Indicators of Diet Quality, Nutrition, and Health for Americans by Program Participation Status, 2011–2016: WIC Report

Appendix I. WIC Multivariable Regression Analyses

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Appendix I. WIC Multivariable Regression Analyses

The *Indicators of Diet Quality, Nutrition, and Health for Americans by Program Participation Status: 2011–2016* is the fourth study in a series that uses National Health and Nutrition Examination Survey (NHANES) data to compare indicators of diet quality, nutrition, and health among program participants and nonparticipants of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). The study employed two types of analyses to make these comparisons:

> **Regression Outcomes**
>
> **Energy Intakes**
> - Total calories
> - Calories from saturated fats and added sugars
>
> **Overall diet quality**
> - Total HEI-2015 scores
> - Component HEI-2015 scores
>
> **Indicators of nutrition and health**
> - BMI-for-age
> - Hemoglobin
>
> Note: BMI = body mass index; HEI = Healthy Eating Index

▸ Descriptive analyses provided information on indicators of diet quality, nutrition, and health among participants and both income-eligible and higher income nonparticipants; *t*-tests were used to test for differences between the groups overall and by age and gender groups. Results of the descriptive analyses are presented in the main body of the report.

▸ Multivariable regression was used to examine associations between program participation and selected indicators of diet quality, nutrition, and health. Ordinary least squares (OLS) regressions provide a linear interpretation of the association, such that a unit increase in the independent variable of interest is associated with a unit increase in the dependent variable, conditional on covariates. For regressions with binary outcomes, logistic regression results are presented in terms of average marginal effects, which are the expected percentage difference in the dependent variable based on a change in the independent variable. A multivariable regression also facilitates an estimate of the association between the primary independent variables of interest and the dependent variable, after adjusting for covariates. This appendix summarizes and presents findings from the above-described multivariable regression analysis and addresses study objective 6 (see text box).

> **Study Objective 6**
>
> Use advanced regression approaches to examine the multivariable association between program participation and as appropriate the study variables of interest.

Some of the descriptive analysis limitations described in the main report also apply to the multivariable regression analyses presented in this appendix. For example, WIC participation status was determined by the answer to a single NHANES survey question and was not verified with WIC administrative data. Because of the cross-sectional nature of the data, causality cannot be inferred. Finally, even in the multivariable context, it is possible some variables that may influence participant outcomes are not being measured, so the relationships between the independent and dependent variables are not fully explained. For these reasons, readers should be cautious when interpreting and extrapolating findings.

A. Methods Summary

This section describes the sample and details the approach used to conduct the multivariable regression analyses. See appendix A of the main report for additional information about the analytic approach, including the use of NHANES 2011–2016 sampling weights, calculation of standard errors, and age standardization.

1. Analytic Sample

For all analyses in this appendix, WIC participants were compared with income-eligible and higher income nonparticipants. Analyses were based on NHANES 2011–2016 data. WIC participants were defined through an affirmative response to the NHANES question, "Is [sample person] now receiving benefits from the WIC program?" (Centers for Disease Control and Prevention [CDC], National Center for Health Statistics [NCHS], 2020c). Children not currently participating in WIC were defined as income-eligible if their annual household income was less than or equal to 185 percent of the Federal Poverty Guidelines.[1]

Table I.1 presents ages and associated sample sizes for each type of outcome. The analytic sample sizes are smaller for some regressions because of missing data. See table I.7 in section D for the number of NHANES respondents by participant group.

Table I.1. Analytic Sample Age and Sample Size by Outcome Type

Outcomes	Age of Relevant NHANES Survey Respondents (in Years)	Number of NHANES Respondents
Usual intake of calories; calories from saturated fats and added sugars; hemoglobin	1–4	2,129
Overall diet quality score; BMI-for-age	2–4	1,592

Note: BMI = body mass index; NHANES = National Health and Nutrition Examination Survey

Regressions presented in this appendix are based on NHANES data. NHANES does not sample some subsets of the population, such as institutionalized or homeless individuals. Therefore, results labeled "All Individuals" should be interpreted to mean all individuals in the NHANES sample population.

2. Data Analysis

The study team used two types of regressions, depending on the outcome variable. Continuous outcomes (total energy, energy from saturated fats, energy from added sugars, overall HEI-2015 and individual component scores, and hemoglobin concentration) were modeled using OLS regressions. Binary outcomes (overweight or obese body mass index [BMI]-for-age) were modeled using logistic regressions (see table I.2). In this case, results are presented according to the average marginal effects (for example, see table I.9). Average marginal effects are an alternative to odds ratios that the study team selected for ease of interpretation. The average marginal effect for an independent variable is the difference in percentage points between the predicted probability of the modeled outcome associated with a change in that independent variable (either a 1-unit increase for a continuous independent variable or the difference between the reference group and another group for a categorical independent variable). When calculating average marginal effects for program participation, each

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[1] WIC eligibility was determined based on these guidelines and adjunctive eligibility through Medicaid or SNAP participation.

covariate is held at its mean value. For example, when examining weight status, an average marginal effect of 0.02 for WIC participants compared with income-eligible nonparticipants means, on average, WIC participants are 2 percentage points more likely to be overweight or obese compared with income-eligible nonparticipants.

