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Original Research

Whole grain intake among young children ages 12 to 48 months participating in the Feeding Infants and Toddlers Study was higher in 2016 compared to 2008

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ABSTRACT

Consumption of whole grains confers multiple benefits and is an important source of fiber; as such, federal programs have updated policies to support increased whole grain consumption. Limited literature is available on consumption among young children and before and after nutrition policy changes. We assessed whole grain and fiber consumption among children aged 12 to 47.9 months participating in the Feeding Infants and Toddlers Study 2008 ($n = 2385$) and 2016 ($n = 1733$) to address this information gap. The percent consuming whole grains was determined using predicted marginals and compared between years using *t*-tests from weighted logistic regression. For children consuming whole grains, the Usual Intake method was used to estimate mean grams of whole grains and fiber intake from whole grains. Models were adjusted for child age, sex, race and ethnicity, and total energy intake, and household poverty level, caregiver education, marital status, ever breastfed, and Special Supplemental Nutrition Program for Women, Infants, and Children status. A higher percentage of children consumed whole grain foods in 2016 compared to 2008 (74.4%, standard error [SE] 0.02 vs. 65.2%, SE 0.02; $P = .0001$) and they ate a greater amount of whole grains (23.4 g, SE 0.32 vs. 19.1 g, SE 0.23, $P < .0001$). Children in 2016 consumed 30.8% more fiber from whole grains compared to children from 2008 ($P < .0001$). Grams of whole grains consumed from sweet bakery items and cereal/nutrition bars ($P = .0003$) and baby food cereal ($P = .0123$) were

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significantly higher in 2016 compared to 2008. Whole grain consumption among young children aged 12 to 47.9 months was higher in 2016 compared to 2008, providing more dietary fiber. Despite promising changes between 2008 and 2016, many young children in 2016 were still falling short of meeting whole grain recommendations.

1. Introduction

Whole grain consumption is associated with reduced risk of chronic disease, including cardiovascular diseases, type 2 diabetes, and some forms of cancer such as colorectal cancer [1–4] and is also associated with a reduced risk of weight gain [5,6]. The benefits of whole grain consumption for adults are well documented; however, limited literature is available on young children [7]. The studies with children show increased consumption is associated with better diet quality, nutrient intake, and reduced risk of obesity [8–10]. Whole grain foods retain all parts of the grain and include important vitamins, minerals, and phytochemicals [11]. The protective health benefits of whole grains can be attributed to these nutrients, but dietary fiber also plays an important role [12]. Whole grain foods are an important contributor to dietary fiber intake in both children and adults [13]. In children, adequate fiber intake has short-term benefits like constipation relief and improved gut microbiota; potential long-term benefits, such as protection against obesity-related disease, are less understood [14–16]. In the United States, an estimated 15% of dietary fiber comes from whole grain foods [17]. Thus, Americans need to be encouraged to increase intake of whole grain foods high in dietary fiber.

In the United States, several policies encourage and support the consumption of whole grains. Since 2005, the federal Dietary Guidelines for Americans (DGAs) have recommended adults and children consume at least half of their total grain intake from whole grains [18–20]. The DGAs play a critical role in federal nutrition programs and labeling regulations, which in turn can influence food marketing and product reformulations, making healthier products more readily available to all consumers [21]. In 2010, the Healthy, Hunger-Free Kids Act required that all grains offered as part of the National School Lunch Program (NSLP) and the School Breakfast Program (SBP) contain at least 50% whole grains [22,23]. These updates led to improvements in the diet quality of children [24,25]. The current US Department of Agriculture (USDA) nutrition guidelines for school meals require that at least 80% of the weekly grains offered in the NSLP and SBP be "whole grain-rich," as defined by the USDA (e.g., must contain at least 8 g of whole grain per ounce) [26]. Of particular relevance to the diets of young children, the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in 2009 included whole grains as part of the food package for the first time, which significantly impacted the purchasing of whole grain products [27].

This study fills a gap in the literature by using data from the 2008 and 2016 Feeding Infants and Toddlers Study (FITS) to assess young children's intake of whole grain foods and fiber from whole grain foods before and after federal policies went into effect. FITS is among the largest and most comprehensive dietary survey of young children in the United States. Although not nationally representative, its rigorous study design provides data on a broad socioeconomic sample of children using state-of-the-art 24-hour dietary recall methodology [28].

The hypothesis of this study is that intake of whole grain foods in children will be higher in 2016 compared to 2008. Thus, this study aims to determine: (1) whether a higher percentage of young children are consumers of whole grain foods—that is, eating any foods listing whole grains as a first ingredient—in 2016 compared to 2008; (2) whether young children who are whole grain consumers consume larger amounts of whole grain foods in 2016 compared to 2008 and how that contributes to their fiber intake from whole grains; and (3) what foods are providing the main sources of whole grains. This study offers a unique opportunity to assess young children's whole grain and fiber intake during a period of policy change, which can inform future policy and intervention efforts aimed at improving whole grain intake in young children in the United States.

