A Simulation Study of the Potential Effects of Whole Grain Food Substitutions on Diet Quality in Lower Mississippi Delta Adults

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The majority of adult diets in the United States do not meet recommendations for consumption of whole grains (3), putting these individuals at increased risk for diet-related chronic diseases (10). Poor diet quality, inadequate consumption of whole grains, and chronic diseases are particularly prevalent in the impoverished rural South (1,7,9,12). Hence, dietary interventions designed to address nutrition inadequacies and thereby improve diet quality could lower chronic disease prevalence in this region of the country.

Assessing a population's diet quality is a necessary step for determining nutrition inadequacies and subsequently designing effective dietary interventions that address these problems. The Healthy Eating Index–2005 (HEI-2005) is a tool that assesses diet quality in terms of adherence to the 2005 *Dietary Guidelines for Americans* (DGA). Whole grains are among the 2005 and 2010 DGA key recommendations for food groups to encourage (10,11). However, little research has been conducted to determine the potential impact of whole grain for refined grain substitutions on diet quality. Hence, the objective of this study was to use simulation modeling to determine the effects of substituting familiar, more healthful whole grain foods for less healthy, refined grain foods on diet quality and total energy intake in lower Mississippi Delta (LMD) adults.

Analyses were performed using data from the Foods of Our Delta Study (FOODS), a cross-sectional telephone survey of residents in a 36-county LMD region that was conducted from January to June 2000 (2). Dietary intake data were collected using the U.S. Department of Agriculture's (USDA) 24-hour dietary recall multiple pass methodology with the assistance of a foods measurement guide that had been mailed to study participants. Dietary intake data were collected for 1,751 adults (18 years of age and older) using a single 24-hour recall. However, only plausible (500 ≤ intake kcal ≤ 6,000) 24-hour recalls were used for this study (13). The HEI-2005, a scoring method designed to measure adherence to the 2005 DGA (5), was used to measure diet quality. Briefly, the HEI-2005 is composed of

12 components corresponding to total fruit, whole fruit, total vegetables, dark green and orange vegetables and legumes, total grains, whole grains, milk, meat and beans, oils, saturated fat, sodium, and kcal from solid fats, alcoholic beverages, and added sugars (SoFAAS). The total score, calculated as the sum of the component scores, has a maximum value of 100. For each component, higher scores reflect better adherence to DGA recommendations corresponding to that component.

All foods selected as substitutions were deemed familiar foods based on their inclusion in the FOODS data set. White breads, rolls, biscuits, and spaghetti were replaced with their whole wheat counterparts, and white rice was replaced with brown rice. To simulate the effects of substituting 25, 50, and 100% of targeted foods with their replacements on HEI-2005 total and component scores, the targeted items' nutrient profiles were reduced by the respective amounts for the analyses and the replacement items' nutrient profiles were inserted at the corresponding level. The nutrient profiles for the replacement foods were extracted from the FOODS data set.

All statistical analyses were performed using SAS software (version 9.2, SAS Institute) and SUDAAN software (version 10.0.1, Research Triangle Institute). SAS survey and SUDAAN procedures were used to compute frequencies, means, and their associated 95% confidence intervals. These procedures are tailored to account for the complex sampling design used in FOODS. Hence, the results are weighted and should be considered representative of the LMD adult population. The population ratio method was used to compute mean HEI-2005 scores and corresponding 95% confidence intervals using jackknife variances for the overall population. It is the least biased way to estimate a mean HEI-2005 score for a population (4).

Sixty-two of the 1,751 LMD respondents were excluded due to implausible dietary records, resulting in a total sample size of 1,689 adults. The sample was composed of 48% males, 43% African Americans, 21% < 30 years of age, and 23% ≥ 60 years of age. Approximately one-fourth (23%) of the sample's household income was under $15,000 per year and 23% of the sample had less than a high school education. Almost one-fourth (24%) of the respondents were current smokers and 18% were former smokers. Based on self-reported heights and weights, 67% of the sample was either overweight (25.0 ≤ BMI ≤ 29.9) or obese (BMI ≥ 40.0). The mean daily energy intake for the LMD adult respondents was 2,010 kcal.

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The HEI-2005 whole grains component and total scores for the LMD population were 0.8 (95% confidence interval [CI] = 0.7– 0.9) and 54.5 points (95% CI = 52.0–57.1), respectively. For refined grain products including white bread, spaghetti, and rice, 25%, 50%, and 100% replacement of these items with their whole grain counterparts resulted in 0.6-, 1.2-, and 2.5-point improvements in the HEI-2005 whole grains components score, respectively; and 0.5-, 1.0-, and 1.9-point improvements in the HEI-2005 total score, respectively. A small (0.2 point) improvement in the HEI-2005 sodium component score was also apparent at the 100% replacement level. Substituting refined grains with whole grains resulted in a 15 kcal/day (0.7%) daily energy increase at the 100% replacement level.

While these improvements are encouraging, more work is needed to increase the availability, acceptance, and consumption of whole grain foods not only in the United States overall, but particularly in health disparate populations. Further, determining barriers to dietary compliance, including whole grain consumption, across sociodemographic groups and geographic areas is warranted because only a small percentage of U.S. adults follow the DGA recommendations (6). However, when educating the general public, emphasis needs to be placed on substituting less healthy foods with more healthful ones and not simply adding healthy items to an unhealthy diet. For example, findings from a study designed to test for associations between whole and refined grain intakes and body fat suggested that the inclusion of whole grains into a diet already high in refined grains may not translate to lower abdominal adiposity (8). Clearly, a randomized, controlled trial assessing the impact of such dietary substitutions on weight status is warranted in overweight and obese populations.

Simulation analyses are an economical approach to modeling the impact of replacing more healthful formulations of commonly consumed foods, including those containing whole grains, on overall nutrient intake and diet quality for a given population. Further, such simulations can help determine which replacements have the potential to provide the greatest health benefit. This information can be used to guide intervention efforts and the development of new food products or the reformulation of existing products in order to improve the health of all Americans, particularly those with the poorest diet quality. Efforts to help individuals improve the quality of their diet may include implementing policy and environmental changes that make the more nutritious food choice the easier choice.

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