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Dried fruit consumption is associated with improved diet quality and reduced obesity in US adults: National Health and Nutrition Examination Survey, 1999-2004

Debra R. Keast[a], Carol E. O'Neil[b,*], Julie M. Jones[c]

[a]Food & Nutrition Database Research, Inc, Okemos, MI 48864, USA
[b]School of Human Ecology, Louisiana State University Agricultural Center, Baton Rouge, LA 70803, USA
[c]Department of Family, Consumer and Nutritional Sciences, St Catherine University, St Paul, MN 55112, USA

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Abstract

Epidemiological studies examining potential associations between dried fruit consumption, diet quality, and weight status are lacking. The goal of this study was to examine the association of dried fruit consumption with nutrient intake, diet quality, and anthropometric indicators of overweight/obesity. A secondary analysis of dietary and anthropometric data collected from adult (19+ years) participants (n = 13 292) of the 1999-2004 National Health and Nutrition Examination Survey was conducted. Dried fruit consumers were defined as those consuming amounts ⅛ cup-equivalent fruit per day or more and identified using 24-hour recalls. Diet quality was measured using the Healthy Eating Index 2005. Covariate-adjusted means, SEs, prevalence rates, and odds ratios were determined to conduct statistical tests for differences between dried fruit consumers and nonconsumers. Seven percent of the population consumed dried fruit. Mean differences ($P < .01$) between consumers and nonconsumers in adult shortfall nutrients were dietary fiber (+6.6 g/d); vitamins A (+173 μg retinol activity equivalent per day), E (+1.5 mg α-tocopherol per day), C (+20 mg/d), and K (+20 mg/d); calcium (+103 mg/d); phosphorus (+126 mg/d); magnesium (+72 mg/d); and potassium (+432 mg/d). Dried fruit consumers had improved MyPyramid food intake, including lower solid fats/alcohol/added sugars intake, and a higher solid fats/alcohol/added sugars score (11.1 ± 0.2 vs 8.2 ± 0.1) than nonconsumers. The total Healthy Eating Index 2005 score was significantly higher ($P < .01$) in consumers (59.3 ± 0.5) than nonconsumers (49.4 ± 0.3). Covariate-adjusted weight (78.2 ± 0.6 vs 80.7 ± 0.3 kg), body mass index (27.1 ± 0.2 vs 28.1 ± 0.2), and waist circumference (94.0 ± 0.5 vs 96.5 ± 0.2 cm) were lower ($P < .01$) in consumers than nonconsumers, respectively. Dried fruit consumption was associated with improved nutrient intakes, a higher overall diet quality score, and lower body weight/adiposity measures.

Keywords: Raisins; dried fruit; nutrient intake; diet quality; weight; adults; NHANES

Abbreviations: BMI, body mass index; BP, blood pressure; DGAC, Dietary Guidelines Advisory Committee; DRI, dietary reference intakes; FNDDS, Food and Nutrient Database for Dietary Studies; HEI-2005, Healthy Eating Index 2005; μg RAE, microgram retinol activity equivalents; mg AT, milligram α-tocopherol; MEC, mobile examination center; MPED, MyPyramid Equivalents Database; NHANES, National Health and Nutrition Examination Survey; SFA, saturated fatty acids; SoFAAS, solid fats/alcohol/added sugars; SR, Standard Reference.

1. Introduction

Fruit contains a wide array of micronutrients, including vitamins A (particularly in the form of beta carotene) and C,

* Corresponding author. Tel.: +1 225 578 1631; fax: +1 225 578 4443.
E-mail address: coneil1@lsu.edu (C.E. O'Neil).

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folate, potassium, and magnesium; it is also high in fiber but low in total fat, saturated fatty acids (SFA), and sodium. Having insufficient fruit intake makes it difficult to consume adequate amounts of most of the 10 nutrients that the 2010 Dietary Guidelines Advisory Committee (DGAC) identified as "tenuous for adult men and women," including vitamins A, C, D, E, and K, and choline, calcium, magnesium, potassium, and dietary fiber [1]. Adequate consumption of fruit is also associated with a reduced likelihood of dyslipidemia [2], high blood pressure (BP) [3], stroke [4], type 2 diabetes mellitus [5], and some types of cancer [6]. Most fruit is naturally low in energy, and whole fruit has been shown to increase satiety [7]; however, the role of fruit and vegetable consumption in weight loss is unclear [8], but fruit may play a role in weight maintenance [9,10]. The role of dried fruit is less well studied; not only have there been fewer studies, but dried fruit is higher in energy per serving than fresh, canned, or frozen fruit and most fruit juices, so there consumers may have concerns about weight.

The recommendation for fruit intake is dependent on age, sex, and physical activity level; for a 8374 kilojoules (kJ) diet, the MyPyramid recommendation is 2 cups per day [11]. Health promotion organizations, such as the National Cancer Institute [12], the American Heart Association [13], and the Produce for Better Health Foundation's program "More Matters" [14], all promulgate intakes of fruit consistent with MyPyramid recommendations. A variety of forms, that is, fresh, frozen, canned, 100% juice, or dried, can be consumed to meet the requirements [11,14].