2. Methods and materials

2.1. *Study design: FITS 2008 and 2016 and participants*

FITS is a series of cross-sectional surveys of food and beverage intake in random national samples of children from birth through age 47.9 months in the United States. FITS data were collected by telephone. This study includes data from the 2008 and 2016 FITS only because whole grain intake was not assessed in the 2002 FITS. Detailed FITS 2008 and 2016 survey procedures and the design are presented elsewhere [28,29]. In brief, households were identified through 4 stratified random sampling frames to obtain target sample sizes in cells based on 12 age groups and participation in WIC. The sampling plans reflect the geographic and sociodemographic diversity of households with young children across the 50 states and Washington, DC. The 2008 samples were drawn from targeted lists of prenatal and postnatal records from the New Parent Database from Experian Information Solutions, Inc. (Costa Mesa, CA, USA); the 2016 sample was drawn from a combination of the New Parent Database, address-based and cell phone sampling frames, and a web panel. The sample for this study included infants and young children ages 12 to 47.9 months from FITS 2008 ($n = 2385$) and FITS 2016 ($n = 1733$). Further details of the sampling and methodology are available in methods publications from each of the FITS [28,29]. Sampling weights were calculated to account for the probability of selection and adjusted for nonresponse and incomplete coverage to reflect the U.S. population younger than 4 years of age.

2.2. Data collection

Structured telephone interviews were conducted by highly trained interviewers with the primary caregiver of the selected child (1 child per household). Interviewers administered a comprehensive household survey with the mother or primary caregiver assessing self-reported household sociodemographic characteristics including sex, race and ethnicity, and feeding behaviors of infants and young children. All interviews and materials were available in both English and Spanish. Informed verbal consent was obtained from all participants involved in the study. All 2008 instruments and procedures were reviewed and approved by the University of Minnesota and Mathematica Policy Research's independent institutional review boards (Public/Private Ventures, Philadelphia, PA) and 2016 materials were reviewed and approved by the institutional review boards of RTI International (IRB 13781), the University of Minnesota, and the Docking Institute of Public Affairs, Fort Hays State University. As described in Briefel 2010 and Anater 2016, FITS 2008 and 2016 complied with HHS Policy for Protection of Human Research Subjects (45 CFR part 46) [28,29]. The current project relied on nonidentifiable information.

2.3. Dietary intake

Following the questionnaires, a multiple-pass 24-hour dietary recall was conducted by telephone. A second 24-hour recall was collected at least 1 week later on a random subset of respondents (21% in 2008, and 25% in 2016) to estimate usual nutrient intakes; mean intakes and standard errors are presented in this paper. Before reporting dietary intakes, respondents were mailed materials to assist them with accurate reporting of portion sizes. These included a ruler, a measuring cup, and a Food Measurement Aids booklet. Dietary intake data were collected using the Nutrient Data System for Research (NDSR) software versions 2008 and 2015, University of Minnesota Nutrition Data System for Research, Minneapolis, MN [30].

2.4. Dietary data

This analysis used the NDSR definition of whole grain foods, which includes foods that list the whole grain ingredient as the first ingredient on the food label [31]. Products that have whole grain listed elsewhere on a product label were not considered "whole grain foods" because whole grain was not a predominant ingredient. The NDSR serving size food file was used because NDSR data collected before 2013 does not include ounce equivalents for grains. The serving size food file reports the number of servings of whole grains a product contains; we converted serving size to grams using a multiplier of 16 [32]. To determine fiber intake from whole grain foods, the distributions of grain type from each food were assessed (i.e., percent from refined grains, some whole grains, and 100% whole grains). In 2008, there were 8 instances of fiber coming from mixed grain foods (i.e., from whole grain foods as well as foods with some whole grain and/or refined grains); in 2016, there were 38 instances of fiber coming from mixed grain foods. Given the small amount of fiber coming from mixed grain foods that also included whole grains, they were included in the "fiber coming from whole grain foods" category before most refined grain foods do not contain substantial amounts of fiber [33,34]. Therefore, in 2008 0.3% of fiber from whole grain foods also included some mixed grains, and in 2016 1.5% of fiber from whole grain foods also included some mixed grains. Final calculations were completed using NDSR (version 2015). The NDSR time-related database updates analytic data while maintaining nutrient profiles true to the version used for data collection.

2.5. Statistical analyses

All statistical analyses were performed using SAS (version 9, SAS Institute Inc., Cary, NC, USA) and SAS-callable SUDAAN (version 11, RTI International, Research Triangle Park, NC, USA) software. All analyses used the sampling weights to account for differential probabilities of selection and the complex sample design (Appendix 1) [35]. A weighted logistic regression model that accounted for the FITS complex survey design was used to estimate percent consuming whole grains and standard error (SE) using up to two 24-hour dietary recalls. For each child, the National Cancer Institute's Usual Intake method was used to estimate average grams per day and SE of whole grains and fiber from whole grains using up to two 24-hour dietary recalls (data was from foods only and did not include dietary supplements use) [36]. Covariates in all models included child age, child sex, child race and ethnicity, household poverty level, caregiver education, marital status, whether child was ever breastfed, and WIC enrolled status as well as total energy intake. Respondents with missing values for covariates were excluded from the analyses. This resulted in removing 38 participants in 2008 and 38 participants in 2016. $P < .05$ was considered statistically significant. We did not adjust P values for multiple comparisons given the descriptive nature of the study, in line with existing recommendations, and to highlight opportunities for future studies [37,38]. Percent consuming whole grain foods was determined using predicted marginal means and compared between years using t-tests from weighted logistic regression from SUDAAN. Grams per consumer of whole grain foods and mean grams per day for usual nutrient intake of fiber from whole grains were tested between years and sociodemographic groups using independent t-tests. To determine the top food sources contributing to whole grain intake, we used the first day of intake to estimate the grams of whole grains per day coming from each food source. Grams of whole grains from food sources were analyzed using bivariate analyses by sociodemographic characteristics. Differences between years were assessed using an independent t-test.

