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Whole grain and fiber consumption are associated with lower body weight measures in US adults: National Health and Nutrition Examination Survey 1999-2004

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Abstract

This study examined the association of whole grain consumption with body weight measures and prevalence of overweight/obesity in a recent, nationally representative sample of adults. A secondary analysis of 1999-2004 National Health and Nutrition Examination Survey (NHANES) data was conducted using adults 19 to 50 years of age (y) (n = 7,039) and 51+ y (n = 6,237). Participants were categorized by whole grain consumption: ≥ 0 to <0.6, ≥ 0.6 to <1.5, ≥ 1.5 to <3.0, and ≥ 3.0 servings/day. Main outcome measures included body mass index (BMI), waist circumference (WC), and prevalence of overweight/obesity. Sample weights were applied and the number and percentages of adults in whole grain consumption groups were determined. Least-square means and standard errors were calculated for body weight measures. Two regression models were developed and compared. Model 1 covariates included age, gender, ethnicity, and total energy intake; Model 2 was extended to include cereal fiber. Trend analysis was conducted to test for differences between least-square means. Significance was set at $P \leq .05$. Adults 19-50 and 51+ y consumed a mean of 0.63 and 0.77 servings of whole grains/day, respectively. A significant trend was observed in both age groups for increased consumption of whole grains with lower BMI, WC, and percentage overweight/obese (Model 1); however, a significant trend was not observed when cereal fiber was added as a covariate (Model 2). Results confirm overall whole grain intake well below recommendations, and adults who consumed the most servings of whole grains had lower body weight measures. Results also suggest that fiber in whole grain foods may mediate associations with weight measures in adults. Intake of whole grain foods should be encouraged by health professionals.

Keywords: Whole grains; Fiber; Overweight; Obesity; Adults; NHANES

Abbreviations: BMI, body mass index; WC, waist circumference; NHANES, National Health and Nutrition Examination Survey; US, United States; CVD, cardiovascular disease; CHD, coronary heart disease; FDA, Food and Drug Administration; USDA, US Department of Agriculture; MPED, MyPyramid Equivalents Database; MEC, mobile examination center.

1. Introduction

The majority of grains consumed in the US are refined [1-4], rather than whole. Whole grains include cereal grains that consist of the intact, or ground, cracked or flaked fruit of

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the grains whose principal components are present in the same proportions as they exist in the intact grain [5,6]. Whole grains are nutrient-dense foods composed of protein, lipids, dietary fiber, B vitamins, vitamin E, minerals, and flavonoids and other phytochemicals [7-9]. In the US, wheat comprises 66-67% of whole grains consumed; oats, brown rice, maize, and barley are other commonly consumed whole grains [7]. In 2001-2002, ready-to-eat cereals, corn or tortilla chips, and yeast breads were the major food sources of whole grains (30.9%, 21.7% and 18.1%, respectively) [10].

Studies of intake of whole grains and their potential health benefits [11-15] have been complicated by lack of a standard definition and understanding by consumers of what constitutes a whole grain. Since different studies have used different definitions, it has been difficult to interpret and compare results [16,17]. Jacobs and co-workers [18] recommended a definition of whole grain foods as those with 25% or more whole grains or bran content by weight. Several epidemiologic studies have also used this definition [12,19]; however, the amount of whole grains in each serving can vary considerably and this method did not separate out bran added during processing. Jensen and colleagues [20] calculated whole grain intake by determining the whole grain content of all grain foods according to the dry weight of whole grain ingredients; in that study whole grain intake was calculated with and without bran and germ. The Federal Food and Drug Administration (FDA) allows health claims for whole grain foods that contain $\geq$ 51% whole grain ingredient(s) by weight per reference amount customarily consumed [21]. The current definition of whole grains in the US excludes bran and pearled barley; most published studies have not used this newer definition. However, there is no internationally accepted definition of whole grains [22]. The USDA's MyPyramid Equivalents Database provides quantified measures of whole grain foods [17,23,34], and this database provides information with and without bran.

Despite these challenges, historically, studies have consistently shown that in industrialized countries, consumption of whole grains has been low in all ethnic and income groups [4]. Data from the Continuing Survey of Food Intake by Individuals (CSFII) was used to show that American adults consumed an average of 6.7 servings of grain products per day; however, only 1.0 serving was from whole grains [1]. In that study, only 8% of individuals consumed at least 3 servings of whole grains per day. More recently, using data from the 1999-2000 National Health and Nutrition Examination Survey (NHANES), it was shown that only 6% of women consumed 3 or more servings of whole grains and that 30% of the final sample consumed no whole grains at all on the day of the recall [24]. Data from 2001-2002 NHANES also showed that less than 10% of grain products consumed were whole grain [10].

Previous epidemiologic and prospective cohort studies of adult populations have reported an inverse relationship between whole grain intake (including bran) and changes in body mass index (BMI), waist circumference (WC), and abdominal adiposity in men and women [24-27]. The objectives of this study were: 1) to examine the relationship of whole grain consumption, using the current definition for whole grain, with body weight measures in a nationally representative sample of adults from the NHANES 1999-2004; and 2) to compare the relationship of whole grain intake with anthropometric measures based on a model with age, gender, ethnicity, and energy as covariates and a model with cereal fiber added as an additional covariate.

2. Methods and materials

2.1. Data collection

The continuous NHANES is a cross-sectional survey that collects data about the nutrition and health status of the US population using a complex, multi-stage, probability sampling design. Data are released in 2 year increments; and as recommended by NHANES, the data sets from 1999-2000, 2001-2002, and 2003-2004 were combined [28] to form a larger sample size. Detailed information about the NHANES design, procedures, and methodologies can be found on the National Center for Health Statistics Web site [29].

Trained interviewers conducted in-person 24-hour dietary recalls using an automated multiple pass data collection method [30,31]. For data collection years, 1999-2002, a single multiple-pass 24-hour dietary recall was conducted during an interview using computer-assisted software to record dietary intake data from participants [32]. In 2003-2004, two days of intake were collected; however, for this study, only the data from the interview administered recall (first recall) were used to assure consistency with the earlier study. Detailed descriptions of the dietary interview methods are provided in the NHANES Dietary Interviewer's Procedure Manual, which includes pictures of the Computer-Assisted Dietary Interview system screens, measurement guides, and charts used to collect dietary information [33].

2.2. Subjects and whole grain consumption categories

The NHANES data collected from 1999-2004 were used in a secondary analysis to compare whole grain consumption and body weight measures in adults 19-50 years of age (y) (n = 7,039) and 51+ y (n = 6,237). These age groups were selected based on the Dietary Reference Intake (DRI) age groupings. Pregnant and lactating females (n = 993) were excluded from the analyses. In addition, there were six foods that were introduced in 2003 that could contain whole grain; however, there was no information in the nutrient database to calculate the whole grain content of these foods. The foods included Milk n' Cereal bar (General Mills, Minneapolis, MN), several character cereals, Berry Burst Cheerios (General Mills), Fruit Harvest cereal (Kellogg, Battle Creek, MI), and Optimum Nature's Path (Nature Path's Foods, Richmond, BC, Canada). Adults (n = 31) who