Nutrition 31 (2015) 708–715

Contents lists available at ScienceDirect

Nutrition

journal homepage: www.nutritionjrnl.com

Applied nutritional investigation

Dietary contributors to glycemic load in the REasons for Geographic and Racial Differences in Stroke study

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ARTICLE INFO

Article history:
Received 25 July 2014
Accepted 30 November 2014

Keywords:
Dietary carbohydrates
Glycemic index
Sweetened beverages
Dietary assessment
Food frequency questionnaire

ABSTRACT

Objective: High dietary glycemic load (GL) has been associated with an increased risk for chronic diseases, including type 2 diabetes, coronary heart disease, and selected cancers. The aim of this study was to identify the main food and food group contributors to dietary GL in a representative sample of US adults to inform future interventions.

Methods: Participants were from the REGARDS (REasons for Geographic and Racial Differences in Stroke) study, a longitudinal cohort of 30 239 community-dwelling black and white women and men ages ≥45 y from throughout the United States. Diet was assessed with a food frequency questionnaire. The amount of each carbohydrate food, and its glycemic index, were used to calculate GL values for each carbohydrate food reported. These were totaled to estimate the mean total daily GL for each participant. Individual carbohydrate foods also were collapsed into 18 carbohydrate food groups, and the portion of the total GL contributed by each carbohydrate food and food group was determined. Analyses were conducted overall, by race/sex groups, and by region.

Results: Sweetened beverages were the main contributors to GL overall (12.14 median percentage [median %] of daily GL), by far the largest contributors in black men (17.79 median %) and black women (16.43 median %), and major contributors in white men (12.02 median %) and white women (11.22 median %). Other important contributors to GL overall and in all race/sex groups and regions included breads, starchy side dishes, and cereals.

Conclusions: In this US cohort of white and black adults, sweetened beverages were major contributors to GL overall, especially in black participants. This information may help to inform future interventions targeting reduction in dietary GL.

Introduction

Carbohydrates elicit a wide spectrum of blood glucose and insulin responses, influenced by both their quality and quantity. Glycemic index (GI) is a ranking of carbohydrate-containing foods based on their postprandial blood glucose responses relative to a carbohydrate standard and is a measure of carbohydrate quality [1]. Generally, the lower the GI, the lower the rate

This study was supported by cooperative agreement U01 NS041588 from the National Institute of Neurologic Disorders and Stroke, National Institutes of Health, Department of Health and Human Services. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute of Neurologic Disorders and Stroke or the National Institutes of Health. Representatives of the funding agency have been involved in the review of the manuscript but not directly involved in the collection, management, analysis, or interpretation of the data. Additional funding for scanning and analysis of the dietary questionnaires used in this study was provided by General Mills Bell Institute of Health and Nutrition. Representatives from General Mills Bell Institute of Health and Nutrition did not have any role in the design and conduct of this study; the collection, management, analysis, and interpretation of the data; or the preparation or approval of the manuscript. JMS conceptualized and designed the study, supervised data analysis, interpreted the data, and drafted the manuscript. SEJ and AJL assembled and analyzed the data, and reviewed and revised the manuscript. JDA and PKN reviewed and revised the manuscript. All the authors approved the final version of the manuscript.

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http://dx.doi.org/10.1016/j.nut.2014.11.017
0899-9007/

of absorption of the carbohydrate and the smaller the rise in postprandial glucose and insulin concentrations [2]. In general, most refined, high-starch carbohydrates have a high GI, whereas low-starch vegetables, fruits, and legumes tend to have low GI values. Glycemic load (GL) is a measure that incorporates both the quality and quantity of dietary carbohydrates. The concept of GL was introduced to advance the notion that the overall glycemic effect of the diet, not the GI of carbohydrates or the amount of carbohydrates alone, is the more important exposure in relation to disease risk [3].

Observational studies have provided evidence that consumption of high-GL diets is associated with an increased risk for chronic diseases, including type 2 diabetes [4,5], dyslipidemia [3, 6], coronary heart disease (CHD) [7–9], selected cancers [10–12], and combined chronic diseases [11]. Additionally, small clinical studies have suggested that GL may play a role in overeating and obesity [13–15].

Although studies investigating the association between GL and chronic diseases have increased over the past decade, there is a dearth of information in the literature on the major dietary contributors to GL in the US population. As interest in the possible role of GL in the risk for chronic disease increases, dietary interventions to reduce GL likely will become more prevalent. Determining the major food contributors to dietary GL in the typical US diet will be necessary to inform effective dietary interventions. The REGARDS (REasons for Geographic and Racial Differences in Stroke) study provided an opportunity to determine contributors to GL in a representative sample of US white and black adults overall and also by race/sex groups and geographic region.

Participants and methods

Study population

Details on the design, methods, and objectives for REGARDS previously were published [16]. Briefly, REGARDS is a longitudinal cohort of 30 239 community-dwelling black and white women and men who were recruited between January 2003 and October 2007 via mail and telephone using commercially available lists of residents of the United States. The sampling scheme included 30% of participants from the stroke belt (North Carolina, South Carolina, Georgia, Tennessee, Alabama, Mississippi, Arkansas, and Louisiana), 20% from the stroke buckle (the coastal plain of North Carolina, South Carolina, and Georgia), and the remainder from elsewhere in the continental United States. Within each region, the goal was to include 50% white and 50% black participants.