3. Results

3.1. Sample characteristics

Both the FITS 2008 and 2016 samples included mostly non-Hispanic White children and caregivers who were married and had at least a college degree (Table 1). In both the FITS 2008 and 2016, most children were ever breastfed (80.4% and

Table 1 – Unweighted count and percent of children 12 to 47.9 months old participating in the Feeding Infants and Toddlers Study 2008 and 2016.

	FITS 2008, *n* (%)		FITS 2016, *n* (%)	
	Total	Whole grain consumers	Total	Whole grain consumers
Total[a]	2385	1571	1733	1283
Age groups				
12–23.9 months	924 (38.7)	622 (39.6)	1133 (65.4)	850 (66.3)
24–47.9 months	1461 (61.3)	949 (60.4)	600 (34.6)	433 (33.7)
Sex				
Male	1243 (52.1)	804 (51.2)	853 (49.2)	630 (49.1)
Female	1142 (47.9)	767 (48.8)	880 (50.8)	653 (50.9)
Child race and ethnicity				
Hispanic	229 (9.6)	148 (9.4)	245 (14.2)	184 (14.4)
Non-Hispanic White	1811 (75.9)	1208 (76.9)	1157 (67.0)	860 (67.1)
Non-Hispanic Black	169 (7.1)	99 (6.3)	260 (15.0)	184 (14.4)
Non-Hispanic other	176 (7.4)	116 (7.4)	66 (3.8)	53 (4.1)
Federal poverty level[b]				
≤ 200% poverty level	822 (34.5)	502 (32.0)	908 (52.4)	645 (50.3)
> 200% poverty level	1560 (65.5)	1067 (68.0)	825 (47.6)	638 (49.7)
Caregiver education				
≤ High school	520 (21.9)	307 (19.6)	419 (24.2)	299 (23.3)
Some postsecondary	392 (16.5)	239 (15.3)	363 (21.0)	256 (20.0)
≥ College or graduate work	1466 (61.6)	1021 (65.2)	949 (54.8)	726 (56.7)
Marital status				
Married	2063 (86.6)	1391 (88.5)	1180 (68.9)	899 (70.7)
Separated or divorced	59 (2.5)	31 (2.0)	125 (7.3)	92 (7.2)
Widowed	9 (0.4)	6 (0.4)	21 (1.2)	14 (1.1)
Never married	153 (6.4)	78 (5.0)	199 (11.6)	137 (10.8)
Living with partner	99 (4.2)	65 (4.1)	188 (11.0)	130 (10.2)
Ever breastfed				
Yes	1897 (80.4)	1288 (83.0)	1363 (79.0)	1029 (80.6)
No	461 (19.6)	263 (17.0)	363 (21.0)	248 (19.4)
WIC status				
WIC enrolled	519 (21.8)	311 (19.8)	541 (31.3)	387 (30.3)
WIC eligible, not enrolled	343 (14.4)	217 (13.8)	368 (21.3)	259 (20.3)
Not WIC eligible	1521 (63.8)	1042 (66.4)	819 (47.4)	633 (49.5)
Total energy (calories)				
<800	249 (10.4)	156 (9.9)	216 (12.5)	162 (12.6)
800–1099	622 (27.8)	440 (28.0)	502 (29.0)	362 (28.2)
1100–1399	747 (31.3)	504 (32.1)	529 (30.5)	391 (30.5)
1400+	727 (30.5)	471 (30.0)	486 (28.0)	368 (28.7)

FITS, Feeding Infants and Toddlers Study; WIC, Special Supplemental Nutrition Program for Women, Infants and Children.
[a] Sum of subgroups may not add to total because of missingness.
[b] Federal poverty level is based on reported income and household size.

79.0%, respectively); about one quarter were enrolled in WIC (21.8% vs 30.3%, respectively). There were some notable demographic differences in the FITS samples across the 2 surveys; the unweighted FITS 2016 sample had a larger number of 12- to 23.9-month-olds, non-Hispanic Black children, and households with incomes less than 200% of the federal poverty level compared to FITS 2008. The weighted samples used for analysis can be found in Appendix 1.

