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White Potatoes, Including French Fries, Contribute Shortfall Nutrients to Children's and Adolescents' Diets

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Abbreviations:

WP; white potatoes; FF; french fries; OBF; oven-baked fries; NHANES; National Health and Nutrition Examination Survey; FNDDS; Food and Nutrient Database for Dietary Studies MUFA; monounsaturated fatty acids; PUFA; polyunsaturated fatty acids; RACC; Reference Amount Customarily Consumed

Abstract

To test the hypothesis that white potatoes (WP), oven-baked fries (OBF), and french fries (FF) contribute important nutrients within energy needs to children's and adolescents' diets, secondary analysis of 24-hour dietary recall data from the National Health and Nutrition Examination Survey (NHANES) 2003–2006 was conducted. Potato content of survey foods was determined using USDA recipe databases (SR-link files). Nutrient content of potatoes was determined by linking SR codes to USDA food composition data. Daily nutrient intakes from potatoes were determined by applying the composition database to respondent's recall data. Sample weighted data were analyzed; t-tests assessed differences between age and gender groups. Results indicated approximately 35% of children and adolescents consumed WP+FF+OBF; 18% consumed FF. Intakes were lower in children compared to adolescents ($P<.01$). Among adolescents, more males than females consumed FF ($P<.05$); males ate larger amounts of WP+FF+OBF (134 g/d) and FF (100 g/d) ($P<.01$). WP+FF+OBF and FF provided 9-12% of total daily calories (but was within energy requirements in the highest consumers); 8-15% of daily fat (>75% MUFA+PUFA); ≥10% dietary fiber, vitamin B_6 and potassium; ≥5% thiamin, niacin, vitamin K, phosphorus, magnesium and copper; and <5% sodium intake, for all gender-age groups. WP+FF+OBF provided ≥5% vitamin C for all gender-age groups, and ≥5% vitamin E and iron for most groups; FF provided ≥5% vitamin E intakes for all. These cross-sectional data show WP, including FF, provided shortfall nutrients within caloric requirements to children and adolescents, and when consumed in moderate amounts, can be part of healthful diets.

Key words: Potato, French fries, Nutrient intake, Child, Adolescent, NHANES

1. Introduction

Most American children and adolescents 2 to 18 years of age fail to consume recommended amounts of fiber, potassium, magnesium, calcium and vitamin E, shortfall nutrients identified by the 2005 Dietary Guidelines Advisory Committee [1]. Already

inadequate fruit and vegetable intake [2-5] was reported to further decline during the transition from early to older adolescence in both boys and girls [6]. Despite this overall pattern of lower produce intake (including decreased intake of non-fried white potatoes), there was a concomitant increased intake of fried potatoes [7-9]. During recent years and the prior decade, potatoes, which are nutrient-dense vegetables [10], were the largest single contributor to overall daily vegetable intake by adolescents [2,5]. By including fried potatoes, which are energy dense [11], vegetable consumption increases from 0.7 to 1.2 cups/day [2].

The Dietary Guidelines recommend meeting nutrient requirements while limiting energy intake [1]. We hypothesized that potatoes, including french fries, contribute important nutrients within energy needs to the diets of children and adolescents. To test this hypothesis, we used the National Health and Nutrition Examination Survey (NHANES) data to examine, in children and adolescent consumers, potato and french fry consumption patterns, and the contribution of these foods to total daily nutrient intakes.

2. **Methods and Materials**

2.1. Data Source

The NHANES is a continuous, nationally representative, cross-sectional survey conducted by the National Center for Health Statistics of the Centers for Disease Control. Each survey is a stratified, multistage, area probability sample of the noninstitutionalized civilian population. For this study, data collected from participants of the NHANES 2003–2004 [12] and the NHANES 2005–2006 [13] were combined. The sample design, methodology, and protocol used to collect NHANES data during these years were similar to those used in previous survey years [14]. The sample design was to oversample adolescents, Mexican-Americans, African-Americans, and low-income non-Hispanic whites.