When assessing consumption levels, many studies have combined intake of fruit and vegetables; however, those reporting fruit separately have shown that few adults meet the recommendations [15-18]. Data from the 2003-2004 National Health and Nutrition Examination Survey (NHANES) showed that female adults had the highest percentage (12.3%) of those meeting the fruit recommendation; only 8.6% of male adults met the recommendation. For both sexes, the median number of servings consumed was 0.61 per day. Orange juice, bananas, and apples were the most frequently consumed foods from the fruit group [18]. Despite extensive, coordinated public health campaigns by government collaboration with industry [14], consumption of fruit (and vegetables) declined slightly from 1994 to 2005 [15].

Studies have examined associations of whole fruit [2-8] or 100% fruit juice [19,20] with nutritional or health outcomes; however, studies examining potential links between dried fruit, diet quality, and weight status are lacking. Dried fruits, for example, dried plums (prunes), figs, dates, apricots, apples, raisins, currants, and cranberries, contain potassium [21], iron [21], and phytochemicals [22,23]. Dried fruits are also "good sources" of fiber, providing more than 5% of the recommended daily intake (25-g fiber) per labeled serving (40 g) [21]. Therefore, consumption of dried fruit could increase fiber intake; and because of hypothesized effects of fiber on satiety [7], dried fruit could have a role in reducing prevalence of overweight and obesity among adults. Little is known about the overall effect that consumption of dried fruit has on diet quality in adults. The purpose of this study was to determine the association of dried fruit consumption with nutrient intake, diet quality, and weight status among adults in the United States.

2. Methods and materials

2.1. Study population

Data from adults 19+ years old (n = 13 292) participating in the NHANES 1999-2000, 2001-2002, and 2003-2004 were combined for these analyses [24]. Women were excluded from the study if they were pregnant (n = 840), lactating (n = 134), or both (n = 21). National Health and Nutrition Examination Survey has stringent consent protocols and procedures to ensure confidentiality, which protects individual participants from identification under federal laws [25]. Because of the nature of the analysis (secondary data analysis) and the lack of personal identifiers, this study was exempted by the Institutional Review Board of the Louisiana State University Agricultural Center.

2.2. Collection of dietary intake data

Intake data were obtained from in-person 24-hour dietary recall interviews administered using an automated multiple-pass method [26,27]. For data collection years, 1999-2002, only a single 24-hour dietary recall was collected. In 2003-2004, 2 days of intake were collected; however, for this study, only the data from the in-person interview (first recall) were used to ensure consistency. Only recall data judged to be complete and reliable by National Center for Health Statistics staff were included in these analyses. Detailed descriptions of the dietary interview methods are provided in the NHANES Dietary Interviewers Procedure Manual, which includes pictures of the Computer-Assisted Dietary Interview system screens, measurement guides, and charts that were used to collect dietary information [28].

2.3. Nutrient analysis

The USDA Food and Nutrient Database for Dietary Studies (FNDDS), versions 1.0 [29] and 2.0 [30], were used in NHANES, 2001-2002 and 2003-2004, respectively. The USDA 1994-98 Survey Nutrient Database [31] was used to process the dietary interview data in NHANES 1999-2000. In the original release of NHANES 1999-2000, data on vitamin A intake were only available in microgram retinol equivalents; vitamin E intake data were only available in milligram α-tocopherol (mg AT) equivalents; and no data on vitamin K (micrograms) were available [32]. Currently, dietary reference intakes (DRI) for vitamins A and E are expressed as microgram retinol activity equivalents (μg RAE) and mg AT, respectively. The special database released by USDA to determine vitamin A as μg RAE and vitamin E as mg AT [33] was used. The FNDDS was used to

append the intakes of vitamin K (micrograms) to the NHANES 1999-2000 database.

2.4. Fruit group analysis

A food composition database was developed to assess cup equivalent intakes of the MyPyramid fruit group contributed by raisins and other dried fruit. Survey foods consumed in NHANES 1999-2004 that contained any dried fruit (n = 200) were identified. Databases used to identify these foods and determine amounts of dried fruit that they contained included the Nutrient Database for Standard Reference (SR)-Link file (the survey recipe database) of the FNDDS, version 2 [30], the USDA Food Commodity Intake Database [34], and the MyPyramid Equivalents Database (MPED), version 2 [35]. Using the FNDDS, survey foods containing dried fruit were identified if their recipe in the SR-Link file included SR codes for any dried fruit or other foods, such as ready-to-eat cereals that contained dried fruit. Specific types and proportionate gram weights of dried fruit contained in survey foods were also determined using the USDA Food Commodity Intake Database. The proportionate gram weight of dried fruit contained in survey foods was converted to MyPyramid cup equivalents using information derived from the MPED [35]. One-half cup of dried fruit is equivalent to 1 scup of fruit according to the MyPyramid guidelines. Using raisins as an example, given that 1 cup of raisins weighs 145 g, then 100 g (0.68965 cups) of raisins contains 1.3793 cup equivalents of fruit according to the MPED. Consumers were defined as those whose intake from dried fruit eaten out of hand or contained in foods contributed ⅛ equivalent cup per day or more of the MyPyramid fruit group.

2.5. Diet quality

The Healthy Eating Index [36,37] was used to determine diet quality [38]. The whole fruit food composition data and SAS code used to calculate Healthy Eating Index 2005 (HEI-2005) scores were downloaded from the Center for Nutrition Policy and Promotion Website [39].

2.6. Anthropometric and BP measurements

Body mass index (BMI) was calculated as body weight (kilograms) divided by height (meters) squared [40]. For the odds ratio assessments, overweight/obesity and waist circumference were determined using the National Heart Lung and Blood Institute Clinical Guidelines [40]. Waist circumference [41], skinfold thickness measurements [41], and BP [42] were measured by trained personnel in a mobile examination center (MEC) according to NHANES protocols. Hypertension was defined as a systolic BP 130 mm Hg or higher or diastolic BP 85 mm Hg or higher [43].