3.2. *Whole grain consumption*

Overall, a higher percentage of children consumed whole grains in 2016 compared to 2008 (74.4% vs. 65.2%, $P = .0001$) and consumers ate a greater amount per day (23.4 g vs. 19.1 g, $P < .0001$) (Table 2). Between 2008 and 2016, the percent of children consuming whole grains and grams of whole grains per consumer were significantly higher across most of the sociodemographic characteristics. There were no statistical differences between 2008 and 2016 in percent consuming whole grains for children who were female, Hispanic, >200% poverty level, never married, living with a partner, never breastfed, enrolled in WIC, or WIC-eligible. However, there were significant differences in amount consumed among consumers, with each group consuming higher amounts of whole grains in 2016. For non-Hispanic Black children there was no significant difference between 2008 and 2016 in the percent consuming whole grains or grams of whole grains consumed. Hispanic children, younger children, female children, and children from caregivers with a high school education or less had the greatest difference in grams of whole grains consumed among con-

Table 2 – Percent consuming whole grains and grams of whole grains consumed among consumers, by year, sociodemographic characteristics and total energy intake among 12- to 47.9-month-olds participating in the Feeding Infants and Toddlers Study 2008 (*n* = 2385) and 2016 (*n* = 1733).

Characteristic		FITS 2008		FITS 2016		*P* value	
		Percent consuming (SE)	Grams per day per consumer (SE)	Percent consuming (SE)	Grams per day per consumer (SE)	Percent consuming	Grams per day per consumer
Overall[a,b]		65.2 (0.02)	19.1 (0.22)	74.4 (0.02)	23.4 (0.32)	.0001	<.0001
Child age	12–23.9 months	64.6 (0.03)	15.0 (0.30)	77.0 (0.02)	20.2 (0.33)	.0001	<.0001
	24–47.9 months	65.5 (0.02)	21.2 (0.30)	73.0 (0.02)	25.0 (0.57)	.0135	<.0001
Child sex	Male	60.6 (0.02)	21.4 (0.34)	74.9 (0.02)	23.3 (0.46)	<.0001	.0007
	Female	70.2 (0.02)	16.9 (0.29)	73.8 (0.02)	23.5 (0.43)	.2248	<.0001
Child race and ethnicity	Hispanic	65.3 (0.04)	14.6 (0.60)	75.5 (0.04)	22.4 (0.80)	.0728	<.0001
	Non-Hispanic White	63.7 (0.02)	19.9 (0.26)	71.3 (0.02)	23.9 (0.39)	.0068	<.0001
	Non-Hispanic Black	69.1 (0.05)	22.0 (0.95)	75.1 (0.04)	22.6 (0.89)	.3298	.6704
Household income	≤200% Poverty level	61.4 (0.04)	18.8 (0.42)	73.1 (0.03)	23.4 (0.45)	.0123	<.0001
	>200% Poverty level	69.0 (0.03)	19.3 (0.27)	75.8 (0.03)	23.6 (0.44)	.1152	<.0001
Caregiver education	≤High school graduate	64.7 (0.03)	17.8 (0.53)	74.4 (0.03)	24.0 (0.68)	.0316	<.0001
	Some postsecondary	61.9 (0.04)	17.7 (0.56)	73.8 (0.03)	21.6 (0.66)	.0134	<.0001
	≥College degree	66.6 (0.03)	20.0 (0.28)	74.7 (0.02)	23.8 (0.42)	.0192	<.0001
Marital status	Married	67.3 (0.02)	19.4 (0.25)	75.1 (0.02)	24.0 (0.38)	.0059	<.0001
	Never married	59.9 (0.06)	17.6 (0.99)	73.9 (0.05)	21.2 (0.90)	.0732	.0081
	Living with partner	66.8 (0.08)	16.8 (1.01)	67.4 (0.05)	22.8 (1.01)	.9529	<.0001
Ever breastfed	Yes	66.8 (0.02)	19.1 (0.25)	76.1 (0.02)	23.4 (0.35)	.0003	<.0001
	No	59.6 (0.03)	19.1 (0.58)	68.4 (0.04)	23.5 (0.74)	.0778	<.0001
WIC status	WIC enrolled	62.7 (0.04)	19.3 (0.56)	69.3 (0.04)	23.6 (0.58)	.1953	<.0001
	WIC eligible, not enrolled	71.0 (0.04)	18.5 (0.62)	76.7 (0.04)	23.4 (0.73)	.3448	<.0001
	Not WIC eligible	64.5 (0.04)	19.2 (0.27)	76.8 (0.03)	23.5 (0.44)	.0078	<.0001
Total energy (calories)	<800	67.9 (0.05)	12.6 (0.47)	73.7 (0.05)	16.0 (0.57)	.405	<.0001
	800–1099	62.8 (0.03)	15.4 (0.33)	73.1 (0.03)	18.8 (0.44)	.020	<.0001
	1100–1399	65.8 (0.03)	19.4 (0.35)	70.5 (0.03)	22.4 (0.47)	.257	<.0001
	1400+	65.7 (0.03)	24.6 (0.45)	78.8 (0.02)	29.2 (0.66)	.000	<.0001

FITS, Feeding Infants and Toddlers Study; WIC, Special Supplemental Nutrition Program for Women, Infants and Children.

