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Variety of fruit and vegetables is related to preschoolers' overall diet quality

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ABSTRACT

Children are encouraged to eat a specific amount of fruits and vegetables to optimize health. The purpose of this study was to assess whether consumption of a variety of fruits and vegetables, respectively, was associated with a greater diet quality among preschool-aged children. Analyses were performed using a cross-sectional, nationally representative sample of US children. Dietary intakes from 24-h dietary recalls of two-five year old children ($n = 2595$) in 2005–2010 NHANES were examined. Diet quality was evaluated using MyPlate equivalents and the Healthy Eating Index 2010 (HEI-2010). Variety categories were determined based on children's fruit, fruit juice, and vegetable consumption on the recalled day. Differences in diet quality were examined using *t*-tests. Variety of fruits and vegetables was linked to higher overall diet quality. Children who consumed whole fruit had better diet quality scores for total fruit, whole fruit, whole grains, dairy, seafood, refined grains, sodium, and empty calories ($P \le 0.018$). Significantly higher HEI-2010 scores for total fruit, whole fruit, fatty acids, sodium, and empty calories, but a lower dairy HEI-2010 score, were identified in children who drank fruit juice ($P \le 0.038$). Vegetable consumption was significantly associated with higher total vegetables, greens/beans, and empty calories, but a lower sodium score ($P \le 0.027$). Children who consumed whole fruit, fruit juice and non-starchy vegetables ($P \le 0.017$), but not white potatoes, had significantly higher total HEI-2010 scores. Reinforcing fruit and 100% fruit juice consumption may indirectly support healthier diets among children. However, underlying associations between fruit and vegetable intakes and overall diet quality should be examined further.

1. Introduction

Numerous health promotion efforts reinforce increased consumption of fruits and vegetables because of the many resulting health benefits (Kim et al., 2014; Miller et al., 2011; World Health Organization, 2002). While young children's consumption of fruit is more likely to meet current guidelines, vegetable consumption in the United States continues to be less than recommended (Guenther et al., 2006; Ramsay et al., 2014; US Department of Health and Human Services and United States Department of Agriculture, 2015). Not only do national guidelines encourage the general population to consume a greater quantity of fruits and vegetables, but guidelines also promote the consumption of a variety of fruits and vegetables to optimize health and nutritional status (US Department of Agriculture, 2010). However, the leading sources of fruits in children's diets are in the forms of 100% fruit juice, apples, and oranges that are generally lacking in the variety needed to promote nutritional diversity (Lorson et al., 2009).

Although, achieving adequate overall intakes of fruits and vegetables are important, greater focus on variety is needed to support the health benefits conferred by various vitamins, minerals and phytochemicals (US Department of Agriculture, 2010). While some nutrients are commonly found in many fruits and vegetables, such as vitamins A and C, and potassium, there can be vast differences in overall nutrient content (Drewnowski, 2005). Consumption of a variety of fruits and vegetables can increase the likelihood of a greater nutrient intake in children (US Department of Agriculture, 2010). To date, a paucity of research with children and adolescents has examined fruit and vegetable intakes separately (Ramsay et al., 2014; Krolner et al., 2011) as well as the actual benefit of consuming a variety of fruits and vegetables (Ramsay et al., 2014). While the Dietary Guidelines for Americans (US Department of Agriculture, 2010) has consistently encouraged the consumption of a variety of fruits and vegetables, and previous research suggest a consumption of a variety of fruits and vegetables is linked with overall nutrient intakes in young children (Ramsay et al., 2014), there is a need for further research.

Children's eating behaviors develop in early childhood (Birch and Fisher, 1998) and are related to food preference and intake in adolescence (Skinner et al., 2002). Much of the health promotion efforts for children's consumption of fruits and vegetables have emphasized

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quantity rather than a variety (Evans et al., 2012); however, reinforcing and supporting intakes and liking of a variety of fruit and vegetables in early childhood could have important implications for improving children's overall diet quality and health status later in life.

To fill the gap in evidence for the relationship between variety in children's fruit and vegetable intakes and overall diet quality (Ramsay et al., 2014), the purpose of this study was to assess whether consumption of a variety of fruits and vegetables, respectively, was associated with a greater diet quality among preschool-aged children as measured using the Healthy Eating Index 2010 (HEI-2010) (Guenther et al., 2013; Guenther et al., 2014). Specific objectives of the study were to: 1) Describe children's fruit and vegetable intake in terms of amount and variety of fruit and vegetables; 2) Determine whether differences in overall diet quality exist among children based on the variety of fruit and vegetables consumed; 3) Determine whether differences exist in overall diet quality between children who consume commonly researched fruits and vegetables categories versus those who do not.

2. Methods

One day dietary intakes of children aged 2–5 years ($n = 2595$) from the 2005–2010 National Health and Nutrition Examination Survey were examined to identify the relationship between consuming a variety of fruits and vegetables and overall diet quality. These data represent a cross-sectional national nutrition monitoring survey that assessed the health and nutritional status of the non-institutionalized US population (Centers for Disease Control and Prevention, 2009). Household 24-h recall interviews were conducted to collect sociodemographic and personal characteristics. Physical examinations and dietary intake data were collected in a Mobile Examination Center. Data were collected in two-year cycles as NHANES employs a multi-stage, random sampling approach, with an oversampling of young children, adolescents, Hispanics, African Americans and low-income persons. Informed consent was obtained from all parents who volunteered to participate in the study before they provided information on their children's dietary intake. More information about the procedures utilized to collect the data is described elsewhere (Centers for Disease Control and Prevention, 2009). All protocols were approved by the NHANES ethics review board.

