



Longer Participation in WIC Is Associated with Better Diet Quality in 24-Month-Old Children



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ABSTRACT

Background Little is known about duration of exposure to the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in relation to children's diet quality.

Objective The objective of the study was to examine the association between duration of WIC participation and diet quality of 24-month-old children.

Design A national longitudinal observational study was conducted with participants initially enrolled in WIC in 2013. Telephone interviews were conducted with study mothers from 2013 to 2016. Duration of WIC participation was categorized as high, medium, or low based on the number of interviews during which participants reported receiving WIC benefits.

Participants Participants in the WIC Infant and Toddler Feeding Practices Study 2 who had completed a baseline interview and all interviews through 24 months were included; participants who reported discontinuing WIC due to perceived program ineligibility were excluded from analyses (N=1,250). Data were weighted to represent the study-eligible population.

Main outcome measure Healthy Eating Index 2015 scores of children at age 24 months were calculated based on 24-hour dietary recalls.

Statistical analyses performed Unadjusted analysis of variance examined Healthy Eating Index 2015 scores by WIC participation duration. Multivariate linear regression analysis tested independent effects of WIC duration on Healthy Eating Index 2015 total scores, controlling for sociodemographic factors.

Results After controlling for covariates, WIC participation duration was significantly associated with diet quality. Children in the high duration group had significantly higher Healthy Eating Index 2015 total scores (adjusted mean 59.3, 95% CI 58.6 to 60.1) than children in the low duration group (adjusted mean 55.3, 95% CI 51.6 to 59.0) ($P=0.035$).

Conclusions Children who received WIC benefits during most of the first 2 years of life had better diet quality at age 24 months than children who, despite remaining eligible for benefits, discontinued WIC benefits during infancy. Findings suggest nutritional benefits for eligible children who stay in the program longer.

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HIGHER PARENTAL EDUCATION AND INCOME HAVE been associated with healthier dietary intakes by children.¹ The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), administered by the Food and Nutrition Service at the US

Department of Agriculture (USDA), could reduce the effects of this income gap by providing nutrition education, breast-feeding support, health care referrals, and supplemental foods to low-income pregnant and postpartum women, and to their children up to age 5 years. To qualify for the program, households must have an income at or below 185% of the federal poverty guideline or participate in Medicaid, the Supplemental Nutrition Assistance Program, or Temporary Assistance for Needy Families; program participants must also be at nutritional risk. A number of cross-sectional studies of national samples have evaluated measures of diet quality of young children, using 24-hour recalls as reported by caregivers, comparing children participating in WIC to children not participating in the program.²⁻⁸

In studies that compared WIC participants to higher-income families that did not participate in WIC, children

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receiving WIC benefits had diets that were less healthy than their higher income peers, particularly with regard to consumption of whole grains, whole fruit, and sugar-sweetened beverages.^{3-5,8} However, when children participating in WIC were compared with nonparticipants who were from low-income households, children receiving WIC tended to have superior diets. In addition to better total diet quality, young children participating in WIC have been shown to consume less added sugar, more cow's milk, more 100% juice, and more beans compared with income-eligible non-participants.^{2,4-7}

Prior studies have assessed WIC participation at the child or household level either concurrently, or retrospectively at some point in the past 12 months. Because WIC provides ongoing nutrition education for caregivers, and healthy foods for young children as they are developing food preferences and consumption patterns, longer exposure to WIC services may have a cumulative positive influence on child diet quality. A literature search yielded no prior studies that have examined duration of exposure to WIC in relation to the diet quality of young children. This study uses a diet quality tool consistent with the most recent Dietary Guidelines for Americans, the Healthy Eating Index-2015 (HEI-2015),⁹ to evaluate diet quality in relation to duration of WIC participation. Thus, this study extends other studies' findings by examining duration of WIC participation longitudinally over a 2-year period, in relation to diet quality at age 24 months as measured using the HEI-2015.