The study team structured regressions to produce a coefficient for WIC participants and chose income-eligible nonparticipants as the reference group to facilitate a narrative discussion of differences between these two groups. All regression analyses controlled for the same set of covariates (see text box), except regressions used to examine sample characteristics which did not control for any covariates. Table I.2 presents the outcomes and measures examined through multivariate regression analyses.

> ### Covariates Included in Regression Models
>
> - Age (years)
> - Race/ethnicity
> - Educational attainment for household reference person
> - Marital status of household reference person
> - Household income-to-poverty ratio
> - Household size
> - Household food security status

Table I.2. Summary of Outcomes and Measures for Multivariable Regression Analyses

Outcome	Measures	Age of Relevant NHANES Respondents (Years)
Energy Intakes		
Usual energy intakes	- Total calories (kcal/day) [a]	1–4
Calories from saturated fats and added sugars on a given day	- Calories contributed from saturated fats and added sugars (kcal/day) [a]	1–4
Overall Diet Quality		
HEI scores on a given day	- HEI-2015 total score (points) [a] - HEI-2015 component scores (points) [a]	2–4
Indicators of Nutrition and Health		
BMI-for-age	- Greater than or equal to 85th percentile of BMI-for-age (overweight or obese) versus less than 85th percentile of BMI-for-age (not overweight or obese) [b]	2–4
Blood biomarker	- Low hemoglobin (< 110 g/L) versus not low hemoglobin (≥ 110 g/L) [b] - Hemoglobin concentration (g/L) [a]	1–4

Note: BMI = body mass index; HEI = Healthy Eating Index; kcal = kilocalorie; NHANES = National Health and Nutrition Examination Survey
[a] Measure examined using ordinary least squares regression
[b] Measure examined using logistic regression

As noted previously, this research was not designed to measure the causal impact of WIC participation on diet quality or health. Therefore, significant differences between WIC participants and nonparticipants cannot be attributed to participation in WIC. Similarly, the absence of a significant difference cannot be interpreted as evidence that participation in WIC has no effect. Regression with an indicator of program participation provides an estimate of the expected difference by participation category, after adjusting for covariates, but does not enable a causal interpretation of that difference. The accurate assessment of WIC impacts requires specially designed studies or, at minimum, complex analytical models that require a variety of measures, some of which are not available in NHANES data.

B. Sample Characteristics

WIC participants were younger, had a lower household income-to-poverty ratio, and had more people per household than income-eligible and higher income nonparticipants (see table I.7). A higher percentage of WIC participants were Hispanic, and a lower percentage were non-Hispanic White than either nonparticipant group. A higher percentage of WIC participants than higher income nonparticipants were non-Hispanic Black, but a lower percentage were non-Hispanic Asian.

A higher percentage of WIC participants' households reported low or very low food security than higher income nonparticipants (see table I.7). Compared with income-eligible nonparticipants, a higher percentage of WIC participants were covered by health insurance. Compared with either group of nonparticipants, a higher percentage of WIC participants received anemia treatment in the past 3 months.

Among children aged 2–4, WIC participants had a higher mean total Healthy Eating Index (HEI)-2015 score on a given day compared with income-eligible nonparticipants (approximately 53 versus 52 points) but a lower score than higher income nonparticipants (53 versus 55 points) (see table I.7). WIC participants scored higher than income-eligible nonparticipants in 8 of the 13 HEI-2015 components and scored higher than higher income nonparticipants in 4 of the components. Among children aged 1–4, WIC participants had a lower average hemoglobin concentration than either income-eligible or higher income nonparticipants (12.39 versus 12.47 and 12.41 grams per liter).

C. Findings

This section discusses significant differences, after adjusting for covariates, in overall diet quality, energy intakes, weight status, and hemoglobin concentrations for WIC participants compared with income-eligible nonparticipants. Supporting tables presented in section D include an additional comparison group (higher income nonparticipants) not discussed in this section.

1. Overall Diet Quality

The HEI-2015 is a measure of diet quality that assesses adherence to the 2015–2020 Dietary Guidelines for Americans (DGA) recommendations (U.S. Department of Agriculture [USDA] & U.S. Department of Health and Human Services [HHS], 2010). A higher HEI score—for each component and in total—indicates a diet that aligns more closely with the DGA. HEI scores are calculated for children aged 2 and older. See table 2.1 in chapter 2 of the WIC report for more details on HEI-2015 scoring.

After adjusting for covariates, total HEI-2015 scores on a given day were similar for WIC participant and income-eligible nonparticipants. There were, however, some differences in HEI-2015 component scores after adjusting for covariates:

▸ WIC participants scored higher (i.e., better) in the fatty acids component (0.72 points) and added sugar component (0.52 points) on a given day than income-eligible nonparticipant children.