2.7. Statistical analyses

Sample-weighted data were used, and all analyses were performed using Statistical Analysis Software (version 9.1.3, 2006; SAS Institute, Inc, Cary, NC) and SUDAAN (version 9.0.3, 2007; Research Triangle Institute, Research Triangle Park, NC) to adjust the variance for the complex sample design. For the 6-year 1999-2004, a 6-year weight variable was created by assigning two thirds of the 4-year weight for 1999-2002 if the person was sampled in 1999 to 2002 or assigning one third of the 2-year weight for 2003-2004 if the person was sampled in 2003 to 2004. The 6-year MEC examination sample weight was used in analyses of intake and anthropometric measurements.

The sample-weighted percentages (and SE of the percentages) of adults in dried fruit consumption groups were calculated using PROC CROSSTAB of SUDAAN. Least-square means (and the SEs of the least-square means) were calculated using PROC REGRESS of SUDAAN. The adjusted prevalence of a risk factor was determined by calculating the least-square mean of a dichotomous variable using PROC REGRESS. Data are presented as mean ± SE.

Least-square mean intakes were adjusted for energy (kJ), sex, age (years), and race/ethnicity. Sex, age (years), and race/ethnicity were covariates in the analysis of least-square mean energy intake. In model 1, energy (kJ), sex, age (years), and race/ethnicity were used as covariates in analyses of body weight. In model 2, covariates included energy (kJ), BMI (kilogram per square meter), sex, age (years), race/ethnicity, income, education, marital status, physical activity, TV/computer use, and smoking. Odds ratios were determined by logistic regression calculated using PROC RLOGIST of SUDAAN.

3. Results

Dried fruit consumers (n = 921), defined as those consuming amounts greater than or equal to ⅛ cup equivalent of fruit, constituted 6.9% of the population (Table 1).

3.1. Nutrient and food group intake

Nutrient intake by consumers and nonconsumers of dried fruit is shown in Table 2. Energy intake was higher in dried fruit consumers than nonconsumers (10253 ± 176 vs 9215 ± 42 kJ/d; $P < .01$); thus, subsequent analyses of nutrient intakes were also adjusted for total energy intake. There were

Table 1
Percentage of adults 19+ years (n = 13 292) with dried fruit intakes ⅛ cup equivalent of fruit per day or more by age groups: NHANES 1999-2004

Population age group	Sample size	Consumption level	
		≥1/8 cup equivalent fruit	<1/8 cup equivalent fruit
Adults 19+ y	(n = 13,292)	6.9 ± 0.3	93.1 ± 0.3
Adults 19-50 y	(n = 7049)	5.1 ± 0.4	94.9 ± 0.4
Adults 51+ y	(n = 6243)	10.1 ± 0.4	89.9 ± 0.4

Data are presented as sample-weighted percentages ± SE estimated using SUDAAN. Dried fruit intake is the intake of dried fruit out of hand and in food.

Table 2
Covariate-adjusted mean daily nutrient intake by dried fruit consumption groups in adults 19+ years of age: NHANES 1999-2004

Nutrient[a]	Consumption of fried fruit	
	≥1/8 cup equivalent fruit (n = 921)	<1/8 cup equivalent fruit (n = 12 371)
Food energy (kJ)[b]	10253 ± 176 **	9215 ± 42
Protein (g)	81.6 ± 1.1	82.4 ± 0.4
Total fat (g)	78.1 ± 1.1 **	83.4 ± 0.4
Saturated fatty acids (g)	24.3 ± 0.4 **	27.4 ± 0.1
Monounsaturated fatty acids (g)	29.0 ± 0.5 **	31.3 ± 0.2
Polyunsaturated fatty acids (g)	17.9 ± 0.4	17.1 ± 0.1
Cholesterol (mg)	240 ± 7 **	293 ± 3
Carbohydrate (g)	301 ± 3 **	271 ± 1
Total dietary fiber (g)	21.8 ± 0.4 **	15.2 ± 0.2
Alcohol (g)	5.9 ± 1.0 **	12.3 ± 0.5
Vitamin A (μg RAE)	772 ± 26 **	599 ± 10
Vitamin E (mg AT)	8.4 ± 0.3 **	7.0 ± 0.1
Vitamin C (mg)	111 ± 4 **	91 ± 2
Vitamin K (μg)	109 ± 6 **	89 ± 2
Thiamin (mg)	1.9 ± 0.04 **	1.6 ± 0.01
Riboflavin (mg)	2.4 ± 0.04 **	2.1 ± 0.02
Niacin (mg)	25.9 ± 0.4 **	23.4 ± 0.2
Vitamin B-6 (mg)	2.3 ± 0.05 **	1.8 ± 0.02
Total folate (μg)	484 ± 12 **	392 ± 4
Vitamin B-12 (μg)	6.1 ± 0.4 *	5.1 ± 0.1
Calcium (mg)	953 ± 17 **	850 ± 8
Phosphorus (mg)	1445 ± 18 **	1319 ± 6
Magnesium (mg)	350 ± 5 **	278 ± 2
Iron (mg)	19.1 ± 0.5 **	15.3 ± 0.1
Zinc (mg)	13.1 ± 0.3 **	11.9 ± 0.1
Copper (μg)	1.62 ± 0.04 **	1.29 ± 0.01
Sodium (mg)	3270 ± 52 **	3478 ± 17
Potassium (mg)	3149 ± 36 **	2717 ± 17

Data are presented as sample-weighted least-square means ± SE using PROC REGRESS of SUDAAN.