METHODS

Study Design and Participants

Data were drawn from the WIC Infant and Toddler Feeding Practices Study 2 (WIC ITFPS-2), a national longitudinal study of feeding practices, nutrition, and health outcomes of children from birth to age 6 years, who were initially enrolled in WIC.¹⁰ In 2013, WIC ITFPS-2 sampled, screened, and enrolled participants in person from 80 WIC sites across 27 states and territories, using a stratified two-stage sampling approach. Eligible WIC sites were limited to those expected to enroll at least 30 new study-eligible cases each month. Follow-up telephone interviews were conducted with study mothers from 2013 to 2016, prenatally and at child ages 1, 3, 5, 7, 9, 11, 13, 15, 18, and 24 months, regardless of continuation of WIC program enrollment. Each interview included questions about the mother and target child's receipt of WIC, socio-demographic characteristics, infant feeding practices and dietary intake, and other health-related behaviors. The Westat Institutional Review Board approved the national study under expedited authority; state health department and local hospital Institutional Review Boards approved local study activities as needed. All participants provided written informed consent at the time of study enrollment. Participants received an incentive of \$50 for study enrollment and \$20 for completion of each interview through 24 months.

Study participants were recruited either prenatally or before their infants were aged 2.5 months. Eligible mothers were aged at least 16 years, and able to complete interviews in English or Spanish. Although study participants may have received WIC benefits for a previous pregnancy or child, they were recruited at the time of initial enrollment in WIC for the current pregnancy or child. The full analysis sample for the

RESEARCH SNAPSHOT

Research Question: Is longer duration of participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) associated with better diet quality in 24-month-old children?

Key Findings: This longitudinal observational study included 1,250 children from the WIC Infant and Toddler Feeding Practices Study 2, followed from birth. After controlling for covariates, children who continued WIC participation through 18 to 24 months, compared with WIC-eligible children who discontinued WIC participation during infancy, had better quality diets on the Healthy Eating Index 2015 ($b=4.06$; $P=0.035$), suggesting benefits of longer participation of eligible children in the WIC program.

study includes 3,777 participants who completed a postnatal interview at 1 or 3 months. To ensure complete longitudinal information on study children, the current study utilized a subset of the sample that completed all postnatal interviews from 1 or 3 through 24 months (unweighted $n=1,349$). This longitudinal subset of data are weighted to represent the national population of study-eligible infants enrolled at larger WIC clinics during the 20-week recruitment period in 2013, and further adjusted to account for interview nonresponse. In analyses comparing this longitudinal subsample of 1,349 to the 2,428 excluded from the current analyses, mothers in the longitudinal subsample, compared with those not in the subsample, were likely to be older at the time of the child's birth, were more likely to be feeding only breastmilk and less likely to be feeding only infant formula at 1 month, and were likely to have enrolled in WIC early in pregnancy. Both maternal age at child's birth, and timing of WIC enrollment are included in the longitudinal weight's nonresponse adjustment. Feeding practice, although not included in the nonresponse adjustment, is related to several variables in the adjustment, including race, ethnicity, poverty status, maternal age at child's birth, and timing of WIC enrollment. Consequently, the nonresponse adjustment implemented in the weighting is expected to account for these differences between participants who were included in the longitudinal sample and those who were not.

Dietary Intake and Diet Quality

The telephone interview at 24 months included a dietary recall, using the USDA Automated Multi-Pass Method.¹¹ The Automated Multi-Pass Method 24-hour dietary recall is constructed such that the interviewer guides the participant through the previous day, and asks her to report all foods, beverages, and dietary supplements consumed by the study child for each eating event during the 24-hour period. Participants received a food-model booklet and measuring guides by mail in advance of the interview to facilitate accurate reporting of portion sizes. Foods, beverages, and dietary supplements consumed by the child were coded and energy, nutrient, and food group intake were computed using the USDA Food and Nutrient Database for Dietary Studies version 5.0 as the source of the nutrient values.¹² A randomly selected 10% subsample of mothers completed a second

24-hour dietary recall within 10 days of the first recall interview. These second, replicate interviews were used to produce an adjustment factor to calculate usual intake of energy, nutrients, and foods for all study children, using the National Cancer Institute method.^{13,14}

The 24-hour recall data were used to compute the HEI-2015 using the population ratio method. The HEI-2015 is a standard measure of diet quality for age 2 years and older that aligns with the 2015–2020 Dietary Guidelines for Americans (DGA).¹⁵ The HEI-2015 produces scores for dietary components, as well as a total score that is the sum of the component scores. The population ratio method involves summing the intakes and dietary components for all individuals in a population and using the ratio of each component to energy in scoring.¹⁶ Total scores of 100 on the HEI-2015 indicate that an individual is fully meeting the DGA recommendations. Components that are scored for adequate intake levels include total fruits (including 100% juice), whole fruits (which excludes 100% juices), total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, and fatty acids. Components that should be eaten in moderation and are scored for overconsumption include refined grains, sodium, added sugars, and saturated fats. For all components, a higher score indicates better adherence to DGA recommendations. Maximum component scores range from 5 to 10.