Table I.3. Regression-Adjusted Association of WIC Participation With HEI-2015 Scores on a Given Day Among Children Aged 2–4

Outcome	Maximum Points	Income-Eligible Nonparticipants	WIC Participants
Total fruits	5	Ref	0.13
Whole fruits	5	Ref	-0.05
Total vegetables	5	Ref	0.04
Greens and beans	5	Ref	0.06
Whole grains	10	Ref	0.09
Dairy	10	Ref	0.10
Total protein foods	5	Ref	-0.02
Seafood and plant protein	5	Ref	-0.02
Fatty acids	10	Ref	0.72 *
Refined grains	10	Ref	-0.22
Sodium	10	Ref	-0.34
Added sugars	10	Ref	0.52 *
Saturated fats	10	Ref	0.52
HEI-2015 Total Score	100	Ref	1.54
Observations (n)	N/A	493	530

Note: Sample includes National Health and Nutrition Examination Survey (NHANES) respondents aged 2–4 with a complete day 1 dietary recall. Income-eligible nonparticipants were defined as individuals from households with monthly family income less than or equal to 130 percent of the relevant Federal Poverty Guidelines, and higher income nonparticipants were individuals from households with monthly income greater than 130 percent of the relevant Federal Poverty Guidelines. Estimates were calculated using ordinary least squares regressions and pooled NHANES dietary day 1 sample weights. Estimates were adjusted for age, race/ethnicity, gender, educational attainment of household reference person, marital status of household reference person, income-to-poverty ratio, number of individuals in the household, household food security status, usual intake of calories, and NHANES cycle. Significant differences in estimates are noted by *$p < .05$, **$p < .01$, or ***$p < .001$.
HEI = Healthy Eating Index; N/A = not applicable; Ref = reference group; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children
Sources: NHANES 2011–2016 dietary recalls and demographic data

2. Energy Intakes

The total energy an individual needs each day to maintain energy balance varies by age, gender, height, weight, and level of physical activity. See table 5.4 in chapter 5 of the report for more details on estimated energy needs. After adjusting for covariates, total energy intakes were similar for WIC participants and income-eligible nonparticipants. There was, however, a difference in the calories consumed from saturated fats and added sugars[2] on a given day after adjusting for covariates:

▶ WIC participants consumed 31 fewer calories on a given day from saturated fats and added sugars than income-eligible nonparticipant children.

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[2] The 2015–2020 DGA recommends consuming less than 10 percent of calories from saturated fats and less than 10 percent of calories from added sugars per day.

Table I.4. Regression-Adjusted Association of WIC Participation With Energy Intakes Among Children Aged 2–4

Outcome	Income-Eligible Nonparticipants	WIC Participants
Calories, usual intake	Ref	1.88
Calories from saturated fats and added sugars on a given day	Ref	-30.57 *
Observations (n)	605	763

Note: Sample includes National Health and Nutrition Examination Survey (NHANES) respondents aged 2–4 and older with a complete day 1 dietary recall. Income-eligible nonparticipants were defined as individuals from households with monthly family income less than or equal to 130 percent of the relevant Federal Poverty Guidelines, and higher income nonparticipants were individuals from households with monthly income greater than 130 percent of the relevant Federal Poverty Guidelines. Estimates were calculated using ordinary least squares regressions and pooled NHANES dietary day 1 sample weights. Estimates were adjusted for age, race/ethnicity, gender, educational attainment, marital status, income-to-poverty ratio, number of individuals in the household, household food security status, and NHANES cycle. For the outcome calories from saturated fats and added sugars, estimates were also adjusted for usual intake of calories to control for daily energy intake. Significant differences in estimates are noted by *$p < .05$, **$p < .01$, or ***$p < .001$.
Ref = reference group; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children
Sources: NHANES 2011–2016 dietary recalls and demographic data

3. Weight Status

Weight status for children aged 2–4 was determined using the Centers for Disease Control and Prevention (CDC) BMI-for-age percentile growth charts, which account for a child's age and gender. BMI-for-age can be used as a tool to screen for overweight and obesity (CDC, 2018). After adjusting for covariates, the likelihood of being overweight or obese was similar for WIC participants and income-eligible nonparticipants.

Table I.5. Regression-Adjusted Association of WIC Participation With Overweight or Obesity Among Children Aged 2–4

Outcome	Income-Eligible Nonparticipants	WIC Participants
Overweight or obesity	Ref	0.02
Observations (n)	318	329

Note: Sample includes National Health and Nutrition Examination Survey (NHANES) respondents aged 2–4 with a complete day 1 dietary recall. Income-eligible nonparticipants were defined as individuals from households with monthly family income less than or equal to 130 percent of the relevant Federal Poverty Guidelines, and higher income nonparticipants were individuals from households with monthly income greater than 130 percent of the relevant Federal Poverty Guidelines. Estimates were calculated using logistic regressions with average marginal effects and were calculated using pooled NHANES dietary day 1 sample weights. Estimates were adjusted for age, race/ethnicity, gender, educational attainment of the household reference person, marital status of the household reference person, income-to-poverty ratio, number of individuals in the household, household food security status, length of breastfeeding, and NHANES cycle. Significant differences in estimates are noted by *$p < .05$, **$p < .01$, or ***$p < .001$.
Ref = reference group; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children
Sources: NHANES 2011–2016 dietary recalls and demographic data

4. Hemoglobin Concentration

Hemoglobin status was assessed for children aged 1–4. Low hemoglobin (< 110 g/L) is a criterion WIC uses to establish nutritional risk among WIC participants and as a proxy for iron deficiency. Among children, iron deficiency anemia can have serious cognitive and psychomotor effects that can lead to learning difficulties (National Institutes of Health [NIH], Office of Dietary Supplements [ODS], 2019).