[a] Covariates in analyses of nutrients include energy (kilojoules), sex, race/ethnicity, and age (years).

[b] Sex, race/ethnicity, and age (years) were covariates in analysis of energy (kilojoules).

* Dried fruit consumption groups differ significantly at $P < .05$

** Dried fruit consumption groups differ significantly at $P < .01$

positive between-group differences ($P < .01$) in nutrients listed by the 2010 DGAC report as "tenuous" in adults, including dietary fiber (+6.6 g/d); vitamins A (+173 μg RAE/d), E (+1.5 mg AT/d), K (+20 mg/d), and C (+20 mg/d); calcium (+103 mg/d), phosphorus (+129 mg/d); magnesium (+72 mg/d); and potassium (+432 mg/d). Dried fruit consumers had significantly lower intakes than nonconsumers of total fat, SFA, monounsaturated fatty acids, cholesterol, alcohol, and sodium (all $P < .01$).

Compared with nonconsumers, dried fruit consumers had significantly higher ($P < .01$) intakes of most MyPyramid food groups, except that intakes of total vegetables, meat, and soy products were not different and intakes of eggs ($P < .01$), oils ($P < .05$), and solid fats/alcohol/added sugars (SoFAAS) ($P < .01$) were lower (data not shown). These findings were mirrored by the higher ($P < .01$) total HEI-2005 score in consumers than nonconsumers (59.3 ± 0.5 vs 49.4 ± 0.3) (Table 3). Dried fruit consumers had higher ($P < .01$) scores than nonconsumers on most components of the total HEI-2005 score, including total fruit, whole fruit, dark green/orange vegetables and legumes, total grains, whole grains, milk, and SoFAAS. Scores on the SFA, sodium, and SoFAAS components of the total HEI-2005 were significantly higher ($P < .01$).

When adjusted for lifestyle measures, dried fruit consumers had lower weight (78.2 ± 0.6 vs 80.7 ± 0.3 kg; $P < .01$) and BMI (27.1 ± 0.2 vs 28.1 ± 0.2 kg/m^2; $P < .01$) than nonconsumers. Between-group differences in weight and BMI were −2.6 kg and −1.1 kg/m^2, respectively. Waist circumference (94.0 ± 0.5 vs 96.5 ± 0.2 cm; $P < .01$) and subscapular skinfolds were also lower in dried fruit consumers (18.7 ± 0.3 vs 19.7 ± 0.2 mm; $P < .05$) than nonconsumers. Finally, systolic BP (121.4 ± 0.7 vs 122.9 ± 0.3 mm Hg) and diastolic BP (71.1 ± 0.6 vs 72.1 ± 0.2 mm Hg) were lower in dried fruit consumers than in nonconsumers (both $P < .05$) (Table 4). The prevalence (percentages) and risk for overweight/obesity (56.2 ± 2.3 vs 65.8 ± 0.7; $P < .01$; odds ratio, 0.65; 95% confidence interval, 0.52-0.81) were both lower in dried fruit consumers than nonconsumers.

4. Discussion

The percentage of US adults who consumed dried fruit was low. Using NHANES 2001-2002 data, Bachman et al [44] reported that dried fruit contributed only 2.6% of whole

Table 3
Covariate-adjusted mean HEI-2005 component score by dried fruit consumption groups in adults 19+ years of age: NHANES 1999-2004

HEI-2005 component score (maximum)[a]	Consumption of dried fruit	
	≥1/8 cup equivalent fruit (n = 921)	<1/8 cup equivalent fruit (n = 12 371)
Total HEI-2005 (100)	59.3 ± 0.5 **	49.4 ± 0.3
Total fruit (5)	3.33 ± 0.08 **	2.04 ± 0.05
Whole fruit (5)	3.44 ± 0.07 **	1.77 ± 0.04
Total vegetables (5)	3.03 ± 0.06	3.02 ± 0.03
Dark green/orange vegetables/legumes (5)	1.49 ± 0.09 **	1.16 ± 0.03
Total grains (5)	4.34 ± 0.05 **	4.15 ± 0.02
Whole grains (5)	1.79 ± 0.06 **	0.90 ± 0.02
Milk (10)	5.35 ± 0.16 **	4.70 ± 0.06
Meat and beans (10)	8.01 ± 0.13	8.16 ± 0.04
Oils (10)	5.66 ± 0.15 *	5.30 ± 0.05
Saturated fat (10)	6.83 ± 0.14 **	5.88 ± 0.06
Sodium (10)	4.86 ± 0.14 **	4.15 ± 0.05
SoFAAS calories (20)	11.14 ± 0.24 **	8.18 ± 0.14

Data are presented as least-square means ± SE using PROC REGRESS of SUDAAN.

[a] Covariates include energy (kilojoules), sex, race/ethnicity, and age (years).

* Dried fruit consumption groups differ significantly at $P < .05$.