2.2. Study sample

This cross-sectional analysis included 7,332 participants aged 2 to 18 years with dietary recalls deemed reliable by the NHANES staff. Because secondary data analysis was conducted and personal identifiers were absent, this study was deemed exempt by the Institutional Review Board of San José State University.

2.3. Dietary intake

Dietary data (including detailed descriptions of all food and quantities eaten) were collected by trained interviewers using 24-hour recall methodology. Two days of intake were collected. For this study, only Day 1 recalls were included in the analysis. The USDA SR-Link file (the recipe database) of the Food and Nutrient Database for Dietary Studies (FNDDS), version 2.0 and 3.0 (2006, 2008, Food Surveys Research Group, Beltsville, MD), was used to determine the gram amounts of potatoes contained in survey foods consumed in NHANES 2003–2004 and 2005–2006, respectively. Standard Reference nutrient database codes in the SR-Link file were used to identify ingredients of survey foods in 3 potato categories: white potatoes (WP), french fries (FF), and oven-baked fries (OBF). WP were contained in over 100 different survey foods mentioned by an unweighted sample of survey participants with complete, reliable

24-hour recall dietary data on Day 1. Frequently mentioned foods in the WP category were mashed potatoes, potato salad, baked potatoes, home fries and hash browns. Other survey foods in this category were primarily mixed meat, poultry or fish dishes mentioned < 25 times. FF, not oven-baked, included only deep-fried commercially prepared french fries, whereas OBF included oven-baked french fried potatoes and other commercially fried oven-baked potato products such as potato puffs.

2.4. Nutrient content

The nutrient content of potatoes contained in survey foods was determined by linking the SR codes for potatoes listed in the SR-link files (Release 18 and 20) [15,16], to the USDA National Nutrient Database for Standard Reference. Recipe calculations of nutrient composition values (nutrient amounts per 100 g weight of the food consumed) accounted for the gram weight of moisture or fat lost (or gained) in cooking. Recipe calculations also adjusted nutrient composition values for nutrient losses using the USDA Table of Retention Factors, Release 6 [17]. The gram amounts of potatoes consumed by survey respondents were determined by applying the potato composition database to the respondent's 24-hour recall dietary interview data. Potato intakes from each food consumed were aggregated over the entire day. Consumption of any of the 3 potato categories was defined as intake at least once per day of any amount of any survey food containing that type of potato or potato product.

2.5. Statistical analyses

Sample-weighted data were used in all statistical analyses, performed using Statistical Software for Analysis of Correlated Data (SUDAAN, version 9.0.3, 2005, RTI, Research Triangle Park, NC). Standard t-tests were used to assess nutrient intake differences between age groups and between genders. Data are presented as means $\pm$ standard errors. Significance was set at $P < .05$.

3. Results

Overall, approximately 35% of children and adolescents consumed WP+FF+OBF and approximately 18% consumed FF on the day of the recall (**Table 1**). Among males, a greater percentage of adolescents compared to children consumed FF ($P < .01$). Among adolescents, a greater percentage of males than females consumed FF ($P < .05$). With respect to amount consumed, males aged 2 to 18 years, compared to females, reported significantly higher intakes of WP+FF+OBF ($P < .01$), but not significantly higher intakes of FF (**Table 2**). Among adolescents, males had significantly higher intakes of WP+FF+OBF and FF ($P < .01$). Male and female adolescents consumed significantly higher amounts of WP+FF+OBF compared to children of the same gender ($P < .01$). All adolescents consumed significantly more FF compared to all children, likely because male adolescents consumed significantly higher amounts of FF than did male children ($P < .01$).

Table 1. Percent of US children and adolescents aged 2 to 18 years consuming white potatoes, french fries and oven-baked fries (WP+FF+OBF) and french fries (FF), NHANES 2003 – 2006.