[a] Weighted data were used and adjusted for child age, child sex, child race and ethnicity, poverty level, caregiver education, marital status, whether child was ever breastfed, WIC enrolled status, and total energy intake.

[b] Sum of subgroups may not add to total because of missingness; non-Hispanic Other, separated or divorced, and widowed have been omitted because of small sample sizes.

sumers between 2008 and 2016 (14.6 g vs 22.4 g, 15.0 g vs 20.2 g, 16.9 g vs 23.5 g, and 17.8 g vs 24.0 g, respectively).

Within each sociodemographic characteristic, there were some significant differences. In 2008, more female children were consuming whole grains compared to male children ($P = .0231$), but among consumers, males ate more grams of whole grains ($P < .0001$). Hispanic children consumed fewer grams of whole grains among consumers compared to non-Hispanic Black ($P < .0001$) and non-Hispanic White children ($P < .0001$), and non-Hispanic Black children consumed more compared to non-Hispanic White children ($P = .0168$). Children from caregivers with a college education consumed more than those with a high school education or less or some postsecondary education ($P < .0001$). In 2008 and 2016, among consumers younger children consumed fewer grams of whole grains per consumer compared to older children ($P < .0001$). In 2016, children from caregivers with some postsecondary school consumed less whole grains than those with a high school education or a college education ($P = .0084$ and $P = .0036$, respectively).

3.3. *Fiber consumption*

Among those children who consumed whole grains, fiber intake from whole grain foods was significantly higher in 2016 compared to 2008 (3.0 g vs. 2.3 g, $P < .001$, Table 3). Between 2008 and 2016, daily fiber intake from whole grains per consumer was significantly higher within all sociodemographic characteristics, except for non-Hispanic Black children where there was no significant difference (2.7 g vs 2.9 g, $P = .2738$).

Table 3 – Usual nutrient intake of fiber from whole grain foods among whole grain consumers, by year, sociodemographic characteristics and total energy intake among 12- to 47.9-month-olds participating in the Feeding Infants and Toddlers Study (n = 1571) and 2016 (n = 1283).

Characteristics		FITS 2008 Mean (SE)	FITS 2016 Mean (SE)	P value
Overall[a,b]		2.32 (0.03)	3.04 (0.05)	<.0001
Child age	12–23.9 months	1.83 (0.04)	2.65 (0.05)	<.0001
	24–47.9 months	2.57 (0.04)	3.24 (0.08)	<.0001
Child sex	Male	2.59 (0.05)	3.01 (0.06)	<.0001
	Female	2.05 (0.04)	3.05 (0.06)	<.0001
Child race and ethnicity	Hispanic	1.66 (0.08)	2.89 (0.11)	<.0001
	Non-Hispanic White	2.43 (0.04)	3.13 (0.06)	<.0001
	Non-Hispanic Black	2.73 (0.14)	2.94 (0.13)	.2738
Household income	≤200% poverty level	2.26 (0.06)	3.00 (0.06)	<.0001
	>200% poverty level	2.35 (0.04)	3.12 (0.06)	<.0001
Caregiver education	≤High school	2.06 (0.07)	3.09 (0.10)	<.0001
	Some postsecondary	2.25 (0.08)	2.73 (0.09)	.0002
	≥College or graduate work	2.43 (0.04)	3.13 (0.06)	<.0001
Marital status	Married	2.35 (0.04)	3.10 (0.05)	<.0001
	Never married	2.09 (0.14)	2.69 (0.13)	.0019
	Living with partner	2.11 (0.15)	3.04 (0.13)	<.0001
Ever breastfed	Yes	2.32 (0.04)	3.06 (0.05)	<.0001
	No	2.31 (0.08)	2.99 (0.10)	<.0001
WIC status	WIC enrolled	2.33 (0.08)	3.02 (0.08)	<.0001
	WIC eligible, not enrolled	2.20 (0.09)	3.03 (0.10)	<.0001
	Not WIC eligible	2.34 (0.04)	3.09 (0.06)	<.0001
Total energy	<800	1.53 (0.07)	2.04 (0.08)	<.0001
	800–1099	1.88 (0.05)	2.44 (0.06)	<.0001
	1100–1399	2.38 (0.05)	2.90 (0.07)	<.0001
	1400+	2.94 (0.07)	3.81 (0.10)	<.0001

FITS, Feeding Infants and Toddlers Study; WIC, Special Supplemental Nutrition Program for Women, Infants and Children.

[a] Weighted data were used and adjusted for child age, child sex, child race and ethnicity, poverty level, caregiver education, marital status, whether child was ever breastfed, WIC enrolled status, and total energy intake.

[b] Sum of subgroups may not add to total because of missingness; non-Hispanic Other, separated or divorced, and widowed have been omitted because of small sample sizes.

Among children consuming whole grains, Hispanic children had the greatest difference in fiber intake from whole grains with a 74.4% higher intake in 2016, this was followed by children from caregivers with a high school education or less with 49.9% higher intake and younger children with a 44.9% higher intake in 2016.