** Dried fruit consumption groups differ significantly at $P < .01$.

Table 4
Covariate-adjusted mean body weight measures, prevalence of overweight/obesity, prevalence of abdominal obesity, mean systolic and diastolic BP, and prevalence of hypertension by dried fruit consumption groups in adults 19+ years old: NHANES 1999-2004

Examination component	Consumption of dried fruit	
	≥1/8 cup equivalent fruit (n = 921)	<1/8 cup equivalent fruit (n = 12 371)
Weight (kg)		
Model 1 [a]	77.9 ± 0.6 *	80.6 ± 0.3
Model 2 [b]	78.2 ± 0.6 **	80.7 ± 0.3
BMI (kg/m^2)		
Model 1 [a]	26.9 ± 0.2 **	28.1 ± 0.1
Model 2 [b]	27.1 ± 0.2 **	28.1 ± 0.1
Overweight/obesity (%)		
Model 1 [a]	55.8 ± 2.1 **	65.7 ± 0.7
Model 2 [b]	56.2 ± 2.3 **	65.8 ± 0.7
Waist circumference (cm)		
Model 1 [a]	93.5 ± 0.6 **	96.5 ± 0.3
Model 2 [b]	94.0 ± 0.5 **	96.5 ± 0.2
Abdominal obesity (%)		
Model 1 [a]	39.4 ± 2.2 **	49.5 ± 0.8
Model 2 [b]	40.9 ± 2.2 **	49.4 ± 0.8
Triceps skinfold (mm)		
Model 1 [a]	18.6 ± 0.3	19.1 ± 0.1
Model 2 [b]	18.6 ± 0.3	19.1 ± 0.1
Subscapular skinfold (mm)		
Model 1 [a]	18.7 ± 0.3 *	19.6 ± 0.2
Model 2 [b]	18.7 ± 0.3 *	19.7 ± 0.2
Systolic BP (mm Hg)		
Model 1 [c]	121.4 ± 0.8	123.1 ± 0.3
Model 2 [d]	121.4 ± 0.7 *	122.9 ± 0.3
Diastolic BP (mm Hg)		
Model 1 [c]	71.2 ± 0.6	72.0 ± 0.2
Model 2 [d]	71.1 ± 0.6 *	72.1 ± 0.2
Hypertension (%)		
Model 1 [c]	30.4 ± 1.5 *	33.9 ± 0.8
Model 2 [d]	30.5 ± 1.5	33.6 ± 0.8

Data are presented as sample-weighted least-square means ± SE and percentages using PROC REGRESS of SUDAAN. Overweight/obesity, BMI 25 kg/m^2 or higher; abdominal obesity, waist circumference greater than 102 cm (men), greater than 88 cm (women); hypertension, systolic BP 130 mm Hg or higher or diastolic BP 85 mm Hg or higher.

[a] Covariates: energy (kilojoules), sex, age (year), ethnicity.

[b] Covariates: energy (kilojoules), sex, age (year), ethnicity, income, education, marital status, physical activity, TV/computer use, and smoking.

[c] Covariates: energy (kilojoules), BMI (kilogram per square meter), sex, age (year), and ethnicity.

[d] Covariates: energy (kilojoules), BMI (kilogram per square meter), sex, age (year), ethnicity, income, education, marital status, physical activity, TV/computer use, and smoking.

* Dried fruit consumption groups differ significantly at $P < .05$.

** Dried fruit consumption groups differ significantly at $P < .01$.

fruit cup equivalents consumed in the United States. Despite the low level of consumption, this study showed that consumption of dried fruit was associated with improved nutrient intake, diet quality, anthropometric measures, and BP.

Dried fruit consumers had higher intakes of nutrients that the 2010 DGAC indicated were "tenuous" in adults (dietary fiber; vitamins A, C, and E; calcium; phosphorus; magnesium; and potassium), when compared with nonconsumers [1]. The nutrient content of individual dried fruit varies [21] and reflects the concentration of nutrients found in the raw product. For example, dried apricots, which have 12 669 IU of vitamin A per 100 g, are an excellent source of this shortfall nutrient; by comparison, dried plums have 781 IU of vitamin A per 100g, and raisins have none [21]. Thus, variety is an important component in selecting dried fruit, as it is with any fruit.

Several dried fruits are "good sources" of dietary fiber and potassium, both shortfall nutrients in adults. Raisins, the most commonly consumed dried fruit, have 3.7 g of dietary fiber per 100g. Figs are an excellent source of dietary fiber with 9.8 g per 100g, and dried plums have 7.1 g of fiber per 100g [21]. The difference in dietary fiber intake between dried fruit consumers and nonconsumers was 6.6 g/d, suggesting that additional high-fiber foods contributed to fiber intake in consumers. Assessment of MyPyramid food group intakes indicated that dried fruit consumption was associated with increased intakes of whole grains, dark green/orange vegetables, nuts, and seeds as well as total fruits, which all are good food sources of fiber. Dietary fiber intake is associated with many health benefits including improved weight status, serum cholesterol levels, BP, and blood sugar control [45]. Dietary fiber also decreases insulin resistance and is inversely associated with risk of type 2 diabetes [46]. The dietary fiber DRI for men 19 to 50 years old and 51+ years old is 38 g/d and 30 g/d, respectively; and for women of those ages, it is 25 g/d and 21 g/d, respectively [47]. Most adults in the United States do not meet the daily fiber recommendation [45]. In fact, the average intake is only one half to one third of recommended levels [45]. Mean fiber intakes in this study, even among dried fruit consumers, are consistent with previous findings and are below the adequate intake level recommended for most individuals.