Age and gender group	Number	Percent of population consuming WP+FF+OBF	Percent of population consuming FF
Children and adolescents	7332	35.3 ± 1.5	18.4 ± 1.0
Males	3624	35.4 ± 1.8	18.7 ± 1.3
Females	3708	35.1 ± 1.9	18.2 ± 1.2
Children aged 2 to 13 years	4649	35.3 ± 1.7	17.9 ± 1.2
Males	2273	34.7 ± 2.0	17.4 ± 1.4[a]
Females	2376	35.8 ± 2.0	18.5 ± 1.5
Adolescents aged 14 to 18 years	2683	35.2 ± 1.6	19.5 ± 1.1
Males	1351	36.8 ± 1.8	21.5 ± 1.6[b]
Females	1332	33.5 ± 2.7	17.3 ± 1.4

Data are presented as sample-weighted means ± SE and percentages using SUDAAN, based on a single 24-hour dietary recall.
[a] $P < 0.01$ between age groups but the same gender.
[b] $P < 0.05$ between gender groups in the same age range.

Table 2. Mean gram intake of white potatoes, french fries and oven-baked fries (WP+FF+OBF) and french fries (FF) by consumers of these foods among children and adolescents aged 2 to 18 years participating in the National Health and Nutrition Examination Survey 2003 – 2006[a]

Age and gender group	Number	Intake of WP+FF+OBF (g)	Number	Intake of FF (g)
Children and adolescents	2673	89.8 ± 3.1	1514	72.1 ± 2.5
Males	1328	99.4 ± 4.2[a]	756	75.4 ± 2.9
Females	1345	79.6 ± 3.6	758	68.5 ± 3.6
Children aged 2 to 13 years	1710	78.9 ± 3.3[b]	903	63.5 ± 2.9[b]
Males	834	82.6 ± 3.9[c]	441	61.5 ± 3.0[c]
Females	876	75.3 ± 4.1[c]	462	65.5 ± 5.3
Adolescents aged 14 to 18 years	963	114.4 ± 6.0	611	89.7 ± 4.3
Males	494	134.4 ± 8.6[a]	315	100.0 ± 6.2[a]
Females	469	90.4 ± 4.7	296	75.8 ± 3.7

Data are presented as sample-weighted means ± SE and percentages using SUDAAN, based on a single 24-hour dietary recall. [a] $P < 0.01$ between gender groups in the same age range.
[b] $P < 0.01$ between all children compared to all adolescents. [c] $P < 0.01$ between age groups but the same gender.

Consumption of WP+FF+OBF contributed < 10% of the total energy consumed daily by each gender-age group. These foods provided 8-10% of total daily fat intake, with over 75% comprised of monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA). Over 20% of dietary fiber was provided by WP+FF+OBF among adolescent consumers, and 16-18% among children who consumed these foods (**Table 3).** Among all gender-age groups of consumers, WP+FF+OBF provided ≥ 10% of the total daily intake of vitamin B_6, potassium and copper among all groups; magnesium among all groups except male children; vitamin C among all adolescents; thiamin among female adolescents; and vitamin K among male adolescents. WP+FF+OBF provided ≥ 5% of total daily intake of niacin and phosphorus among all groups; thiamin among all groups except female adolescents and vitamin K among all groups except male adolescents; vitamin E and iron among all groups except male children; vitamin C among all children; total folate among all adolescents; and magnesium among male children. Among all consumers, WP+FF+OBF provided < 5% of the total sodium intake.

Consumption of FF contributed 9-12% of the total energy consumed daily by children and adolescents. These foods provided 12-15% of total daily fat intake; the majority (> 75%) was comprised of MUFA and PUFA. Over 20% of dietary fiber was provided by FF among adolescent consumers, and 16-19% among children who consumed them. Among all gender-age groups, FF provided ≥ 10% of vitamin B_6, vitamin K and potassium; magnesium among all groups except male children; vitamin E and copper among all adolescents; and thiamin among female adolescents. Among all gender-age groups, FF provided ≥ 5 of niacin, total folate, phosphorus and iron; thiamin among all groups except female adolescents; vitamin E and copper among all children; magnesium among male children; and folate DFE and zinc among female adolescents. FF provided < 5% of the total sodium intake of consumers (Table 4).