WIC Participation and Duration

At every interview, study participants were asked about their ongoing participation in WIC with the following question: “Are you currently getting WIC food or checks for yourself or [CHILD]?” Based on responses to this question, participants were categorized as receiving WIC benefits or not receiving WIC benefits at each cross-sectional interview month. To capture the extent of program exposure during the first 2 years of the child’s life, a WIC participation duration variable was calculated. The number of interviews during which the caregiver reported that the child was receiving WIC benefits was used to define duration groups. The Month 1 interview was excluded from these definitions because the window for

that interview began at 2 weeks postpartum and may have included infants not yet certified for WIC who would nonetheless be certified during the first month of life. A review of participation patterns yields a low duration pattern, an intermediate duration pattern, and a high duration pattern, as described in Table 1.

Sociodemographic Variables

Questions at enrollment and follow-up telephone interviews covered a variety of sociodemographic variables. Variables used as covariates for the current multivariate analyses included race/ethnicity of the mother; household income relative to the poverty guideline at 13 months; and maternal educational attainment at baseline. Covariates were selected based on previous literature on sociodemographic correlates of WIC participation and child diet quality.^{1,6}

Statistical Analysis

In the case that during an interview the study participant indicated for the first time that she and her child were no longer receiving WIC benefits, she was asked a series of yes/no questions about the reasons they might have stopped going to WIC, including whether they stopped because she believed they no longer qualified for WIC benefits. Families who no longer qualify for WIC may be systematically different from those who leave WIC by choice. For example, families who no longer qualify due to improved financial circumstances may be able to purchase the types of healthy foods WIC would otherwise provide as supplemental foods. Combining participants who reported no longer qualifying for WIC with those who left WIC for other reasons, but are still eligible, may lead to erroneous conclusions about the effects of WIC participation, either obscuring outcomes associated with duration of WIC participation, or creating the impression that leaving WIC, rather than other changed circumstances, produces positive outcomes. To address this potential confounding factor, the group that reported discontinuing WIC due to perceived program ineligibility (n=99) was excluded from analyses, bringing the sample size to an unweighted sample of 1,250 participants.

Table 1. Categorization of duration of participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) during the first 2 years of life for children in the WIC Infant and Toddler Feeding Practices Study-2 (unweighted n=1,250)^a

Participation duration group	Group description
Low duration (unweighted n=43, 3% weighted)	Receiving WIC benefits at 4 or fewer study interviews, ^b not receiving WIC benefits after 13 mo
Intermediate duration (unweighted n=186, 15% weighted)	Receiving WIC benefits at 5-7 study interviews. Or, if receiving WIC benefits at 4 or fewer interviews, must include at least one of the 15-24 mo interviews
High duration (unweighted n=1,013, 82% weighted)	Receiving WIC benefits for 8 or 9 interviews, continued participation through most of the first 2 y of life

^aThe current study was restricted to the 1,349 participants who completed a postnatal interview at 1 or 3 months, and who completed all subsequent interviews through 24 months. Data were weighted to represent the national population of study-eligible infants enrolled at larger WIC clinics during the 20-week recruitment period in 2013, and further adjusted to account for interview nonresponse. Analyses were restricted to exclude those who reported discontinuing WIC due to perceived eligibility, resulting in a final n=1,250.

^bThe number of study interviews during which the caregiver reported that the child was receiving WIC benefits was used to define duration groups. Nine interviews were considered, including interviews at child ages 3, 5, 7, 9, 11, 13, 15, 18, and 24 months.