Within sociodemographic characteristics, there were some significant differences. In 2008, younger children had fewer grams of fiber from whole grains per consumer compared to older children ($P < .0001$); Hispanic children had fewer grams of fiber from whole grains compared to non-Hispanic Black and non-Hispanic White children ($P < .0001$). Male children had more grams of fiber from whole grains per consumer compared to female children ($P < .0001$). Children from caregivers with a high school education or less had fewer grams of fiber from whole grains per consumer compared to those with caregivers with a college degree or more ($P < .0001$). In 2016, younger children had fewer grams of fiber from whole grains per consumer compared to older children ($P < .0001$); children from married caregivers had more compared to children from caregivers who were never married ($P = .0030$). Children from caregivers with some postsecondary education had less grams of fiber compared to those with caregivers with a high school education or less ($P = .0059$) and those with a college education or more ($P = .0002$).

3.4. *Food sources*

Overall, in 2008, 70.2% of grams of whole grains consumed per day came from ready-to-eat cereal (5.2 g), followed by hot cereal (4.5 g) and bread (3.7 g) (Figure 1). In 2016, the top 3 whole grain food groups were the same as 2008, but only contributed 57.5% of whole grains consumed: ready-to-eat cereal (5.0 g), bread (4.5 g), and hot cereal (4.0 g). These were followed by chips and other salty snacks; sweet bakery items and cereal/nutrition bars; pasta and rice; crackers, pretzels, and rice cakes; pancakes, waffles, and French toast; and baby food cereal. These 9 food groups accounted for 95.1% of all whole grains consumed by whole grain consumers in 2008 compared to 90.6% in 2016. Overall, a higher percentage of grams of whole grains came from sweet bakery items and cereal/nutrition bars ($P = .0003$) and baby food cereal ($P = .0123$) from 2008 to 2016. Across demographic characteristics, the top foods consumed remained similar with no notable differences.

4. Discussion

According to national data from FITS, not only were a higher percentage of young children consuming whole grains in 2016,