Table 3. Percentage of total daily nutrient intake contributed from intake of white potatoes, french fries and oven-baked fries (WP+FF+OBF) by male and female consumers of WP+FF+OBF among children and adolescents, NHANES 2003-2006

Nutrient	Children aged 2 to 13 years			Adolescents aged 14 to 18 years		
	Total daily intake	Intake from food group	Percentage of intake	Total daily intake	Intake from food group	Percentage of intake
Food energy (kcal)						
Males	203 37	156.8 8.0	7.7	296 78	270.4 13.9	9.1
Females	190 48	154.2 9.8	8.1	203 52	187.0 10.8	9.2
Macronutrient						
Protein (g)						
Males	70.2 1.7	2.3 0.1	3.3	106.9 4.3	3.9 0.2	3.6
Females	64.4 1.8	2.2 0.1	3.4	67.1 2.0	2.7 0.1	4.0
Total fat (g)						
Males	76.2 1.7	6.1 0.5	8.0	112.3 3.3	11.2 0.7	10.0
Females	72.9 2.4	6.3 0.6	8.7	80.6 2.9	7.7 0.7	9.5
Saturated fat (g)						
Males	26.4 0.7	1.4 0.1	5.4	37.9 1.2	2.6 0.2	7.0
Females	25.0 0.9	1.5 0.1	6.0	26.5 0.9	1.8 0.2	6.9
MUFA (g)						
Males	28.9 0.6	3.5 0.3	12.0	43.9 1.4	6.4 0.4	14.5
Females	27.8 1.0	3.6 0.3	13.1	30.6 1.2	4.4 0.4	14.4
PUFA (g)						
Males	14.8 0.5	1.0 0.1	7.0	21.4 0.7	1.9 0.1	9.0
Females	14.4 0.6	1.1 0.1	7.5	17.3 0.9	1.3 0.1	7.5
Cholesterol (mg)						
Males	22 9	0.2 0.0	0.1	35 18	0.3 0.1	0.1
Females	22 13	0.2 0.0	0.1	21 11	0.2 0.0	0.1
Carbohydrates (g)						
Males	27 5	23.9 1.0	8.8	37 10	39.5 2.2	10.5
Females	25 6	22.6 1.2	8.9	26 7	27.4 1.3	10.4
Dietary fiber (g)						
Males	13.6 0.5	2.2 0.1	16.4	15.7 0.5	3.7 0.2	23.5
Females	12.3 0.3	2.1 0.1	17.2	11.7 0.5	2.5 0.1	21.8
Micronutrient						

Vitamin A (μ RAE)										
Males	55	21	0.3	0.1	0.1	62	31	1.0	0.7	0.2
Females	51	22	0.2	0.1	0.0	41	16	0.4	0.2	0.1
Vitamin C (mg)										
Males	89.1	4.9	7.0	0.4	7.9	97.9	7.9	10.6	0.9	10.8
Females	89.7	4.3	6.3	0.5	7.1	77.7	7.0	5.7	0.4	10.5
Alpha-tocopherol (mg)										
Males	5.3	0.1	0.3	0.0	4.8	7.1	0.3	0.5	0.0	6.8
Females	5.4	0.3	0.3	0.0	5.1	5.8	0.3	0.3	0.0	5.7
Thiamin (mg)										
Males	1.5	0.0	0.1	0.0	7.8	2.1	0.1	0.2	0.0	9.1
Females	1.4	0.0	0.1	0.0	7.8	1.3	0.1	0.1	0.0	10.4
Riboflavin (mg)										
Males	2.2	0.1	0.04	0.0	1.6	2.8	0.1	0.06	0.0	2.2
Females	2.0	0.1	0.03	0.0	1.7	1.7	0.1	0.04	0.0	2.5
Niacin (mg)										
Males	20.9	0.5	1.6	0.1	7.6	32.8	1.1	2.6	0.2	8.1
Females	19.6	0.7	1.5	0.1	7.6	20.4	0.7	1.8	0.1	9.0
Vitamin B_6 (mg)										
Males	1.9	0.1	0.3	0.0	14.4	2.7	0.1	0.4	0.0	16.5
Females	1.7	0.1	0.3	0.0	14.6	1.6	0.1	0.3	0.0	18.8
Total folate (μg)										
Males	37	15	16.2	0.8	4.4	45	20	27.8	1.4	6.2
Females	34	17	15.7	0.9	4.6	30	15	19.3	1.1	6.3
Vitamin B_{12} (μg)										
Males	5.2	0.2	0.0	0.0	0.0	8.1	0.5	0.0	0.0	0.0
Females	4.7	0.2	0.0	0.0	0.0	3.9	0.2	0.0	0.0	0.0
Vitamin K (μg)										
Males	49.9	1.9	4.7	0.3	9.5	69.7	4.0	8.3	0.4	12.0
Females	52.7	3.0	4.8	0.4	9.1	75.4	9.7	5.7	0.4	7.5
Calcium (mg)										
Males	98	30	9.4	0.5	1.0	118	53	15.4	0.8	1.3
Females	89	36	8.7	0.4	1.0	76	32	10.6	0.5	1.4
Phosphorus (mg)										