Table 2. Characteristics of mothers and children in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) Infant and Toddler Feeding Practices Study 2 study sample who completed all interviews from 1 or 3 through 24 months (unweighted n=1,349)

Sociodemographic characteristic ^a	Unweighted n ^b	Weighted n ^c	Weighted %
Race/ethnicity of mother			
Hispanic	524	196,920	44.5
Non-Hispanic white	430	131,750	29.8
Non-Hispanic African American	330	89,364	20.2
Non-Hispanic other	65	24,209	5.5
Poverty level at 13 mo^d			
130% of poverty guideline or below	905	296,891	71.9
Above 130% of poverty guideline	359	116,047	28.1
Mother's education level at baseline			
High school diploma, General Educational Development certificate, or less	795	271,226	61.4
More than high school diploma	551	170,388	38.6
Child's sex			
Male	696	224,282	50.7
Female	653	217,961	49.3
Mother's marital status at baseline^e			
Married	469	159,860	36.1
Not married	880	282,383	63.9
Age of mother at child's birth (y)			
16-19	119	44,276	10.0
20-25	508	177,019	40.0
≥26	722	220,948	50.0
Parity			
First born	535	185,217	41.9
Second born	389	121,891	27.6
Third or subsequent born	425	135,134	30.6

(continued on next column)

Table 2. Characteristics of mothers and children in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) Infant and Toddler Feeding Practices Study 2 study sample who completed all interviews from 1 or 3 through 24 months (unweighted n=1,349) (continued)

Sociodemographic characteristic ^a	Unweighted n ^b	Weighted n ^c	Weighted %
Prior WIC experience^f			
Yes	756	239,100	54.1
No	592	202,916	45.9

^aSociodemographic characteristics were reported by study mothers at the time of study enrollment or during follow-up telephone interviews.

^bTotal n may not equal 1,349 for all variables due to item nonresponse.

^cData were weighted to represent the national population of study-eligible infants enrolled at larger WIC clinics during the 20-week recruitment period in 2013, and further adjusted to account for interview nonresponse.

^dOne hundred percent of the federal poverty guideline was \$23,850 for family of four in 2014.

^eNot married includes divorced, widowed, or separated.

^fPrior WIC experience is defined as having participated in the program for a previous pregnancy and/or child.

All analyses were conducted using weighted data. The first phase of analysis was descriptive. Means and 95% CIs were calculated to describe diet quality in the study population; unadjusted one-way analyses of variance were conducted between WIC participation duration groupings and the HEI-2015 total and component scores, to determine whether diet quality was significantly associated with WIC participation duration in analyses not adjusted for covariates.

Because the limited range within any particular HEI-2015 component may attenuate associations, the second phase of analysis focused on overall diet quality. Ordinary least squares regression methods were used for models with HEI-2015 total score as the dependent variable. Independent variables included sociodemographic covariates (eg, mother's race, mother's educational attainment, and household income relative to the poverty guideline) and WIC duration, to determine whether WIC participation duration was independently associated with diet quality. Regression results are reported using unstandardized regression coefficients (ie, b), to permit practical interpretation of group differences in the same units as the HEI-2015. Unstandardized regression coefficients indicate the average difference on the HEI-2015 (scale=0 to 100) between groups, adjusted for all other variables in the model. Distributions were examined for adherence to normality assumptions using data visualization. Generalized variance inflation factors for predictor variables were calculated to test for multicollinearity. A power analysis was conducted to determine whether power was sufficient to detect a small (<5 point) difference in the HEI-2015 total score between the WIC duration groups. Using a two-tailed test and $\alpha=.05$, the analysis indicated 95% power to detect such a difference. Although the sample included only participants who had completed all study interviews, missing data due to item nonresponse were managed using pairwise deletion.

Statistical analyses were conducted using SAS version 9.4,¹⁷ with the exception of multicollinearity analyses, which were conducted using R version 3.6.1¹⁸ with the Companion to Applied Regression package.¹⁹ A two-tailed value of $P < 0.05$ was used as the standard for statistical significance.

RESULTS

Descriptive Results

Table 2 lists key sociodemographic characteristics of the WIC ITFPS-2 study population. All percentages were weighted. Caregivers were 44.5% Hispanic, 29.8% non-Hispanic white, 20.2% non-Hispanic African American, and 5.5% other race/ethnicity. At baseline, 36.1% were married, 38.6% had more educational attainment than a high school diploma, and 50% were aged 26 years or older. For 41.9% of study mothers this was their first child. At the 13-month interview, 71.9% of study mothers reported income at or below 130% of the federal poverty guideline.

The mean HEI-2015 total score for the study sample at 24-months old was 60.5 out of 100 (median score 60.7) (Table 3). Looking at WIC participation duration, among all study

children 82% were in the high duration group, 15% were in the intermediate duration group, and 3% were in the low duration group.