Criteria for inclusion in the sample included having a name, telephone number, and address in the commercially available nationwide database from which the sample was selected, and age ≥45 y. Exclusion criteria included race other than white or black, active treatment for cancer, chronic medical conditions precluding long-term participation, cognitive impairment, current or impending residence in a nursing home, or inability to communicate in English. An initial phone interview was used to survey participants and establish eligibility. An in-home examination was conducted among those eligible, to perform physical measurements, a resting electrocardiogram, medication inventory, phlebotomy, and urine collection. Although not the focus of this study, the cohort is being followed for incident cerebrovascular and cardiovascular diseases (CVDs), and for changes in cognition. The Institutional Review Board for Human Use at the University of Alabama at Birmingham approved the study protocol, and all participants provided written informed consent.

Of the full cohort of 30 239 REGARDS participants, 8603 who either were missing dietary data, had more than 15% missing data on the food frequency questionnaire (FFQ), or had implausible reported energy intakes (<800 or >5000 kcal/d for men and <500 or >4500 kcal/d for women) were excluded. This resulted in a final analytical data set of 21 636 participants (71.5% of the cohort).

Dietary assessment

During the in-home examination, study personnel left various questionnaires with participants, including the Block 98 FFQ, a semiquantitative FFQ that assessed usual dietary intake of 110 food items (NutritionQuest, Berkeley, CA, USA). This FFQ has been validated using multiple diet records [17,18]. For each item on the FFQ, participants were asked how often, on average, they consumed the food during the previous year. Participants selected from nine possible frequencies ranging from *never* to *every day*. For each item on the FFQ, the quantity of the food consumed also was recorded. For unitary items (e.g., eggs or slices of bacon), the usual number consumed each time the food was eaten was queried (one, two, three, or four). For nonunitary foods, a photo was provided to participants to aid in estimating usual portions for foods served on plates (1/4, 1/2, 1, or 2 cups) and usual portions for foods served in bowls (1/2, 1, or 2 cups).

The FFQ was self-administered by participants and returned in self-addressed prepaid envelopes to the REGARDS Operations Center, where they were checked for completeness and scanned. In accordance with standard procedures, amounts of each food on the FFQ consumed by a participant were calculated by multiplying the frequency of consumption of that food by the usual amount consumed. NutritionQuest then processed the FFQ data for nutrient content. NutritonQuest assigned GI values to each carbohydrate food (GI reflects the quality of the carbohydrate and is independent of quantity) and estimated GL values for a standard portion size of each carbohydrate food (GL reflects the quality and quantity of the carbohydrate) on the Block 98 FFQ. Available carbohydrate—defined as the US Department of Agriculture (USDA) National Nutrient Database for Standard Reference [19] value for grams of carbohydrate per serving minus the USDA value for grams of dietary fiber per serving—was used in calculations of GL because the intended use of GL is as an indicator of the overall glycemic effect of food, and glycemic effect is inherently a function of dietary carbohydrate which actually is digested and absorbed. Using the supplied GL values for standard portion sizes, the GL values for any amount of each carbohydrate-containing food on the FFQ reported by a given participant could be calculated. The GLs contributed by each food were totaled to estimate the mean total daily GL for each participant, as well as the portion of the total GL contributed by each carbohydrate-containing food on the FFQ.

For this analysis, 71 individual foods providing any carbohydrate for any participant from the FFQ were identified as potentially important contributors to overall dietary GL based on carbohydrate content. These foods also were collapsed into 18 carbohydrate food groups based on similarities in type of food, macronutrient content, and intended use (Table 1).

Statistical analysis

Descriptive statistics (including means, SDs, and proportions) of participant characteristics at the baseline assessment according to race/sex subgroups and also by geographic region (stroke belt, buckle, non-belt) using the χ^2 test (for proportions) and analysis of variance (for continuous variables) were calculated. For each participant, the GL contribution from each individual food and carbohydrate food group as a percentage of the daily total were calculated. Median percentages (median %) of daily GL for each race/sex and region subgroup were determined. Median was chosen as a better representation than mean because of inherent skewness in the diet data, and the values for foods and food groups were ranked to identify differences across subgroups. SAS version 9.2 (SAS Institute, Cary, NC, USA) was used for data manipulation and analysis.

Results

The analytical sample included 21 636 REGARDS participants, including 7074 white men, 2472 black men, 7287 white women, and 4803 black women (Table 2). The mean (SD) age of participants was 64.9 (9.3) y at baseline in 2003 to 2007, with the mean (SD) age of the four race/sex groups ranging from 63.3 (9.0) y (black women) to 66.4 (9.2) y (white men). Participants living in the non-belt region were slightly older than those living in the stroke belt and buckle regions. White participants had higher levels of education than black participants, with the highest proportion of college graduates being white men (48.3%) and the lowest being black women (27.4%). Participants living in the non-belt region were more educated than those living in the stroke belt and buckle. Mean body mass index (BMI) was in the obese range in black women (31.9 [7.2] kg/m^2) and was considerably higher than the other three race/sex groups, but did not vary by region. Mean GI varied only slightly among the race/sex groups (highest in black men and lowest in white women), and was slightly lower in the non-belt region. Mean (SD) daily GL was 107.1 (44.1), 115.0 (53.8), 89.9 (40.6), and 100.0 (49.6) g/d in white men, black men, white women, and black women,