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Differences in fruit and vegetable intake of U.S. adults by sociodemographic characteristics evaluated by two methods☆

M. Katherine Hoy*, Joseph D. Goldman, Alanna J. Moshfegh

Food Surveys Research Group, Beltsville Human Nutrition Research Center, Agricultural Research Service – USDA, 10300 Baltimore Avenue, Bldg. 005, Beltsville, MD 20705, USA

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ABSTRACT

Socioeconomic factors have been associated with fruit and vegetable (FV) intake. Nutrition behaviors such as choosing and consuming FV may be among many factors related to racial/ethnic health disparities. Intake can be measured using an epidemiological approach that includes FV from all foods, or a behavioral approach that includes choices consistent with dietary guidance, which excludes incidental amounts present in small quantities (e.g. tomato in catsup) and sources high in added sugars, fat, and sodium. The purpose of this study is to describe and compare FV intake by sociodemographic characteristics using both methods One day dietary intake data of adults 20+ years (N = 10,563) from What We Eat in America, NHANES 2009–2012 were used. FV in foods was estimated using the Food Patterns Equivalents Database (FPED) 2009–2012 and is expressed as cup equivalents (CE). Mean intakes and percent reporting were compared by gender, age, ethnicity, income, education using both methods. Comparisons were made by *t*-tests with regression adjustment for covariates. Results were considered significant at $P < 0.001$. Using the epidemiological approach, estimates of intake ranged from 0.8 to 1.2 CE for fruit and 1.1 to 1.7 CE for vegetables. When estimated by the behavioral approach, fruit intake ranged from 0.8 to 1.1 CE, and vegetable intake excluding potatoes was 0.8 to 1.3 CE. Significance of most differences within each sociodemographic did not change between the two methods. With some exceptions, mean FV intakes and percentage reporting any intake were higher among women, older individuals, Non-Hispanic whites and in some cases Hispanics, individuals at higher income levels and those with less than high school education. These results can inform evaluation of the impact of dietary guidance messages and needs for nutrition education.

1. Introduction

The health benefits of fruit and vegetable (FV) consumption are widely recognized (USDA and US DHHS, 2016; Wang et al., 2014). However, most individuals do not consume recommended amounts on a given day (Moore and Thompson, 2015; Kimmons et al., 2009). Sociodemographic characteristics are among several factors that have been associated with fruit and vegetable intake (Kell et al., 2015; August and Sorkin, 2011; Dubowitz et al., 2008). Differences in food intake behaviors such as FV consumption may, in part, be related to racial/ethnic health disparities (August and Sorkin, 2011; Bahr, 2007). Thus, identifying differences in food intake among socio-demographic groups is informative for tailoring education programs targeting nutrition behaviors.

As previously reported (Hoy et al., 2016), estimates of FV intake vary depending on what is counted towards intake, which may be determined by the research purpose. Intake of the U.S. population is estimated using the Food Patterns Equivalents Database (FPED) (Bowman et al., 2013, 2014) which disaggregates all FV ingredients in a food or beverage to its respective component or subcomponent, regardless of amount of FV, added sugar, fat, and/or sodium it contains. This approach has been termed 'epidemiological' (Hoy et al., 2016; Cullen et al., 1999), and these estimates are important for monitoring nutrient intake of the population and evaluating relationships between dietary components and health. Alternatively, FV intake can be estimated from a 'behavioral' perspective that presumes when FV are identifiable as a discrete item or as an integral component of a mixed dish, an individual is consciously consuming them (Hoy et al., 2016). Foods included towards intake contain FV in a specified minimum amount, while excluding foods high in added sugar, fat, and/or sodium that are identified as nutrients of concern in the 2015–2020 Dietary Guidelines for Americans (USDA and US DHHS, 2016). A behavioral approach is more relevant for evaluating the MyPlate nutrition message to "make half the plate fruit and vegetables". It is also consistent with

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* Corresponding author.
E-mail addresses: kathy.hoy@ars.usda.gov, Mkhoy@aol.com (M.K. Hoy).

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recommendations to limit intake of the nutrients of concern.

The purpose of this study is to describe and compare FV intake of U.S. adults by sociodemographic characteristics utilizing both an epidemiological and a behavioral approach.

2. Methods

Estimates are based on one-day of dietary intake data from 10,563 adults age 20 and over (5380 women and 5183 men) who provided a complete 24-h recall in What We Eat in America (WWEIA), NHANES 2009–2012. The NHANES sample was designed to be representative of the civilian, non-institutionalized US population, with oversampling of non-Hispanic blacks, non-Hispanic Asians (in 2011–2012 only), Hispanics, adults 80 years and older, and low-income persons to improve the accuracy of estimates of health status indicators for these population subgroups (Johnson et al., 2014). The NHANES protocol was approved by the NCHS Research Ethics Review Board (Centers for Disease Control and Prevention, 2015).