Collapsing across all duration groups, the unadjusted association between HEI-2015 total score and WIC participation duration was significant ($F [2,40]=10.34$; $P=0.0002$). The mean HEI-2015 total scores at 24 months ranged from 55.2 (95% CI 51.6 to 58.8) for the low duration group to 60.9 (95% CI 60.2 to 61.7) for the high duration group. The HEI-2015 component scores that were significantly associated with WIC participation duration were total vegetables, greens and beans, seafood and plant protein, refined grains, and saturated fat (Table 3). When participants who discontinued WIC due to perceived ineligibility were included in these analyses mean values did not change substantially, and only saturated fat was no longer significantly associated with WIC duration (see Table 4 for details).

Adjusted Results

Children in the high duration group (adjusted mean 59.3, 95% CI 58.6 to 60.01) had significantly higher HEI-2015 total

Table 3. Mean unadjusted Healthy Eating Index 2015 (HEI-2015) total and component scores at 24 months by Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) participation duration, for children in the WIC Infant and Toddler Feeding Practices Study 2, excluding participants who discontinued WIC due to perceived ineligibility

HEI-2015 Score	Maximum HEI-2015 score	Study Children at 24 mo (Unweighted n=1,242, Weighted n=407,416)		WIC Participation Duration Group ^a						
		Mean	95% CI	Low (Unweighted n=43, Weighted n=12,639 ^b)		Intermediate (Unweighted n=186, Weighted n=59,530 ^b)		High (Unweighted n=1,103, Weighted n=335,247 ^b)		
		Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI	P value ^c
Total HEI-2015 score	100	60.5	59.7-61.2	55.2	51.6-58.8	59.2	57.6-60.8	60.9	60.2-61.7	0.0002
Total vegetables	5	2.5	2.5-2.6	2.2	1.9-2.5	2.3	2.2-2.5	2.6	2.5-2.7	0.0066
Greens and beans	5	2.2	1.9-2.4	1.7	1.3-2.1	1.8	1.6-2.0	2.3	2.0-2.5	0.0002
Total fruit	5	4.7	4.7-4.8	4.3	3.9-4.8	4.8	4.6-4.9	4.7	4.7-4.8	0.17
Whole fruit	5	3.5	3.3-3.7	2.1	0.4-3.7	3.5	3.0-4.1	3.6	3.4-3.8	0.21
Whole grains	10	3.6	3.5-3.7	3.5	3.2-3.8	3.6	3.4-3.8	3.6	3.5-3.7	0.78
Dairy	10	9.5	9.4-9.6	9.1	8.4-9.7	9.1	8.7-9.6	9.6	9.5-9.6	0.09
Total protein foods	5	4.3	4.3-4.4	4.2	3.9-4.6	4.3	4.1-4.5	4.3	4.3-4.4	0.78
Seafood and plant protein	5	1.7	1.5-1.9	1.4	0.8-2.0	1.3	1.0-1.6	1.8	1.5-2.0	0.0049
Fatty acid ratio	10	1.8	1.6-1.9	2.1	1.2-3.0	2.0	1.6-2.5	1.7	1.5-1.9	0.25
Sodium	10	5.6	5.3-5.8	5.3	4.5-6.1	5.5	5.0-6.0	5.6	5.3-5.8	0.73
Refined grains	10	7.4	7.3-7.6	7.3	6.6-7.9	7.1	6.7-7.4	7.5	7.3-7.7	0.0240
Saturated fat	10	4.5	4.3-4.8	3.5	2.7-4.2	4.7	4.2-5.1	4.6	4.3-4.8	0.0125
Added sugar	10	9.1	9.1-9.2	8.7	8.2-9.1	9.1	8.9-9.4	9.2	9.1-9.3	0.10

^aThe number of study interviews during which the caregiver reported that the child was receiving WIC benefits was used to define duration groups.

^bData were weighted to represent the national population of study-eligible infants enrolled at larger WIC clinics during the 20-week recruitment period in 2013, and further adjusted to account for interview nonresponse, and analyses are conducted with weighted data. The total may differ from 1,250 due to item nonresponse.

^cOne-way analysis of variance was calculated to determine statistically significant differences between the duration groups on HEI-2015 total and component scores.