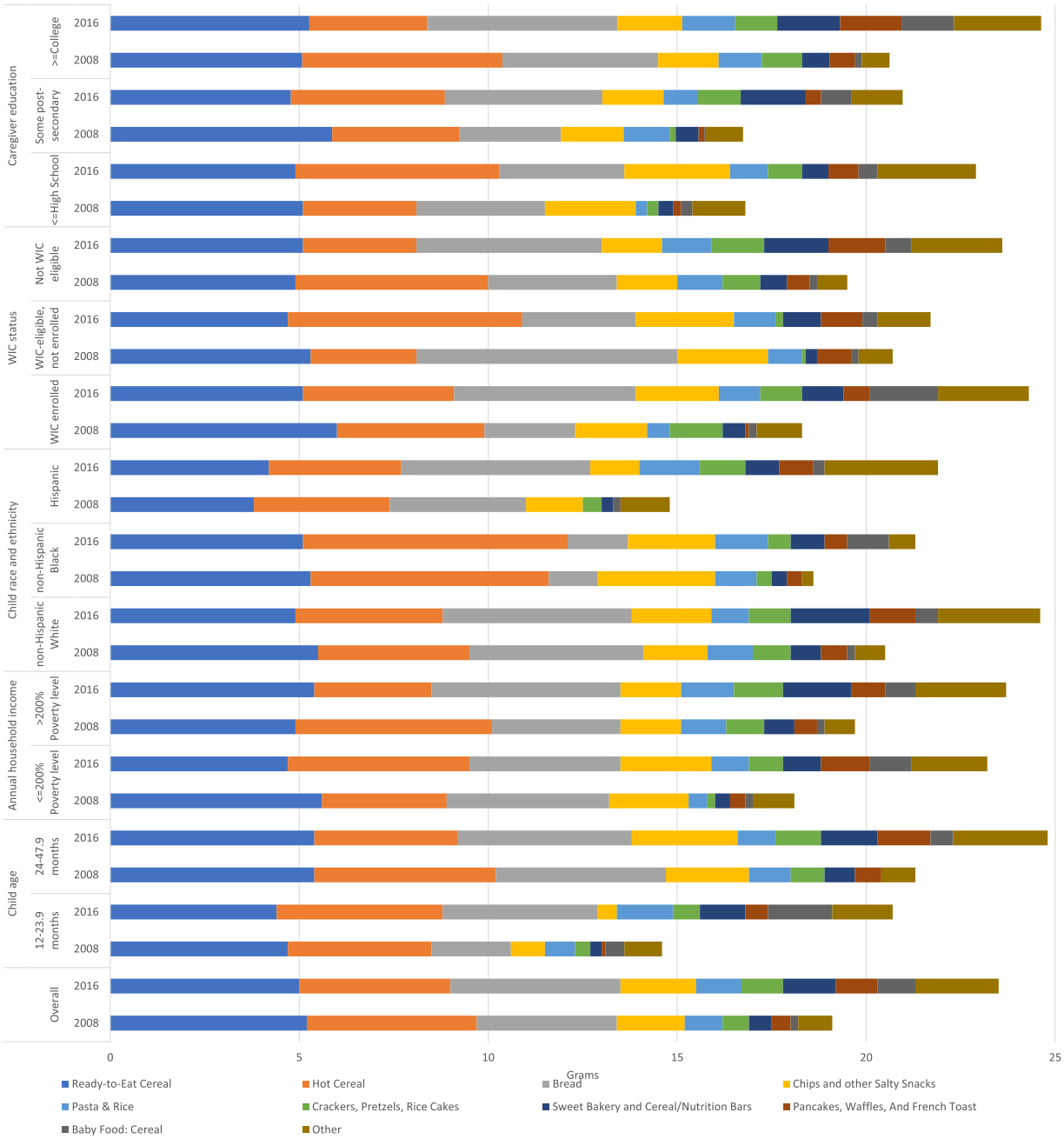

Fig. 1 – Most commonly consumed whole grain foods by percent of total whole grain foods presented by year and demographic group among 12- to 47.9-month-olds participating in the Feeding Infants and Toddlers Study 2008 and 2016. WIC, Special Supplemental Nutrition Program for Women, Infants and Children.

but those who consumed larger amounts compared to their 2008 counterparts. Among consumers of whole grains, children also consumed larger amounts of fiber from whole grains in 2016 compared to 2008. This is a promising result when it comes to improving the diet quality of young children because higher intake of whole grains and fiber has been associated with improved overall diet quality among both children and adults [39–42]. Nevertheless, almost one third (approximately 30%) of children were not consuming any whole grains on a given day. Moreover, among those who did consume whole grains, intake was below recommended levels [18]. The 2020–2025 DGA recommend young children have between 1.5-to-3-ounce equivalents of whole grains each day, which is equal to 24 to 48 g, depending on total calorie intake [18]. Thus, on average, children were not eating the minimum amount of whole grains but are improving and approaching the minimally recommended amount. Although this study looked at fiber intake from whole grain foods only, it is likely children are not meeting recommendations for total fiber intake either. The DGA recommend children consume between 14 and 19 grams of fiber each day depending on age [18]. It is unlikely that whole grains were being substituted with fruits or vegetables, which

are other important contributors of fiber; previous analyses of the FITS 2016 data showed that more than 20% of infants and toddlers were not consuming a single serving of fruit on a given day, and approximately 30% were not consuming vegetables [43,44]. Although not assessed in this analysis, other research has found that more than half of U.S. children have poor diets and overconsume foods that lack fiber and other important vitamins and minerals, such as refined grains, sugary drinks and sweets, and saturated fat [45]. Thus, more efforts are needed to improve children's whole grain and fiber intake. Finding ways to increase consumption of 100% whole grain foods could better contribute to improving fiber intake.

Although few studies have assessed whole grain intake in national samples of young children, studies among older children show whole grain intake is below recommended levels [39,46,47]. Using the National Health and Nutrition Examination Survey (NHANES) 2015–2016 data, Smith et al. assessed intake in children aged 0.5 to 17 years and found whole grain intake was low, especially for children younger than 2 years of age [48]. However, those who consumed ready-to-eat cereal had higher intakes, a potential strategy for meeting recommendations [49]. Lin et al. used nationally representative data from the Continuing Survey of Food Intakes by Individuals and NHANES to assess trends in whole grain intake from 1994 to 2018 among individuals aged 2 years and older [46]. They found increases in consumption of whole grains among school children (aged 5–19 years) likely because of changes in school nutrition standards requiring the inclusion of whole grain-rich foods, but intakes were still below recommended levels. Using data from the FITS 2008, Fox et al. found that 94% of 2- to 3-year olds did not meet the minimum recommended intake for whole grains (1.5 ounce equivalents/1000 calories) [50]. Guthrie et al. reported overall fiber intake for both 12- to 23.9- and 24- to 47.9-month olds participating in the 2008 and 2016 FITS and found 99% consumed less than the Adequate Intake for dietary fiber (19 g/d) in 2008 and 97% and 91%, respectively in 2016 [51]. NHANES is similar to FITS in that it collects dietary recalls on children < 2 years of age, but sample sizes are small, particularly for differentiating breast vs bottle fed children. However, FITS collects data via telephone and therefore lack anthropometric data [52]. Both studies are important for assessing the dietary habits of U.S. children.

More children enrolled in WIC consumed whole grains in 2016 than in 2008; nevertheless, a sizable minority in our sample did not. This was unexpected given the 2009 addition of whole grain products to the WIC food packages [53]. Central to the 2009 revision was ensuring at least half of the total number of breakfast cereals in the state agency food list be whole grain. Thus, it is likely that many non–whole grain cereals are still being purchased with WIC benefits. In fact, Stewart et al. found that whole grain cereal purchases were no different in WIC and non-WIC households [54]. Perhaps our findings reflect the changing landscape of how families eat. Many consumers are switching from eating breakfasts focused on whole grains, like ready-to-eat cereal and hot cereal, to more egg-based breakfasts [55]. Breakfast habits may have changed in the interest of convenience, with children eating foods more suitable for on the go, like nutrition bars, instead of sitting down to eat a bowl of cereal. This is supported by the changes we see in the top food sources of whole grains between 2008 and 2016 with sweet bakery items and cereal/nutrition bars being larger contributors.