Males	126	33	72.5	3.6	5.7	169	63	124.7	6.1	7.4
Females	118	36	71.4	4.2	6.0	110	36	86.6	4.9	7.8
Magnesium (mg)										
Males	23	5	22.8	0.9	9.7	30	11	38.1	2.1	12.6
Females	21	5	21.6	1.2	10.0	20	6	26.7	1.3	12.5
Iron (mg)										
Males	14.7	0.5	0.7	0.0	4.7	19.6	0.9	1.2	0.1	6.2
Females	13.0	0.5	0.7	0.0	5.3	12.7	0.5	0.8	0.1	6.6
Zinc (mg)										
Males	11.2	0.3	0.4	0.0	3.5	16.1	0.6	0.7	0.0	4.2
Females	9.8	0.3	0.4	0.0	3.9	9.9	0.0	0.1	0.0	4.6
Copper (mg)										
Males	1.1	0.0	0.1	0.0	12.1	1.4	0.1	0.2	0.0	15.0
Females	1.0	0.0	0.1	0.0	11.8	1.0	0.0	0.1	0.0	14.6
Sodium (mg)										
Males	294	60	100.6	9.8	3.4	448	218	170.8	11.7	3.8
Females	273	71	96.0	7.1	3.5	306	94	123.3	13.3	4.0
Potassium (mg)										
Males	250	63	381.0	15.6	15.2	318	105	637.3	35.8	20.0
Females	233	60	361.1	20.0	15.5	218	67	483.5	21.7	20.1

Data are presented as sample-weighted means ± SE and percentages using SUDAAN, based on single 24-hour dietary recall collected from 834 male and 876 female children aged 2 to 13 years, and from 46 male and 49 female adolescents aged 1 to 1 years.

Table 4. Percentage of total daily intake contributed from intake of french fries (FF) by male and female consumers of FF among children and adolescents, NHANES 2003-2006

Nutrient	Children aged 2 to 13 years			Adolescents aged 14 to 18 years		
	Total daily intake	Intake from food group	Percentage of intake	Total daily intake	Intake from food group	Percentage of intake
Food energy (kcal)						
Males	212 48	196.2 9.7	9.2	3039 116	318.8 19.7	10.5
Females	2007 74	208.8 17.0	10.4	2072 53	241.8 11.8	11.7
Macronutrient						
Protein (g)						
Males	69.7 2.0	2.3 0.1	3.3	104 5.1	3.8 0.2	3.6
Females	65.0 2.7	2.5 0.2	3.8	67 2.4	2.9 0.1	4.3
Total fat (g)						
Males	82.2 2.7	10.5 0.5	12.8	117 5.1	17.0 1.1	14.6
Females	79.4 4.0	11.2 0.9	14.0	86.6 3.4	12.9 0.6	14.9
Saturated fat (g)						
Males	27.9 1.1	2.5 0.1	8.9	38.8 1.9	4.0 0.3	10.4
Females	26.9 1.4	2.6 0.2	9.8	28.0 1.0	3.1 0.2	10.9
MUFA (g)						
Males	32.6 1.1	6.1 0.3	18.6	47.4 2.1	9.9 0.6	20.8
Females	31.5 1.7	6.5 0.5	20.5	34.2 1.3	7.5 0.4	21.8
PUFA (g)						
Males	15.6 0.7	1.8 0.1	11.6	21.9 0.9	3.0 0.2	13.5
Females	15.4 1.0	1.9 0.2	12.6	18.2 1.3	2.2 0.1	12.3
Cholesterol (mg)						
Males	214 12	0.2 0.0	0.1	325 24	0.4 0.0	0.1
Females	239 26	0.2 0.0	0.1	202 11	0.3 0.0	0.1
Carbohydrates (g)						
Males	283 7	23.1 1.1	8.2	387 14	37.5 2.3	9.7
Females	264 9	24.6 2.0	9.3	260 7	28.5 1.4	11.0
Dietary fiber (g)						
Males	13.1 0.6	2.2 0.1	16.4	15.7 0.7	3.5 0.2	22.3
Females	12.0 0.5	2.3 0.2	19.0	11.6 0.5	2.7 0.1	22.9
Micronutrient						