Table 4. Mean unadjusted Healthy Eating Index (HEI) 2015 total and component scores at 24 months by Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) participation duration, for children in the WIC Infant and Toddler Feeding Practices Study – 2, including participants who discontinued WIC due to perceived ineligibility

	Study children at 24 months	WIC Participation Duration Groups ^a								
		Low			Intermediate			High		
Unweighted n ^b	1,341	63			237			1,041		
Weighted n	439,955	19,285			76,833			343,837		
HEI-2015 Score	Maximum HEI-2015 Score	Mean	95% CI ^c	Mean	95% CI	Mean	95% CI	Mean	95% CI	P value ^d
Total HEI-2015 Score	100	60.4	(59.6, 61.1)	56.4	(53.8, 58.9)	59.2	(57.7, 60.8)	60.8	(60.1, 61.6)	0.0001
Total vegetables	5	2.5	(2.5, 2.6)	2.3	(2.0, 2.6)	2.4	(2.3, 2.5)	2.6	(2.5, 2.7)	0.006
Greens and beans	5	2.1	(1.9, 2.4)	1.7	(1.4, 1.9)	1.8	(1.6, 2.0)	2.3	(2.0, 2.5)	<.0001
Total fruit	5	4.7	(4.7, 4.8)	4.5	(4.1, 4.8)	4.8	(4.7, 4.9)	4.7	(4.7, 4.8)	0.26
Whole fruit	5	3.5	(3.3, 3.7)	2.7	(1.4, 4.0)	3.6	(3.1, 4.0)	3.5	(3.3, 3.7)	0.41
Whole grains	10	3.6	(3.5, 3.7)	3.7	(3.3, 4.1)	3.5	(3.4, 3.7)	3.6	(3.5, 3.7)	0.70
Dairy	10	9.5	(9.4, 9.6)	9.2	(8.8, 9.7)	9.3	(8.9, 9.6)	9.6	(9.5, 9.7)	0.08
Total protein foods	5	4.3	(4.3, 4.4)	4.3	(4.0, 4.6)	4.3	(4.2, 4.5)	4.3	(4.3, 4.4)	0.96
Seafood and plant protein	5	1.7	(1.4, 1.9)	1.1	(0.7, 1.6)	1.3	(1.0, 1.6)	1.8	(1.5, 2.0)	0.001
Fatty acid ratio	10	1.8	(1.6, 1.9)	1.9	(1.3, 2.4)	2.0	(1.6, 2.3)	1.7	(1.5, 1.9)	0.29
Sodium	10	5.5	(5.3, 5.8)	5.1	(4.6, 5.6)	5.5	(5.0, 5.9)	5.6	(5.3, 5.8)	0.25
Refined grains	10	7.4	(7.3, 7.6)	7.1	(6.5, 7.7)	7.1	(6.8, 7.5)	7.5	(7.3, 7.7)	0.015
Saturated fat	10	4.5	(4.3, 4.7)	4.1	(3.3, 4.9)	4.6	(4.1, 5.0)	4.5	(4.3, 4.8)	0.50
Added sugar	10	9.1	(9.1, 9.2)	8.7	(8.3, 9.1)	9.1	(8.9, 9.3)	9.2	(9.1, 9.3)	0.12

^aThe number of study interviews during which the caregiver reported that the child was receiving WIC benefits was used to define duration groups.

^bData were weighted to represent the national population of study-eligible infants enrolled at larger WIC clinics during the 20-week recruitment period in 2013, and further adjusted to account for interview non-response, and analyses are conducted with weighted data. The total may differ from 1,349 due to item nonresponse.

^cCI=confidence interval.

^dOne-way analysis of variance was calculated to determine statistically significant differences between the duration groups on HEI-2015 total and component scores.

scores than did children in the low duration group (adjusted mean 55.3, 95% CI 51.6 to 59.0). Some of the covariates were also significant: HEI-2015 total scores were significantly higher for children of Hispanic mothers (adjusted mean 61.8, 95% CI 60.6 to 63.1) and non-Hispanic African-American mothers (adjusted mean 57.5, 95% CI 55.9 to 59.1), compared with children of non-Hispanic white mothers (adjusted mean 55.6, 95% CI 54.0 to 57.1). Children whose mothers reported incomes at or below 130% of the poverty guideline had significantly higher HEI-2015 total scores (adjusted mean 58.4, 95% CI 57.1 to 59.7), compared with those with incomes above 130% of the poverty guideline (adjusted mean 57.2, 95% CI 55.6 to 58.7). Overall, the independent variables accounted for 16% of the variance ($R^2=0.16$) in HEI-2015 total score. Unstandardized regression coefficients and their 95% CIs are shown in Table 5 (adjusted means and their 95% CIs in the text are not shown in Table 5).