In 2004, the Institute of Medicine increased the recommendation for potassium to 4.7 g/d for adults [48]. This level of potassium intake was chosen to help maintain BP levels, blunt any adverse effects of sodium intake on BP, and possibly decrease bone loss. Recently, it was shown that, on average, very low percentages of individuals in DRI age groups met the potassium recommendation; in adults, the age group 31 to 50 years had the highest percentage of individuals meeting the adequate intake level (3.1%) [49]. Thus, it is important to encourage intake of foods high in potassium, such as dried, fresh, canned, or frozen fruit or 100% fruit juice.

In this study, intake of dried fruit was associated with better overall diet quality as indicated by the higher total HEI-2005 score [36,37] in consumers, compared with nonconsumers. Although consumption of dried fruit was modest, consumption of this single food improved the HEI-2005 by approximately 8%. Scores on many of the individual components of the total HEI-2005 score, including total and whole fruit, dark green/orange

vegetables, total and whole grains, and milk, were also higher in dried fruit consumers than nonconsumers. Because intakes of solid fat, alcohol, and added sugars were lower, dried fruit consumers also had a higher SoFAAS score than nonconsumers. These findings were reflected in the improvement of intake in virtually all macronutrients and micronutrients, except protein. One interpretation of these findings could be that dried fruit consumers are more health conscious and, therefore, have improved diet quality. Another reason could be that although individuals may not reach for fresh fruit even when it is available, by "stealth nutrition," dried fruit could be incorporated into their diet by including it in foods that they do eat, such as ready-to-eat cereals, granola/cereal bars, or baked goods. In addition, if food manufacturers were to incorporate dried fruit into a whole grain product because by itself, whole grain flour has a bitter taste (this is one reason that children prefer refined grain products), then the sweetness and moisture from the dried fruit make the whole grain food more palatable without having added sugar or fat. Thus, the incorporation of dried fruit into foods that are a part of the diet makes them taste better and encourages the consumption of better-for-you foods and not only increases fruit intake but also increases intake of other MyPyramid food groups such as whole grain and nuts and decreases intake of SoFAAS (solid fat and added sugars) calories.

Additional studies are needed to explore the relationship between fruit, including dried fruit, consumption and lifestyle parameters. It is also possible that the incorporation of dried fruit into healthful foods improves the taste without added sugars or fat; this may lead to increased intake of fiber; lower SoFAAS; and, by extension, lower weight. In this study, the definition of dried fruit consumption included dried fruit contained in foods such as fruit and nut mixtures and cereal and grain products; thus, consumption of dried fruit was associated with these foods and also with milk that may have been poured on the cereal. Additional studies looking at pattern analyses of diets including all types of fruit need to be conducted. Overall, it should be noted that diet quality, that is, HEI-2005 scores of dried fruit consumers and nonconsumers needed improvement.

Few studies have looked to see if the consumption of fruit, including dried fruit, was associated with overall nutrient intake or diet quality. Low intake of fruit and vegetables, especially citrus fruit, has been associated with suboptimal intakes of vitamin C [50]. Consumption of 100% fruit juice has also been associated with improved nutrient intake [19,20]. The paucity of comparative studies clearly suggests the need for further research to determine the effect of all fruit on nutrient adequacy and diet quality.

The average energy intake of dried fruit consumers was 1038 kJ higher than nonconsumers; however, weight, BMI, waist circumference, subscapular skinfolds, and risk of overweight were all inversely related to dried fruit consumption. Diastolic and systolic BPs were also inversely associated with dried fruit consumption in this population. Dietary patterns with high intakes of fruit and vegetables have been previously associated with lower BMI, waist circumference, or BP in adults [51,52]; however, no previous studies have assessed this relationship with dried fruit consumption.

This study had several limitations. National Health and Nutrition Examination Survey is a cross-sectional study, and causal inferences cannot be drawn from cross-sectional analyses. Twenty-four–hour dietary recalls do not reflect usual intake; furthermore, they depend on memory; thus, subjects may underreport or overreport intake. However, a single 24-hour recall is sufficient to report mean group intake [53]. Intakes from supplements were not considered. Finally, that only 7% of the population consumed dried fruit could be construed as a study limitation; however, it should be noted that consumption of even modest levels of dried fruit improved nutrient intake and diet quality.

Taken together, results of this dietary and anthropometric assessment suggest that improved diet quality, specifically lower SoFAAS and higher fiber intakes, could account for reduced obesity in dried fruit consumers compared with nonconsumers. Longitudinal studies are needed to determine more fully the effect of dried fruit on diet and weight. Despite ongoing public health campaigns by government and industry [14], fruit consumption in the United States is low. Health professionals should continue to encourage consumption of all fruit, including dried fruit, as part of a healthy diet and overall healthy lifestyle.

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References

[1] U.S. Department of Agriculture. Report of the 2010 Dietary Guidelines Advisory Committee. Part D. Section 2: Nutrient Adequacy (D2-23). Available at: http://www.cnpp.usda.gov/Publications/DietaryGuidelines/2010/DGAC/Report/D-2-NutrientAdequacy.pdf [Accessed October 27, 2010].

[2] Mirmiran P, Noori N, Zavareh MB, Azizi F. Fruit and vegetable consumption and risk factors for cardiovascular disease. Metabolism 2009;58:460-8.

[3] Erlund I, Koli R, Alfthan G, Marniemi J, Puukka P, Mustonen P, et al. Favorable effects of berry consumption on platelet function, blood pressure, and HDL cholesterol. Am J Clin Nutr 2008;87:323-31.