Vitamin A (μ RAE)												
Males	507	25	0.0	0.0	0.0	575	41	0.1	0.0	0.0		
Females	475	21	0.0	0.0	0.0	373	29	0.1	0.0	0.0		
Vitamin C (mg)												
Males	82.8	7.6	1.7	0.1	2.0	81.8	8.6	2.8	1.2	3.4		
Females	84.0	6.1	1.8	0.2	2.1	67.4	6.7	2.1	0.1	3.1		
Alpha-tocopherol (mg)												
Males	5.5	0.3	0.5	0.0	8.6	6.8	0.3	0.8	0.1	11.3		
Females	5.3	0.4	0.5	0.0	9.4	5.6	0.3	0.6	0.0	10.4		
Thiamin (mg)												
Males	1.5	0.0	0.1	0.0	7.3	2.1	0.1	0.2	0.0	8.3		
Females	1.4	0.1	0.1	0.0	8.3	1.3	0.1	0.1	0.0	10.3		
Riboflavin (mg)												
Males	2.2	0.1	0.04	0.0	1.9	2.8	0.1	0.06	0.0	2.4		
Females	2.0	0.1	0.04	0.0	2.2	1.7	0.1	0.05	0.0	3.0		
Niacin (mg)												
Males	21.6	0.7	1.5	0.0	7.1	33.1	1.6	2.5	1.2	7.5		
Females	19.4	0.7	1.6	0.1	8.4	20.8	1.1	1.9	0.1	9.1		
Vitamin B_6 (mg)												
Males	1.8	0.1	0.2	0.0	12.8	2.6	0.1	0.4	0.0	14.3		
Females	1.6	0.1	0.3	0.0	15.5	1.5	0.1	0.3	0.0	18.8		
Total folate (μg)												
Males	358	21	18.5	0.9	5.2	464	26	30.1	1.9	6.5		
Females	335	23	19.7	1.6	5.9	290	16	22.8	1.1	7.9		
Vitamin B_{12} (μg)												
Males	5.1	0.3	0.0	0.0	0.0	8.0	0.6	0.0	0.0	0.0		
Females	4.5	0.2	0.0	0.0	0.0	4.0	0.3	0.0	0.0	0.0		
Vitamin K (μg)												
Males	47.0	2.4	6.9	0.3	14.7	64.9	3.5	11.2	0.7	17.3		
Females	53.1	3.5	7.3	0.6	13.8	73.4	12.9	8.5	0.4	11.6		
Calcium (mg)												
Males	972	36	8.1	0.4	0.8	1143	59	13.1	0.8	1.1		
Females	895	51	5.6	0.7	1.0	789	47	9.9	0.5	1.3		
Phosphorus (mg)												