After adjusting for covariates, the likelihood of having low hemoglobin and hemoglobin concentrations were similar for WIC participants and income-eligible nonparticipants.

Table I.6. Regression-Adjusted Association of Participation With Hemoglobin Concentrations Among Children Aged 1–4

Outcome	Income-Eligible Nonparticipants	WIC Participants
Hemoglobin, low	Ref	0.00
Hemoglobin, continuous (g/L)	Ref	-0.07
Observations (n)	455	559

Note: Sample includes National Health and Nutrition Examination Survey (NHANES) respondents with a complete day 1 dietary recall aged 1–4. Income-eligible nonparticipants were defined as individuals from households with monthly family income less than or equal to 130 percent of the relevant Federal Poverty Guidelines, and higher income nonparticipants were individuals from households with monthly income greater than 130 percent of the relevant Federal Poverty Guidelines. See appendix A, table A.1 for definition of reference values and recommendations for blood biomarkers. Estimates were calculated using logistic regressions with average marginal effects and were calculated using pooled NHANES dietary day 1 sample weights. Estimates were adjusted for age, race/ethnicity, gender, educational attainment of the household reference person, marital status of the household reference person, income-to-poverty ratio, number of individuals in the household, household food security status, health insurance coverage, anemia treatment, and NHANES cycle. Significant differences in estimates are noted by *$p < .05$, **$p < .01$, or ***$p < .001$.
Ref = Reference group; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children
Sources: NHANES 2011–2016 dietary recalls and demographic data

D. Supporting Tables for WIC

1. Sample Characteristics

Table I.7. Characteristics of WIC Participants and Nonparticipants Aged 1–4, 2011–2016

Characteristic	WIC Participants		Income-Eligible Nonparticipants		Higher Income Nonparticipants	
	Mean	(SE)	Mean	(SE)	Mean	(SE)
Individual and Household Characteristics, Continuous Variables						
Age (years)	2.36	(0.04)	2.67 ***	(0.04)	2.59 ***	(0.04)
Household income-to-poverty ratio	1.09	(0.03)	1.17 ***	(0.03)	3.78 ***	(0.04)
Household size (people per household)	4.80	(0.05)	4.59 ***	(0.06)	4.20 ***	(0.04)
Individual and Household Characteristics, Categorical Variables						
Race/ethnicity (percentage)						
Asian, non-Hispanic	2.70	(0.57)	3.13	(0.69)	6.44 **	(0.95)
Black, non-Hispanic	19.92	(1.40)	20.49	(1.59)	4.67 ***	(0.82)
White, non-Hispanic	28.82	(1.59)	46.52 **	(1.97)	70.69 ***	(1.76)
Hispanic	43.52	(1.74)	23.36 ***	(1.67)	12.49 ***	(1.28)
Other race, multiracial	5.03	(0.77)	6.50	(0.97)	5.72	(0.90)
Female (percentage)	51.71	(1.75)	50.63	(1.97)	49.74	(1.93)
SNAP recipient (percentage)	64.01	(1.69)	42.70 **	(1.96)	0.00 ***	(0.00)
Household food security status (percentage)						
Household full food security	45.14	(1.75)	51.68	(1.97)	87.88 ***	(1.26)
Household marginal food security	19.23	(1.38)	18.09	(1.52)	7.84 ***	(1.04)
Household low food security	26.13	(1.54)	20.48	(1.59)	4.17 ***	(0.77)
Household very low food security	9.50	(1.03)	9.76	(1.17)	0.11 ***	(0.13)
Covered by health insurance (percentage)						
No	5.29	(0.79)	11.87 **	(1.28)	4.61	(0.81)
Yes	94.71	(0.79)	88.13 **	(1.28)	95.39	(0.81)