[4] Mizrahi A, Knekt P, Montonen J, Laaksonen MA, Heliovaara M, Jarvinen R. Plant foods and the risk of cerebrovascular diseases: a potential protection of fruit consumption. Br J Nutr 2009;102: 1075-83.
[5] Bazzano LA, Li TY, Joshipura KJ, Hu FB. Intake of fruit, vegetables, and fruit juices and risk of diabetes in women. Diabetes Care 2008;31: 1311-7.
[6] Nomura AM, Wilkens LR, Murphy SP, Hankin JH, Henderson BE, Pike MC, et al. Association of vegetable, fruit, and grain intakes with colorectal cancer: the Multiethnic Cohort Study. Am J Clin Nutr 2008; 88:730-7.
[7] Flood-Obbagy JE, Rolls BJ. The effect of fruit in different forms on energy intake and satiety at a meal. Appetite 2009;52:416-22.
[8] Alinia S, Hels O, Tetens I. The potential association between fruit intake and body weight—a review. Obes Rev 2009;10:639-47.
[9] Buijsse B, Feskens EJ, Schulze MB, Forouhi NG, Wareham NJ, Sharp S, et al. Fruit and vegetable intakes and subsequent changes in body weight in European populations: results from the project on Diet, Obesity, and Genes (DiOGenes). Am J Clin Nutr 2009;90: 202-9.
[10] He K, Hu FB, Colditz GA, Manson JE, Willett WC, Liu S. Changes in intake of fruits and vegetables in relation to risk of obesity and weight gain among middle-aged women. Int J Obes Relat Metab Disord 2004; 28:1569-74.
[11] U.S. Department of Agriculture. Inside the pyramid. MyPyramid.gov Web site. Available at http://www.mypyramid.gov [Accessed June 10, 2010].
[12] National Cancer Institute. Available at www.fruitsandveggiesmatter.gov [Accessed December 22, 2009].
[13] The American Heart Association. Available at http://www.americanheart.org/presenter.jhtml?identifier=4774 [Accessed May 29, 2010].
[14] Produce for better health. Available at http://www.fruitsandveggiesmorematters.org [Accessed May 29, 2010].
[15] Blanck HM, Gillespie C, Kimmons JE, Seymour JD, Serdula MK. Trends in fruit and vegetable consumption among U.S. men and women, 1994-2005. Prev Chronic Dis 2008;5:A35.
[16] Casagrande SS, Wang Y, Anderson C, Gary TL. Have Americans increased their fruit and vegetable intake? The trends between 1988 and 2002. Am J Prev Med 2007;32:257-63.
[17] Guenther PM, Dodd KW, Reedy J, Krebs-Smith SM. Most Americans eat much less than recommended amounts of fruits and vegetables. J Am Diet Assoc 2006;106:1371-9.
[18] Kimmons J, Gillespie C, Seymour J, Serdula M, Blanck HM. Fruit and vegetable intake among adolescents and adults in the United States: percentage meeting individualized recommendations. Medscape J Med 2009;11:26.
[19] Nicklas TA, O'Neil CE, Kleinman R. Association between 100% juice consumption and nutrient intake and weight of children aged 2 to 11 years. Arch Pediatr Adolesc Med 2008;162:557-65.
[20] O'Neil CE, Nicklas TA, Kleinman R. Relationship between 100% juice consumption and nutrient intake and weight of adolescents. Am J Health Promot 2010;24:231-7.
[21] U.S. Department of Agriculture. USDA National Nutrient Database for Standard Reference. Available at http://www.nal.usda.gov/fnic/foodcomp/search [Accessed December 22, 2009].
[22] Parker TL, Wang XH, Pazmino J, Engeseth NJ. Antioxidant capacity and phenolic content of grapes, sun-dried raisins, and golden raisins and their effect on ex vivo serum antioxidant capacity. J Agric Food Chem 2007;55:8472-7.
[23] Vinson JA, Zubik L, Bose P, Samman N, Proch J. Dried fruits: excellent in vitro and in vivo antioxidants. J Am Coll Nutr 2005;24: 44-50.
[24] National Center for Health Statistics, Centers for Disease Control and Prevention. Analytic and reporting guidelines: the National Health and Nutrition Examination Survey (NHANES). Available at http://www.cdc.gov/nchs/data/nhanes/nhanes_03_04/nhanes_analytic_guidelines_dec_2005.pdf [Accessed Aug 4, 2009].
[25] National Center for Health Statistics, Centers for Disease Control and Prevention. Welcome NHANES participants: is my information confidential? Available at http://www.cdc.gov/nchs/nhanes/participant.htm [Accessed December 18, 2009].
[26] Blanton CA, Moshfegh AJ, Baer DJ, Kretsch MJ. The USDA Automated Multiple-Pass Method accurately estimates group total energy and nutrient intake. J Nutr 2006;136:2594-9.
[27] Moshfegh AJ, Rhodes DG, Baer DJ, Murayi T, Clemens JC, Rumpler WV, et al. The US Department of Agriculture Automated Multiple-Pass Method reduces bias in the collection of energy intakes. Am J Clin Nutr 2008;88:324-32.
[28] National Center for Health Statistics. NHANES MEC in-person dietary interviewers procedures manual. Available at http://www.cdc.gov/nchs/data/nhanes/nhanes_03_04/DIETARY_MEC.pdf [Accessed June 6, 2010].
[29] U.S. Department of Agriculture. USDA Food and Nutrient Database for Dietary Studies, 1.0. Available at http://www.ars.usda.gov/Services/docs.htm?docid=12082 [Accessed March 2, 2009].
[30] U.S. Department of Agriculture. USDA Food and Nutrient Database for Dietary Studies, 2.0. Available at http://www.ars.usda.gov/Services/docs.htm?docid=12083 [Accessed June 6, 2010].
[31] Cook AJ, Friday JE, Subar AF. Dietary Source Nutrient Database for USDA Survey Food Codes. Available at http://www.ars.usda.gov/Services/docs.htm?docid=8498 [Accessed Oct 11, 2009].
[32] Friday JE, Bowman SA. MyPyramid Equivalents Database for USDA Survey Food Codes, 1994-2002 Version 1.0 [Online]. Available at http://www.barc.usda.gov/bhnrc/fsrg [Accessed June 6, 2010].
[33] U.S. Department of Agriculture. USDA database of vitamin A (mcg RAE) and vitamin E (mg AT) for National Health and Nutrition Examination Survey 1999-2000. Available at http://www.ars.usda.gov/Services/docs.htm?docid=12088 [Accessed March 2, 2010].
[34] U.S. Department of Agriculture, Agricultural Research Service. Food commodity intake database. Available at http://www.ars.usda.gov/Services/docs.htm?docid=14514 [Accessed May 7, 2009].
[35] Bowman SA, Friday JE, Moshfegh A. MyPyramid Equivalents Database, 2.0 for USDA Survey Foods, 2003-2004 [Online]. Available at http://www.ars.usda.gov/ba/bhnrc/fsrg [Accessed June 6, 2010].
[36] Guenther PM, Reedy J, Krebs-Smith SM. Development of the Healthy Eating Index-2005. J Am Diet Assoc 2008;108:1896-901.
[37] Guenther PM, Reedy J, Krebs-Smith SM, Reeve BB, Basiotis PP. Development and evaluation of the Healthy Eating Index-2005: technical report. Center for Nutrition Policy and Promotion, U.S. Department of Agriculture. Available at http://www.cnpp.usda.gov/HealthyEatingIndex.htm [Accessed December 18, 2009].
[38] Guenther PM, Reedy J, Krebs-Smith SM, Reeve BB. Evaluation of the Healthy Eating Index-2005. J Am Diet Assoc 2008;108:1854-64.
[39] USDA, Center for Nutrition Policy and Health Promotion. Available at http://www.cnpp.usda.gov/HealthyEatingIndex-2005report.htm [Accessed December 18, 2009].
[40] U.S. Department of Health and Human Services, National Heart Lung and Blood Institute. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults. Available at http://www.nhlbi.nih.gov/guidelines/obesity/ob_home.htm [Accessed June 10, 2009].
[41] National Center for Health Statistics. NHANES anthropometry procedures manual. Available at http://www.cdc.gov/nchs/data/nhanes/bm.pdf [Accessed Jan 12, 2009].
[42] National Center for Health Statistics. NHANES 2001-2002 data release. MEC examination: blood pressure section of the physcian's examination. Available at http://www.cdc.gov/nchs/data/nhanes/nhanes_01_02/bpx_b_doc.pdf [Accessed June 10, 2010].
[43] U.S. Department of Health and Human Services. The seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7). Available at http://www.nhlbi.nih.gov/guidelines/hypertension [Accessed June 10, 2010].