Federal policy, including the changes to the WIC food package and the NSLP and SBP, likely incentivized product reformulations to include whole grains and increased their availability [56]. This, along with nutrition education and promotion, perhaps explains the higher amount of whole grains consumed among all children in FITS 2016 compared to 2008 [47]. After introduction of the new WIC food packages, improvements in healthy food availability were observed in WIC and non-WIC stores [57–59]. But improvements were more pronounced for WIC-authorized stores, especially those in lower-income areas, and were driven primarily by the greater availability and variety of whole-grain products [60,61]. For example, although there was no significant difference in the percent of Hispanic children consuming whole grains in 2016 (likely because of already high levels of whole grain foods like corn tortillas [62]), those who ate whole grains consumed more grams of whole grains. Perhaps this lack of difference is due to product reformulations, meaning they were eating the same foods, but now these foods had more whole grains in them [47]. The same could be said for other groups of children consuming higher amounts of whole grains, including those living in low-income households, those enrolled in WIC, and those eligible, but not enrolled; these children may have passively been consuming more whole grains because of product reformulations.

The increased availability of whole grain foods created by product reformulation may have been helpful to parents, who are critical in shaping the household food environment. Although the difference in consumption of whole grain foods and fiber from whole grains foods was small across the 2 timepoints, the significance is noteworthy. Food preferences develop early in life and can be difficult to change as children age [63]. Early and repeated exposure is 1 of the primary determinants of acceptance [64]. As noted by a recent review, 1 of the most effective ways to facilitate whole grain intake in children is to increase the availability and variety of foods containing whole grains [65]. However, many parents struggle with including whole grains in the household diet [66]. The use of vague and nonspecific terms on food packages (e.g., "multigrain," "wheat," or "stone-ground") can make identifying whole grain products difficult and confusing [67]. Manufacturers may label their products with terms that are similar to, but slightly different from the Food and Drug Administration–approved Whole Grain Health Claim. For example, the following terms can be found on products that are not Food and Drug Administration–approved whole grain products: "whole grain," "made with whole grains," "made with whole wheat," or "contains whole grains [67,68]. Consumers may purchase these products wanting to increase whole grain intake for themselves and their families, expecting them to be better sources of whole grains than they actually are. The increased amounts of whole grains obtained from sweet bakery items and cereal/nutrition bars between 2008 and 2016 may reflect a response to consumer desire to improve whole grain intake. However, the actual amount of whole grains included, along with other less nutritious food qualities such as added sugar and fat, may not be clear to consumers. Critical comprehensive examination of the positive

and negative impacts of reformulation may be helpful to consumers and inform decisions about food labeling.

Our analyses are subject to limitations common in dietary analyses including the issue of measurement error, which can be more challenging in young children given variable day-to-day intake and the reliance on proxy report. As with most self-reported dietary intake data, the data may be subject to recall bias. However, results are based on validated methods for estimating food and nutrient intake and reliable survey methods to collect proxy-reports. Before 2013, NDSR output did not include ounce equivalents for grains, making it challenging to determine the precise amount of whole grains consumed. Given we were interested in comparing the 2 timepoints, we used the serving size file output and converted to grams for ease in interpretation. In addition, the most recent FITS data are from 2016 and dietary intake and product availability and composition may have changed since then. Last, despite inclusion of a diverse socioeconomic group of respondents, our sample may not be representative of the general U.S. population [28]; thus, data were weighted to provide U.S. population-representative results.

5. Conclusion

Whole grain consumption among young children was higher in 2016 compared to 2008, which led to higher consumption of fiber from whole grains as well. Although these are positive changes, many children are still falling short of meeting recommendations for whole grain intake. Whole grains are an important source of fiber, vitamins, and minerals; as such, efforts were made to include them in federal school nutrition programs and were added to WIC food packages. These changes likely led to increased availability and reformulations of products, making it easier for children to consume whole grains both at home and away from home in childcare settings and schools. However, some marketing, product labeling, and product reformulations can contribute to consumer confusion and lead to purchases of products that do not contribute as importantly to whole grain intake as consumers believe. Future research is needed to assess the impacts of policy changes in WIC, school meals, and meals served through the Child and Adult Care Food Program on child intake and on longer-term development of preferences and whole grain consumption. Consumer research on food labeling and consumer purchasing can assist development of labeling regulations and consumer education programs that assist parents of young children. Finally, monitoring trends in eating habits, such as the shift to different types of breakfast foods, may provide insight into factors influencing whole grain intakes and the types of whole grain products that could fit changing habits. The next FITS (and other national dietary surveys) could shed light on whether improvements in young children's whole grain intakes continue.

Author declarations

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CRediT authorship contribution statement

Melissa C. Kay: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Conceptualization. **Andrea Anater:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Joanne Guthrie:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Joel Hampton:** Writing – review & editing, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Mary Story:** Writing – review & editing, Supervision, Methodology, Conceptualization.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.nutres.2024.12.007.

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