Males	1291 ± 37	84.9 ± 4.2	6.6	1675 ± 70	137.9 ± 8.5	8.2
Females	1214 ± 52	90.3 ± 7.4	7.4	1133 ± 49	104.6 ± 5.1	9.2
Magnesium (mg)						
Males	234 ± 6	20.9 ± 1.0	9.0	293 ± 15	34.0 ± 2.1	11.6
Females	212 ± 7	22.3 ± 1.8	10.5	207 ± 10	25.8 ± 1.3	12.5
Iron (mg)						
Males	15.4 ± 0.6	0.8 ± 0.0	5.5	20.2 ± 1.3	1.4 ± 0.1	6.8
Females	12.8 ± 0.6	0.9 ± 0.1	7.0	12.8 ± 0.6	1.0 ± 0.1	8.1
Zinc (mg)						
Males	11.2 ± 0.4	0.5 ± 0.0	4.0	15.7 ± 0.8	0.7 ± 0.0	4.6
Females	9.7 ± 0.5	0.5 ± 0.0	4.9	10.2 ± 0.5	0.6 ± 0.0	5.4
Copper (mg)						
Males	1.0 ± 0.0	0.1 ± 0.0	8.7	1.4 ± 0.1	0.1 ± 0.0	10.7
Females	1.0 ± 0.0	0.1 ± 0.0	9.9	0.9 ± 0.0	0.1 ± 0.0	12.0
Sodium (mg)						
Males	2950 ± 72	119.0 ± 5.9	4.0	4505 ± 324	193.3 ± 12	4.3
Females	2764 ± 118	126.7 ± 10.3	4.6	3060 ± 109	146.6 ± 7.2	4.8
Potassium (mg)						
Males	2459 ± 69	340.4 ± 16.8	13.8	3050 ± 115	553.1 ± 34.2	18.1
Females	2305 ± 84	362.4 ± 29.5	15.7	2117 ± 76	419.5 ± 20.5	19.8

Data are presented as sample-weighted means ± SE and percentages using SUDAAN, based on a single 24-hour dietary recall collected from 441 male and 462 female children aged 2 to 13 years and from 315 male and 296 female adolescents aged 14 to 18 years.

4. Discussion

Using NHANES 2003 – 2006 data, this study assessed WP+FF+OBF and FF consumption among a nationally representative sample of American children and adolescents, and examined the nutrient contributions of these foods to their diet. NHANES data indicated that despite widespread consumption of WP+FF+OBF and FF on the day of the dietary recall the mean amount consumed was moderate. Among the highest consumers, mean intake of WP+FF+OBF (134.4 g/d) was an amount < 1 cup of starchy vegetables (defined as a medium baked potato, 2.25 – 3.25 inches in diameter, and weighing 173 g [16]). Among the highest consumers of FF, mean intake (100 g/day) was less than that of a "medium" sized portion of french fries at a fast-food restaurant [18]. Among all respondents who consumed FF, daily consumption amounts reflected the FDA Reference Amount Customarily Consumed (RACC) portion size of 70 g [19], which is equivalent to a "small" portion of french fries at a fast-food restaurant [18].

With respect to calories, WP+FF+OBF provided 7-10% of total daily calories among consumers on the day of the recall; FF provided 9-12%. Yet, among those groups whose caloric intake from these foods was highest, total daily energy intake was lower than their Estimated Energy Requirement [20]. With respect to fat, potatoes contain fewer than 1% of total calories from fat, but FF are energy dense; 45% of their calories come from fat [16]. Indeed, these findings confirm that FF provided about 15% of the total daily fat intake (as measured in g) of adolescents. However, over 75% of the fatty acids from FF were comprised of the healthful MUFA and PUFA. Among adolescent females, whose energy intake from FF was 11.7% of their daily energy total, FF provided 5.6% of total daily fat calories, and 1.3% of total daily saturated fat calories. Thus, especially in light of increased use of more healthful oils in commercial french fry production [18] subsequent to NHANES 2003 – 2006 data collection, consumption of FF at the levels reported supports the contention that FF fit within the Dietary Guidelines, which recommend 20 – 35% of total calories from fat, and < 10% of total calories from saturated fat [1]. Furthermore, simple changes in cooking methods, including shorter frying times, improved oil drainage and using thicker potatoes, can further reduce the fat (and therefore calories) contributed by FF to the diets of children and adolescents [21].