[44] Bachman JL, Reedy J, Subar AF, Krebs-Smith SM. Sources of food group intakes among the US population, 2001-2002. J Am Diet Assoc 2008;108:804-14.
[45] Slavin JL. Position of the American Dietetic Association: health implications of dietary fiber. J Am Diet Assoc 2008;108:1716-31.
[46] Qi L, Meigs JB, Liu S, Manson JE, Mantzoros C, Hu FB. Dietary fibers and glycemic load, obesity, and plasma adiponectin levels in women with type 2 diabetes. Diabetes Care 2006;29:1501-5.
[47] Institute of Medicine, Food and Nutrition Board. Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids (macronutrients). Washington, DC: National Academies Press; 2002.
[48] Institute of Medicine. Dietary reference intakes for water, potassium, sodium, chloride, and sulfate. Available at http://www.nap.edu/catalog.php?record_id=10925 [Accessed December 21, 2009].
[49] Nicklas TA, O'Neil CE, Fulgoni III VL. The role of dairy in meeting the recommendations for shortfall nutrients in the American diet. J Am Coll Nutr 2009;28(Suppl 1):73S-81S.
[50] Taylor CA, Hampl JS, Johnston CS. Low intakes of vegetables and fruits, especially citrus fruits, lead to inadequate vitamin C intakes among adults. Eur J Clin Nutr 2000;54:573-8.
[51] McNaughton SA, Mishra GD, Stephen AM, Wadsworth ME. Dietary patterns throughout adult life are associated with body mass index, waist circumference, blood pressure, and red cell folate. J Nutr 2007; 137:99–105.
[52] Newby PK, Muller D, Hallfrisch J, Qiao N, Andres R, Tucker KL. Dietary patterns and changes in body mass index and waist circumference in adults. Am J Clin Nutr 2003;77:1417-25.
[53] Thompson FE, Byers T. Dietary assessment resource manual. J Nutr 1994;124:2245S-317S.