Characteristic	WIC Participants		Income-Eligible Nonparticipants		Higher Income Nonparticipants	
	Mean	(SE)	Mean	(SE)	Mean	(SE)
Received anemia treatment in past 3 months (percentage)						
No	97.92	(0.51)	99.63 ***	(0.24)	99.31 ***	(0.33)
Yes	2.08	(0.51)	0.37 ***	(0.24)	0.69 ***	(0.33)
NHANES cycle (percentage)						
2011–2012	36.87	(1.69)	35.94	(1.89)	32.84	(1.81)
2013–2014	35.31	(1.68)	31.40	(1.83)	33.60	(1.82)
2015–2016	27.82	(1.57)	32.66	(1.85)	33.56	(1.82)
Individual Outcome Measures						
Energy intake (calories)						
Total calories, usual intake[a]	1443.72	(6.26)	1477.51	(7.66)	1464.17	(7.38)
Calories from saturated fats and added sugars[b]	312.35	(6.25)	353.97	(7.85)	313.42	(5.84)
HEI-2015 total score[b]	53.49	(0.55)	51.73 **	(0.52)	55.09 *	(0.57)
HEI-2015 adequacy components[b]						
Total fruits	3.42	(0.08)	3.35 ***	(0.08)	3.75 ***	(0.08)
Whole fruits	2.74	(0.10)	2.86 ***	(0.10)	3.82 ***	(0.08)
Total vegetables	2.03	(0.07)	1.90 ***	(0.06)	1.91 ***	(0.07)
Greens and beans	1.05	(0.08)	0.90 ***	(0.08)	0.98 ***	(0.08)
Whole grains	2.71	(0.14)	2.69	(0.14)	3.57 ***	(0.16)
Dairy	7.88	(0.12)	7.74 ***	(0.13)	8.32 ***	(0.12)
Total protein foods	3.44	(0.07)	3.38 ***	(0.07)	3.39 ***	(0.07)
Seafood and plant Proteins	1.52	(0.09)	1.54	(0.09)	1.98 ***	(0.10)
Fatty acids	3.90	(0.15)	3.21 ***	(0.14)	3.22 ***	(0.15)
HEI-2015 moderation components[b]						
Refined grains	6.01	(0.16)	6.09	(0.15)	5.92	(0.16)
Sodium	5.70	(0.14)	6.03 ***	(0.14)	5.74	(0.14)
Added sugars	7.32	(0.12)	6.71 ***	(0.14)	7.47 ***	(0.12)
Saturated fats	5.77	(0.14)	5.33 ***	(0.15)	5.01 ***	(0.15)

Characteristic	WIC Participants		Income-Eligible Nonparticipants		Higher Income Nonparticipants	
	Mean	(SE)	Mean	(SE)	Mean	(SE)
Weight status (percentage)						
Underweight	1.99	(0.62)	3.07	(0.78)	3.22	(0.82)
Normal weight	69.52	(2.03)	74.57	(1.98)	73.78	(2.04)
Overweight	15.25	(1.58)	13.40	(1.55)	14.92	(1.65)
Obese	13.24	(1.49)	8.96	(1.30)	8.08	(1.26)
Hemoglobin, low (percentage)	2.50	(0.64)	2.67	(0.73)	1.80	(0.67)
Hemoglobin, continuous (mean, g/L)	12.39	(0.03)	12.47 ***	(0.04)	12.41 ***	(0.04)
Observations (n)	813		645		671	

Note: Sample includes National Health and Nutrition Examination Survey (NHANES) respondents aged 1–4 with a complete day 1 dietary recall. For HEI-2015 score and weight status, the sample is limited further to NHANES respondents aged 2–4 with a complete day 1 dietary recall. Income-eligible nonparticipants were defined as individuals from households with monthly family income less than or equal to 185 percent of the relevant Federal Poverty Guidelines, and higher income nonparticipants were individuals from households with monthly income greater than 185 percent of the relevant Federal Poverty Guidelines. Underweight individuals are defined as children aged 2–4 at or below the 5th percentile of BMI-for-age. Normal weight individuals are defined as children above the 5th percentile and up to the 85th percentile (inclusive) of BMI-for-age. Overweight individuals are defined as children above the 85th percentile and up to the 95th percentile (inclusive) of BMI-for-age. Obese individuals are defined as children above the 95th percentile of BMI-for-age. For children aged 1–4, hemoglobin levels are defined as follows: normal if ≥ 110 g/L, and low if < 110 g/L. See appendix A, table A.1 for definition of reference values and recommendations for blood biomarkers. Estimates were calculated using pooled NHANES dietary day 1 sample weights. Significant differences in estimates are noted by *p < .05, **p < .01, or ***p < .001. Differences were tested by comparing WIC participants with income-eligible nonparticipants or higher income nonparticipants. HEI = Healthy Eating Index; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children

[a] Based on usual intake over 2 days of dietary recall

[b] Based on 1 day of dietary recall

Sources: NHANES 2011–2016 dietary recalls and demographic data

2. Diet Quality

Table I.8. Regression-Adjusted Association of WIC Participation Aged 2–4 With Selected Indicators of Diet Quality, 2011–2016

