sought to extend the reach of these recommendations by assessing the effectiveness of HEI-2005 in predicting outcomes from various nonvascular diseases, including prostate cancer, [4] cognitive function [19], and bone health [20].

Because of interest in extending the application of the HEI beyond the vascular diseases and given the importance of COPD as a cause of death at a rate just below vascular diseases, the hypothesis of this study is that higher overall diet quality will be associated with higher lung function. In addition, component scores from the HEI-2005 and individual macronutrients will illuminate dietary strategies for improved lung function.

2. Methods and materials

2.1. *Subjects*

This manuscript was prepared using Atherosclerosis Risk in Communities (ARIC) Research Materials obtained from the National Heart Lung Blood Institute Biologic Specimen and Data Repository Information Coordinating Center and does not necessarily reflect the opinions or views of the ARIC research groups or the National Heart Lung Blood Institute. Acquisition of this data set was approved by the Institutional Review Board of Appalachian State University. Details of the ARIC study are described elsewhere [21]. Atherosclerosis Risk in Communities participants were recruited from 4 communities across the United States with the intention of creating a biracial cohort of approximately 20% black. The study protocol was approved by institutional review boards at each clinical site. The initial cohort consisted of 15 567 men and women aged 45 to 64 years. Participants were invited to clinical evaluations every 3 years. Data for this analysis were taken from visit 1, 1987 to 1989, and visit 2, 1990 to 1992. Diet, nutrients, HEI-2005 scores, and covariates were taken only from visit 1. Lung function measures were taken from both visits 1 and 2.

Subjects with incomplete data, including spirometry (1794 from visit 2), HEI-2005 score (1196), or covariates (smoking status [114], physical activity [59], height [4], body mass index [BMI] [10]), were excluded from the analysis. To lower the possibility of reverse causation, subjects who identified themselves as still having chronic bronchitis or emphysema were removed from the analysis (749). Also removed were participants with FEV(1)/FVC less than 40% (63 from visit 1 and 60 from visit 2) and 2 subjects with forced expiratory volume in 1 second as a percentage of predicted FEV(1) (%FEV) more than 190% in visit 2. The final number for the primary analysis was 12 532.

2.2. *Lung function*

Lung function measurements were taken with a water-seal spirometer (Collins Medical, Inc, Braintree, MA) and recorded using Pulmo-Screen II software (PDS Healthcare Products, Inc, Louisville, CO). These measures include FEV(1) and FVC. Spirometry was conducted in accordance with the American Thoracic Society/European Respiratory Society guidelines [22]. Sex- and ethnicity-specific predicted values for FEV(1), adjusted for age and height, were calculated [23]. Predicted values for blacks were 12% lower than for whites. Forced expiratory volume in 1 second as a percentage of predicted FEV(1) was calculated. Forced expiratory volume in 1 second as a percentage of FVC was also calculated.