DISCUSSION

This study found that children who received WIC benefits during most of the first 2 years of life had better diet quality at age 24 months than children who, despite remaining eligible for benefits, stopped receiving WIC benefits during infancy. Study participants who discontinued WIC due to perceived ineligibility were excluded from the analyses, making the design more comparable to past research that found better child diet quality among WIC recipients than among income-eligible nonrecipients.^{6,7}

As in previous research, the origins of the diet quality differences may be attributed to higher consumption of greens and beans,⁶ and lower consumption of saturated fats,⁸ possibly due to continued receipt of the WIC food package, which at 24 months includes vegetables, beans, and low-fat or nonfat milk. The current study did not replicate findings

Table 5. Association of the Healthy Eating Index 2015 total score and Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) participation duration adjusted for sociodemographic covariates, for children in the WIC Infant and Toddler Feeding Practices Study 2 (n=1,161)^a

Variable	b ^b	95% CI	P value
Intercept	53.09	49.1 to 57.1	
WIC participation duration^c			
Intermediate group vs low group	3.39	−1.06 to 7.84	0.132
High group vs low group	4.06	0.30 to 7.82	0.035
Mother's race			
Hispanic vs non-Hispanic white	6.25	4.84 to 7.67	<0.0001
Non-Hispanic African American vs non-Hispanic white	1.88	0.38 to 3.38	0.015
Non-Hispanic other vs non-Hispanic white	0.60	−1.97 to 3.16	0.641
Poverty level at 13 mo			
At or below 130% of poverty guideline vs above 130% of poverty guideline ^d	1.24	0.19 to 2.28	0.022
Mother's education level at baseline			
High school diploma, General Educational Development certificate, or less vs more than high school diploma	−1.22	−2.57 to 0.13	0.076

^aData were weighted to represent the national population of study-eligible infants enrolled at larger WIC clinics during the 20-week recruitment period in 2013, and further adjusted to account for interview nonresponse, and analyses are conducted with weighted data. Analyses were restricted to exclude those who reported discontinuing WIC due to perceived ineligibility.

^bUnstandardized regression coefficients indicate the average difference on the HEI-2015 (scale=0 to 100) between the indicated groups, adjusted for all other variables in the model.

^cThe number of study interviews during which the caregiver reported that the child was receiving WIC benefits was used to define duration groups.

^dOne hundred percent of the federal poverty guideline was \$23,850 for family of four in 2014.

about higher total fruit (including 100% juice) consumption among children receiving WIC.^{2,3} Nonetheless, total fruit consumption was still relatively high for all WIC participation duration groups in the current study, and the earlier studies were conducted before changes in the WIC food packages that, among other changes, substantially reduced the amount of juice provided for children.²⁰

This longitudinal study provides a unique focus on WIC participation duration, with results that are similar to past cross-sectional studies. Whereas other studies compared households that received WIC benefits either concurrently or at any time in the past year to those who did not receive benefits, the current study compares those who received WIC services at differing durations, demonstrating that longer duration of receipt of WIC benefits is associated with better diet quality. The current study is also the first to examine the association between WIC participation and the HEI-2015, which uses the 2015 to 2020 DGAs as a standard for diet quality.

WIC may influence child diet quality through two mechanisms: the nutrition education provided to caregivers, and the nutritious foods provided for children. Research has established that WIC nutrition education results in changes in nutrition knowledge and feeding practices, including increased consumption of nutritious foods.²¹ In addition, research has found that children who received WIC benefits at 24 months consumed more of their daily calories from nutritious WIC-eligible foods than did children not receiving WIC benefits.²² Foods purchased with WIC benefits are intended to be supplemental—in 2016, when most study

children were aged 24 months, the average per-person cost for the WIC food package was \$42.76 per month.²³ Direct influences of the food package alone on diet quality may therefore be small in magnitude. Future research should explore the relative contributions of WIC nutrition education and nutritious foods in promoting better diet quality, as well as the role of WIC in establishing food preferences and eating habits early in life.