Characteristic	Calories, Usual Intake[a]		Calories From Saturated Fats and Added Sugars[b]		HEI-2015 Score[b]	
	β	(SE)	β	(SE)	β	(SE)
Program participation						
WIC participant	1.88	(10.56)	-30.57 *	(14.63)	1.54	(1.16)
Income-eligible nonparticipant	Ref		Ref		Ref	
Higher income nonparticipant	0.87	(15.80)	3.67	(20.78)	-1.49	(2.15)
Age (years)	125.23 ***	(4.43)	35.35 ***	(3.98)	-1.29 *	(0.51)
Race/ethnicity						
Asian, non-Hispanic	-9.26	(17.24)	-38.42 *	(14.73)	1.85	(1.79)
Black, non-Hispanic	6.42	(11.34)	2.09	(16.02)	0.50	(1.14)
White, non-Hispanic	Ref		Ref		Ref	
Hispanic	-0.29	(11.51)	-1.43	(14.08)	1.17	(1.18)
Other race, multiracial	0.47	(11.48)	-35.22 *	(15.29)	-0.87	(1.50)
Educational attainment for household reference person						
Less than high school	Ref		Ref		Ref	
High school diploma or GED	-0.89	(11.42)	-12.45	(21.88)	1.11	(1.40)
Some college or Associate's degree	-3.45	(12.76)	-12.57	(18.10)	1.76	(1.34)
College graduate or above	4.75	(14.15)	-33.77	(21.87)	3.75	(1.88)
Marital status of household reference person						
Never married	Ref		Ref		Ref	
Widowed, divorced, or separated	24.29	(13.49)	8.90	(19.76)	-3.15	(1.76)
Cohabitating	8.19	(15.82)	21.83	(26.51)	-1.49	(1.80)
Married	19.30	(13.24)	-12.81	(14.71)	-0.40	(1.73)
Household income-to-poverty ratio	-3.65	(5.31)	-6.06	(5.17)	1.15	(0.58)
Household size (people per household)	3.66	(3.59)	4.14	(3.97)	-0.49	(0.35)

Characteristic	Calories, Usual Intake[a]		Calories From Saturated Fats and Added Sugars[b]		HEI-2015 Score[b]	
	β	(SE)	β	(SE)	β	(SE)
Household food security status						
Household full food security	Ref		Ref		Ref	
Household marginal food security	-10.85	(11.25)	12.35	(17.28)	-1.08	(1.39)
Household low food security	-3.29	(11.98)	-7.59	(16.05)	-0.55	(1.24)
Household very low food security	3.56	(12.77)	-14.15	(18.43)	1.85	(1.86)
Observations (n)	2,017		2,017		1,508	

Note: Sample includes National Health and Nutrition Examination Survey (NHANES) respondents aged 1–4 with a complete day 1 dietary recall for calorie outcomes and NHANES respondents aged 2–4 with a complete day 1 dietary recall for HEI-2015 score. Income-eligible nonparticipants were defined as individuals from households with monthly family income less than or equal to 185 percent of the relevant Federal Poverty Guidelines, and higher income nonparticipants were individuals from households with monthly income greater than 185 percent of the relevant Federal Poverty Guidelines. See appendix A, table A.1 for definition of reference values and recommendations for blood biomarkers. Estimates were calculated using ordinary least squares regressions and were adjusted for the NHANES cycle and calculated using pooled NHANES dietary day 1 sample weights. Significant differences in estimates are noted by $*p < .05$, $**p < .01$, or $***p < .001$.

β = beta; GED = general education diploma; HEI = Healthy Eating Index; Ref = reference group; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children

[a] Based on usual intake over 2 days of dietary recall

[b] Based on 1 day of dietary recall

Sources: NHANES 2011–2016 dietary recalls and demographic data

Table I.8a. Regression-Adjusted Association of WIC Participation With Selected HEI Component Scores Among Young Children Aged 2–4, 2011–2016

Characteristic	Total Vegetables β	(SE)	Greens and Beans β	(SE)	Total Fruit β	(SE)	Whole Fruit β	(SE)
Program participation								
WIC participant	0.04	(0.13)	0.06	(0.18)	0.13	(0.17)	-0.05	(0.23)
Income-eligible nonparticipant	Ref		Ref		Ref		Ref	
Higher income nonparticipant	0.00	(0.24)	0.08	(0.25)	-0.09	(0.22)	0.10	(0.25)
Age (years)	-0.00	(0.05)	0.04	(0.07)	-0.10	(0.09)	-0.12	(0.08)
Race/ethnicity								
Asian, non-Hispanic	0.34	(0.21)	0.84 *	(0.38)	0.06	(0.26)	-0.12	(0.28)
Black, non-Hispanic	0.22	(0.14)	0.06	(0.16)	0.06	(0.18)	-0.06	(0.21)
White, non-Hispanic	Ref		Ref		Ref		Ref	
Hispanic	0.42 ***	(0.11)	0.60 ***	(0.17)	-0.02	(0.17)	0.12	(0.23)
Other race, multiracial	-0.17	(0.29)	-0.33	(0.20)	0.21	(0.26)	0.20	(0.30)
Educational attainment for household reference person								
Less than high school	Ref		Ref		Ref		Ref	
High school diploma or GED	-0.43 **	(0.15)	-0.11	(0.20)	0.27	(0.17)	0.24	(0.22)
Some college or Associate's degree	-0.13	(0.14)	-0.01	(0.19)	0.15	(0.18)	0.19	(0.19)
College graduate or above	-0.18	(0.18)	-0.04	(0.19)	0.22	(0.22)	0.28	(0.28)
Marital status of household reference person								
Never married	Ref		Ref		Ref		Ref	
Widowed, divorced, or separated	0.01	(0.24)	-0.36	(0.26)	0.04	(0.27)	-0.24	(0.26)
Cohabitating	-0.18	(0.22)	-0.01	(0.29)	0.32	(0.25)	-0.10	(0.31)
Married	-0.27	(0.20)	-0.21	(0.29)	0.24	(0.21)	0.14	(0.25)
Household income-to-poverty ratio	0.05	(0.08)	0.03	(0.08)	0.12	(0.09)	0.30 **	(0.09)
Household size (people per household)	-0.05	(0.04)	0.07	(0.05)	-0.08	(0.05)	-0.02	(0.05)