Further, at levels of consumption reported in NHANES 2003 – 2006, WP+FF+OBP and FF made important contributions to children's and adolescents' total dietary intake of 4 of the 5 shortfall nutrients: fiber, potassium, magnesium and vitamin E. With respect to fiber, boiled WP contain 2.0 g dietary fiber/100 g (or 2.2 g dietary fiber/RACC of 110 g), and FF contain 3.5 g dietary fiber/100g (or 2.4 g dietary fiber/RACC of 70 g) [16]. Thus, boiled WP provided 8.8%, and FF provided 9.6%, of the Daily Value of fiber (25 g per 2000 calories), just short of being a "good [fiber] source" [22]. WP+FF+OBF contributed about 17% of total dietary fiber intakes each day children consumed them, and up to 23% of fiber intakes by adolescent consumers. Research regarding nutrient gains and losses associated with frying indicate the dietary fiber content of potatoes increases, secondary to the formation of resistant starch [23]. Despite the significant contribution that WP+FF+OBF made to the daily dietary fiber intake of children and adolescents, overall dietary fiber intake among all age-gender groups was low. Efforts to promote increased dietary fiber intake by increasing consumption of whole grains, fruits and vegetables are thus warranted and would provide a more appropriate overall nutrient density [1].

The Dietary Guidelines recommend increasing intake of foods rich in potassium and magnesium (as part of the DASH eating plan) to help lower blood pressure [1]. Potatoes are

high in potassium. Boiled WP, baked potatoes and FF contain 328, 391 and 550 mg K/100 g (361, 430 and 385 mg K/RACC, respectively) [16]. For children and adolescents, WP+FF+OBF contributed 15-20% of their potassium intakes, and 10-13% of their magnesium intakes each day they were consumed. The DASH eating plan also recommends lowering sodium intake [24]. The salt taste elicited when salt is contained on the food surface may lead to an erroneous perception that the sodium content of that food is higher compared to the sodium content of foods that contain added salt ingrained throughout the food [25]. The amount of sodium contained in a "small" portion of FF from a fast-food restaurant ranges from 122 to 337 mg [16], or 5 – 14% of the Daily Value. Consumers may add salt and/or ketchup to their fries, thereby increasing sodium intake. The Institute of Medicine's strategies to reduce sodium intake in the United States [25] are currently being reviewed by the FDA.

The fourth shortfall nutrient, vitamin E, is provided primarily from the oils used to fry WP and FF. Though french fry preparation methods can have a significant effect on final nutrient content [21], levels of vitamin E (along with thiamin and vitamin C) remain high after frying [26].

This study has several limitations. Analyses of NHANES data are limited by the cross-sectional design that precludes causal inferences. Also 24-hour dietary recalls depend on memory, which might cause subjects to under- or over-report intake, and reported dietary intakes may not reflect usual intakes. However, a single 24-hour recall is sufficient to report the mean usual intake of a group [27]. Finally, this study did not at all address issues regarding acrylamide, a compound that occurs naturally in starchy foods (such as potato and bread products) during the browning process (e.g. when they are baked, roasted, fried and toasted, but not boiled). The FDA has yet to determine the potential public health impact, if any, of the low levels of acrylamide found in these and other foods, and continues to recommend that Americans follow diets consistent with the Dietary Guidelines [28].

In conclusion, NHANES 2003 – 2006 data show that WP+FF+OBF and FF are widely consumed by children and adolescents in moderate amounts. Although these foods contributed 9-12% of total daily calories on the day they were consumed, energy intake among the highest consumers was within the recommended level. While 45% of the calories in FF come from fat, over 75% is comprised of healthful MUFA and PUFA. Further, WP+FF+OBF and FF contributed $\geq$ 10% of 3 essential nutrients (vitamin B_6, fiber and potassium) to the diets of all age-gender groups surveyed, and $\geq$ 10% of 6 essential nutrients (vitamin C, vitamin E, vitamin K, thiamin, magnesium, copper) to the diets of some age-gender groups. Among all consumers, sodium from WP+FF+OBF and FF provided < 5% of total sodium intake. Overall, results of the analysis of NHANES cross-sectional data show that WP+FF+OBF and FF provide, on the day of consumption, important shortfall nutrients (fiber, potassium, magnesium and vitamin E) within mean energy intakes consistent with mean estimated energy requirements of children and adolescents. Thus, moderate consumption of potatoes, including FF, can be part of a healthful diet.

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