The magnitude of the adjusted difference between the low duration and high duration groups on the HEI-2015—4 points—was also small. To our knowledge, clinical guidance for HEI-2015 scores has not yet been developed,²⁴ so it is not possible to determine whether this difference is clinically important for children's long-term health, but past research with the HEI-2010 described a 3.7-point gain in child diet quality, attributable to the new WIC food package, as a meaningful improvement.⁶ The intermediate duration group had an adjusted mean total HEI-2015 score that was somewhat higher in magnitude than that of the low duration group, but the difference was not significant. The intermediate duration group may have left WIC during either the first or second year of life, making it a group with diverse WIC experience. Future research should explore these intermediate duration patterns in greater depth.

Although children who remained on WIC for most or all of their first 2 years of life had better diet quality than children who discontinued WIC participation during infancy, adjusted mean total HEI-2015 scores were 59.3 and 55.3, respectively, and therefore still below the 80 to 100 total score that is considered indicative of a high-quality diet.²⁵ Data from the

National Health and Nutrition Examination Survey (2005–2008) using the HEI-2010 found a mean total score of 56.7 for a national sample of 2-year-old children receiving WIC.²⁶ Data from the National Health and Nutrition Examination Survey (2009–2014) using the HEI-2015 found a mean total score of 60.1 for a national sample of 2- to 5-year-old children.²⁷ WIC ITFPS-2 study children's diet quality is therefore similar to that of children from other studies; nonetheless, there is room for improvement.

This study has several features that limit the conclusions that may be drawn from the data. WIC ITFPS-2 is entirely observational in design, and therefore no causal conclusions may be drawn about WIC participation duration and child diet quality. The percentage of study participants in the high duration group, 82%, is the same as the rate reported by Whaley and colleagues²⁸ at 14 months, and slightly higher than that reported by Jackowitz and Tiehen²⁹ at age 2 years (77%). Nonetheless, WIC participation status was obtained through maternal report, and not independently verified through WIC enrollment records, and may therefore contain some error in reporting. Families may have lapsed in their WIC certification, but responded in line with their intention to recertify in the future. Alternatively, mothers may have affirmed WIC participation in an effort to please the interviewer for a study that recruited participants at WIC sites.

In addition, study mothers were asked about WIC participation for either themselves or the study child. It is possible that a study mother could have been receiving WIC benefits for a subsequent pregnancy while the study child was not receiving benefits, although it would be unusual for a mother to enroll herself and not her eligible child.

Multivariate analysis controlled for an a priori set of sociodemographic characteristics, but there are many contributions to child diet quality, and there may be other, unaccounted for variables that would add to the prediction of diet quality at 2 years. Nonresponse in this longitudinal study may also affect results. Although nonresponse bias adjustments should account for identified differences between mothers in the longitudinal sample and those not in the longitudinal sample, there may be other unidentified factors associated with nonresponse or with study attrition that could affect findings. Finally, 24-hour dietary recalls completed by a caregiver, the source of the data for diet quality, may also be subject to bias and recall errors.³⁰ The study's use of usual intake adjustments should strengthen the measure of dietary intake used in this study.

CONCLUSIONS

Children who received WIC benefits during most of the first 2 years of life had better diet quality at age 24 months than children who, despite remaining eligible for benefits, stopped receiving WIC benefits during infancy, as reflected in higher HEI-2015 total scores. This study supports ongoing efforts by the WIC program to increase retention of children in the program, and provides registered dietitian nutritionists, and other WIC professionals, with insight into the nutritional benefits of encouraging WIC participants to stay on the program longer. Given that eligible children may continue receiving WIC until their fifth birthday, future studies should examine dietary outcomes associated with WIC participation duration beyond 24 months.

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For more information on the subject discussed in this article, see Sites in Review on page 1102.

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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AUTHOR CONTRIBUTIONS

N. S. Weinfield, C. Borger, L. E. Au, S. E. Whaley, L. D. Ritchie, and D. Berman developed the study question. N. S. Weinfield oversaw study management and data collection. C. Borger oversaw data analysis. N. S. Weinfield wrote the first draft of the manuscript with contributions from L. E. Au and L. D. Ritchie. All authors reviewed and commented on subsequent drafts of the manuscript.