Characteristic	Total Vegetables β	Total Vegetables (SE)	Greens and Beans β	Greens and Beans (SE)	Total Fruit β	Total Fruit (SE)	Whole Fruit β	Whole Fruit (SE)
Household food security status								
Household full food security	Ref		Ref		Ref		Ref	
Household marginal food security	0.05	(0.13)	-0.07	(0.20)	-0.39	(0.21)	-0.29	(0.22)
Household low food security	-0.01	(0.14)	-0.09	(0.16)	-0.20	(0.19)	-0.01	(0.18)
Household very low food security	-0.16	(0.19)	-0.27	(0.28)	0.12	(0.30)	0.58 *	(0.26)
Observations (n)	1,508		1,508		1,508		1,508	

Note: Sample includes National Health and Nutrition Examination Survey (NHANES) respondents aged 2–4 with a complete day 1 dietary recall. Income-eligible nonparticipants were defined as individuals from households with monthly family income less than or equal to 185 percent of the relevant Federal Poverty Guidelines, and higher income nonparticipants were individuals from households with monthly income greater than 185 percent of the relevant Federal Poverty Guidelines. Estimates were calculated using ordinary least squares regressions and were adjusted for the NHANES cycle and calculated using pooled NHANES dietary day 1 sample weights. Significant differences in estimates are noted by *$p < .05$, **$p < .01$, or ***$p < .001$.

β = beta; HEI = Healthy Eating Index; GED = general education diploma; Ref = reference group; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children

Sources: NHANES 2011–2016 dietary recalls and demographic data

Table I.8b. Regression-Adjusted Association of WIC Participation With Selected HEI Component Scores Among Young Children Aged 2–4, 2011–2016

Characteristic	Whole Grains		Dairy		Total Protein Foods		Seafood and Plant Protein		Fatty Acids	
	β	(SE)	β	(SE)	β	(SE)	β	(SE)	β	(SE)
Program participation										
WIC participant	0.09	(0.27)	0.10	(0.24)	-0.02	(0.14)	-0.02	(0.22)	0.72 *	(0.32)
Income-eligible nonparticipant	Ref		Ref		Ref		Ref		Ref	
Higher income nonparticipant	0.34	(0.47)	-0.26	(0.32)	0.11	(0.24)	-0.01	(0.34)	-0.04	(0.47)
Age (years)	-0.20	(0.12)	-0.39 **	(0.12)	0.04	(0.07)	0.01	(0.08)	0.33 *	(0.14)
Race/ethnicity										
Asian, non-Hispanic	-0.69	(0.42)	0.02	(0.31)	-0.01	(0.24)	0.37	(0.35)	-0.39	(0.50)
Black, non-Hispanic	-0.51 *	(0.23)	-1.60 ***	(0.36)	0.27 *	(0.14)	-0.42	(0.21)	1.43 **	(0.45)
White, non-Hispanic	Ref		Ref		Ref		Ref		Ref	
Hispanic	-0.76 ***	(0.20)	-0.20	(0.24)	0.13	(0.12)	-0.02	(0.18)	0.19	(0.33)
Other race, multiracial	0.64	(0.69)	-0.42	(0.36)	-0.04	(0.17)	-0.22	(0.34)	0.04	(0.46)
Educational attainment for household reference person										
Less than high school	Ref		Ref		Ref		Ref		Ref	
High school diploma or GED	0.19	(0.27)	0.07	(0.22)	0.05	(0.17)	-0.23	(0.21)	0.21	(0.36)
Some college or Associate's degree	0.36	(0.30)	-0.30	(0.29)	-0.15	(0.16)	-0.10	(0.22)	0.51	(0.35)
College graduate or above	1.23 *	(0.57)	-0.53	(0.32)	0.01	(0.21)	0.28	(0.29)	0.96 *	(0.46)
Marital status of household reference person										
Never married	Ref		Ref		Ref		Ref		Ref	
Widowed, divorced, or separated	-0.53	(0.43)	-0.19	(0.43)	-0.43	(0.24)	-0.65 *	(0.27)	-0.59	(0.39)
Cohabitating	-0.56	(0.47)	-0.41	(0.55)	-0.21	(0.25)	-0.09	(0.29)	-0.42	(0.49)
Married	-0.28	(0.44)	0.39	(0.37)	-0.30	(0.20)	-0.27	(0.28)	-0.52	(0.38)
Household income-to-poverty ratio	-0.14	(0.19)	0.28 **	(0.10)	-0.01	(0.07)	0.08	(0.10)	-0.02	(0.15)
Household size (people per household)	-0.18	(0.10)	0.04	(0.08)	0.08 *	(0.04)	0.03	(0.07)	-0.05	(0.10)