Quantitative dietary intake data were obtained from a 24-h dietary recall interview conducted using a Computer Assisted Dietary Interview process by trained interviewers during a Mobile Examination Center visit. The interview was conducted with an adult proxy that was most familiar with the child's consumption during the time period of assessment using the Automated Multiple Pass Method (Ahuja et al., 2012; Moshfegh et al., 2008). Individual foods and beverages reported for the previous 24 h prior to the interview were collected with the time, eating occasion, food source and amount. The nutrients and MyPlate intake equivalents for fruits and vegetables were estimated using the Food and Nutrition Database for Dietary Surveys (US Department of Agriculture, Agricultural Research Service, 2014) and the Food Patterns Equivalents Database (FPED) as described by Bowman et al. (2013), respectively. Children were included in the final analyses if they had valid and reliable dietary recall data, per NHANES protocol (Ahuja et al., 2012; Moshfegh et al., 2008).

Diet quality was measured by means of the 2010 Healthy Eating Index (HEI-2010) described by Guenther et al. (2013) using the data from the MyPlate food group equivalents from the FPED (Bowman et al., 2013). The total HEI-2010 score (maximum score of 100), a measure of overall diet quality, is comprised of a summative score across 12 subscales, with higher scores indicative of a better diet quality. The subscale scores are computed based on the proportion of children achieving thresholds of food group intakes per 1000 kcals. The HEI-2010 scores were tallied from the number of MyPlate equivalents consumed for the following subscales: total fruit (0–5); whole fruit (0–5); total vegetables (0–5); greens and beans (0–5); whole grains (0−10); dairy (0–10); total protein foods (0–5); seafood and plant proteins (0–5); fatty acids (0–10); refined grains (0–10); sodium (0–10); and empty calories (0−20).

Fruit and vegetable variety was evaluated using intakes of 1) citrus whole fruit (including cut-up fruit), 2) non-citrus whole fruit (including cut-up fruit), 3) 100% fruit juice, 4) dark green vegetables, 5) red and orange vegetables (comprised of tomato products and other red or orange vegetables), 6) starchy vegetables (comprised of white potatoes i.e. French fries, peas, and corn) and 7) other vegetables. Determination of children's Fruit and Vegetable Variety score was computed as the sum of consumption from the aforementioned fruit and vegetable categories (range: 0–7). Thus, three fruit categories and four vegetable categories were used to determine the 7 point variety score.

Children's intakes for each fruit and vegetable category were dichotomized to “consumers” and “non-consumers” based on the total FPED values for the day of record. Consumers from the above fruit and vegetable categories were defined as those children with any reported fruit intake or vegetable intake (in cup equivalents) on the recorded day. For example, a child with a reported zero cup of fruit juice consumed was identified as a ‘non-consumer.” To assess the differences in diet quality across consumption of commonly targeted fruit and vegetable groups from nutrition research, intakes of fruit juice, whole fruit, non-starchy vegetables and white potatoes were dichotomized to identify “consumers” and “non-consumers” on the day of intake for comparison.

2.1. Statistical analysis

Public use data were downloaded from the National Center for Health Statistics (NCHS) and United States Department of Agriculture (USDA) websites and tabulated using the Statistical Package for the Social Sciences (SPSS version 22, 2015, IBM SPSS Inc.,). Means and standard errors of the HEI-2010 total scale score and subscale scores were compared using the stratified Fruit and Vegetable Variety scores of children's reported intake. Analysis also was conducted to assess the diet quality across the consumption of specific fruit and vegetable subgroups. Descriptive statistics were computed to identify the proportion of 2–5 year old children that consumed fruit, vegetable, fruit juice, and white potatoes on the day of record.

To account for the complex sampling design and produce nationally-representative estimates with statistically-appropriate standard errors, data were analyzed using the Complex Samples module of SPSS. Data are presented as means and standard errors or un-weighted counts and weighted population percent for categorical data. Potential differences in total and subscale HEI-2010 scores were assessed between “consumers” and “non-consumers” using independent samples *t*-tests. Significance was established a priori at $P < 0.05$.

3. Results

The sample was 52% male ($n = 1349$), 48% female ($n = 1246$), 55% non-Hispanic white ($n = 852$), 14% African-American ($n = 557$), 16% Mexican American ($n = 774$), and 15% Other ($n = 412$.) The overall mean (SE) intakes per day of fruit and vegetables were 1.5 (SE: 0.04, range:0–11.3) cups and 0.7 cups (SE:0.02, range: 0–6.0), respectively. Of the 2595, 76% ($n = 1989$) drank fruit juice, 74% ($n = 1840$) ate whole fruit, 50% ($n = 1317$) consumed white potatoes and 85% ($n = 2196$) reported a non-starchy vegetable on the day of the recall. The overall mean HEI-2010 score for all children was 49.9 (SE:0.45, range: 12.81–89.3) out of a possible 100 points (Table 1).

3.1. Children's variety of fruit and vegetable intake

Only 1% ($n = 25$) of the children did not consume a fruit or vegetable and 2% ($n = 44$) consumed 7 different fruit or vegetable categories. The highest percentage of children consumed 3–5 different fruits and vegetables on the recalled day: 3 year old children ($n = 595$, 22%), 4 year old