2.1. Dietary intake data collection and coding

Dietary recall data were collected by trained interviewers using the USDA Automated Multiple-Pass Method for the 24-h recall (Moshfegh et al., 2008). This study used food intake data from the first of two nonconsecutive dietary recall days, which were collected in person. All foods were coded using the USDA Food and Nutrient Database for Dietary Studies (FNDDS), which is the database of over 7000 foods and beverages, their nutrient values, and weights for typical portions used to process data from WWEIA, NHANES. Data reported in WWEIA, NHANES 2009–2012 were coded using FNDDS, 5.0 (2009–2010) (USDA-ARS, 2012 and WWEIA, NHANES 2011–2012 (2011–2012) and FNDDS 2011–2012 (USDA-ARS, 2014).

2.2. Estimation of fruit and vegetable intake

The Food Patterns Equivalents Databases (FPED) 2009–2010 and 2011–2012 were used to estimate the FV content of foods and beverages in FNDDS. The FPED converts the foods and beverages in FNDDS to 37 USDA Food Patterns (FP) components. FV are expressed as cup equivalents (CE) per 100 g. Single component foods such as 100% orange juice and carrots can be directly converted to FV food pattern components. Multi-ingredient foods, such as mixed dishes, condiments, and some beverages are disaggregated to ingredients, and any FV contained in the food is assigned to its respective FP component(s). For example, the tomato in catsup is counted towards total vegetable intake and any orange juice in an orange fruit drink is included in estimates of fruit intake. Details about the FPED methodology can found at http://www.ars.usda.gov/Services/docs.htm?docid=23871.

The methodology for estimating intake using each approach has been described previously (Hoy et al., 2016). Briefly, estimates using the epidemiological method were the sum total of FV from all reported foods and beverages, regardless of source or amount provided. The behavioral estimates included FV provided by discrete items (apple, broccoli, 100% fruit juice), and those in mixed dishes that contained approximately ½ cup equivalent per 1 cup serving. In FPED, this equated to about 0.2 CE per 100 g. Foods not considered to be optimal choices because of added sugar, sodium and/or fat content were not included (e.g. potato chips; apples in apple pie). However, estimates of vegetable intake are shown both including and excluding fried potatoes because they are discrete items and are a substantial source of nutrients for some groups (Storey et al., 2013). Legumes were not included in estimates of vegetable intake. Foods included in estimates using the behavioral approach are a subset of those using the epidemiological method.

3. Statistical analyses

To describe the dietary intake of FV using each method, the mean intake in CE and percent meeting recommendations on the reporting day were calculated. Analyses were carried out using SAS® software release 9.3 (2011, SAS Institute, Cary, NC). SUDAAN release 11.0 (2012, Research Triangle Institute, Research Triangle Park, NC) was used to adjust for survey design effects resulting from NHANES' complex, multistage probability sampling. All analyses used sample weights to produce nationally representative estimates.

Mean intake and percentage reporting were compared by gender, age (20–39, 40–59 60+ years), ethnicity (Non-Hispanic white, Non-Hispanic black, Hispanic), family income categorized by the poverty income ratio (PIR) (low: < 130% PIR, middle: 130 ≤ 300% PIR, high: > 300% PIR), and education (< high school (HS), HS graduate, > HS). Differences between subgroups for each characteristic were compared by *t*-tests with regression adjustment for age, gender, race/ethnicity, income, education, physical activity, weight status, and smoking as appropriate. Differences were considered statistically significant at $P < 0.001$.

4. Results

4.1. Mean fruit intake

Mean total fruit intakes for each demographic group using the epidemiological and behavioral methods are shown in Table 1. Compared to the epidemiological approach, estimates of fruit intake using the behavioral approach ranged from 0 to 10% lower across all demographic groups. Significance of differences between the categories of each sociodemographic characteristic remained the same using both methods. Thus, discussion of mean fruit intake applies to results using both methods.

Comparison of the categories within each sociodemographic group showed that mean total fruit intake was higher among those 60+ years vs 20–39 (but not 40–59) years, Hispanics vs Non-Hispanic whites (but not blacks), and those with less than high school education vs education beyond high school (but not high school). There were no significant differences between men and women, or between income categories. However, the CE intake of fruit per 1000 kcal was significantly higher for women vs men. Intake of whole fruit excluding juice was higher as age increased, and among Hispanics vs Non-Hispanic whites and blacks. Intake of 100% juice was higher among blacks, and among low vs middle (but not high) income categories.

4.2. Mean vegetable intake

Mean total vegetable intakes for each demographic group using the epidemiological and behavioral methods are shown in Table 2. Compared to the epidemiological approach, estimates of vegetable intake using the behavioral approach were around 15%–30% lower across all demographic groups. The significance of differences between categories of each demographic group varied between the two approaches. Thus, mean vegetable intake is discussed using results from the behavioral approach unless differences between the two methods are being contrasted.

Mean total vegetable intake was higher for men vs women, but differences were not significant when fried potatoes were excluded. However, the CE vegetable intake per 1000 kcal was significantly higher for women vs men both including (0.7 vs 0.6 CE/1000 kcal) and excluding (0.6 vs 0.5 CE/1000 kcal) fried potatoes. Mean total vegetable intake of those 20–39 years was significantly higher than those 40 years and older but was significantly lower than the older groups when fried potatoes were excluded. Vegetable intake, both including and excluding fried potatoes, was higher for Non-Hispanic whites vs. Non-Hispanic blacks (but not Hispanics). By income level, there were no

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