Characteristic	Whole Grains		Dairy		Total Protein Foods		Seafood and Plant Protein		Fatty Acids	
	β	(SE)	β	(SE)	β	(SE)	β	(SE)	β	(SE)
Household food security status										
Household full food security	Ref		Ref		Ref		Ref		Ref	
Household marginal food security	-0.49	(0.33)	0.47	(0.29)	0.05	(0.14)	-0.02	(0.21)	-0.15	(0.34)
Household low food security	-0.24	(0.41)	0.32	(0.25)	0.00	(0.15)	-0.06	(0.17)	-0.34	(0.28)
Household very low food security	-0.10	(0.48)	0.20	(0.43)	-0.00	(0.23)	-0.17	(0.26)	0.31	(0.51)
Observations (n)	1,508		1,508		1,508		1,508		1,508	

Note: Sample includes National Health and Nutrition Examination Survey (NHANES) respondents aged 2–4 with a complete day 1 dietary recall. Income-eligible nonparticipants were defined as individuals from households with monthly family income less than or equal to 185 percent of the relevant Federal Poverty Guidelines, and higher income nonparticipants were individuals from households with monthly income greater than 185 percent of the relevant Federal Poverty Guidelines. Estimates were calculated using ordinary least squares regressions and were adjusted for the NHANES cycle and calculated using pooled NHANES dietary day 1 sample weights. Significant differences in estimates are noted by *p < .05, **p < .01, or ***p < .001.

β = beta; GED = general education diploma; HEI = Healthy Eating Index; Ref = reference group; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children

Sources: NHANES 2011–2016 dietary recalls and demographic data

Table I.8c. Regression-Adjusted Association of WIC Participation With Selected HEI Component Scores Among Young Children Aged 2–4, 2011–2016

Characteristic	Sodium		Refined Grains		Saturated Fat		Added Sugar	
	β	(SE)	β	(SE)	β	(SE)	β	(SE)
Program participation								
WIC participant	-0.34	(0.25)	-0.22	(0.29)	0.52	(0.29)	0.52 *	(0.25)
Income-eligible nonparticipant	Ref		Ref		Ref		Ref	
Higher income nonparticipant	-0.69	(0.49)	-0.71	(0.50)	-0.41	(0.50)	0.10	(0.28)
Age (years)	-0.19 *	(0.09)	-0.59 ***	(0.13)	-0.11	(0.31)	-0.26	(0.23)
Race/ethnicity								
Asian, non-Hispanic	0.19	(0.44)	-0.29	(0.37)	0.20	(0.56)	1.35 ***	(0.27)
Black, non-Hispanic	-0.22	(0.24)	-0.21	(0.31)	1.24 **	(0.39)	0.24	(0.21)
White, non-Hispanic	Ref		Ref		Ref		Ref	
Hispanic	-0.15	(0.22)	-0.21	(0.31)	0.60	(0.33)	0.48	(0.24)
Other race, multiracial	-0.87 *	(0.39)	-1.40	(0.76)	0.85	(0.57)	0.64	(0.38)
Educational attainment for household reference person								
Less than high school	Ref		Ref		Ref		Ref	
High school diploma or GED	0.23	(0.36)	0.04	(0.43)	0.68	(0.44)	-0.11	(0.36)
Some college or Associate's degree	0.40	(0.33)	0.15	(0.40)	0.71	(0.35)	-0.01	(0.34)
College graduate or above	0.25	(0.36)	-0.50	(0.59)	1.03 *	(0.50)	0.75 *	(0.34)
Marital status of household reference person								
Never married	Ref		Ref		Ref		Ref	
Widowed, divorced, or separated	0.66	(0.54)	0.00	(0.55)	-0.14	(0.46)	-0.75	(0.48)
Cohabitating	0.84 *	(0.39)	-0.41	(0.53)	0.27	(0.50)	-0.55	(0.43)
Married	1.10 *	(0.42)	-0.08	(0.53)	-0.43	(0.37)	0.06	(0.32)
Household income-to-poverty ratio	0.05	(0.14)	0.32	(0.17)	0.09	(0.18)	-0.00	(0.11)
Household size (people per household)	0.08	(0.08)	-0.09	(0.10)	-0.13	(0.12)	-0.18	(0.10)

Characteristic	Sodium		Refined Grains		Saturated Fat		Added Sugar	
	β	(SE)	β	(SE)	β	(SE)	β	(SE)
Household food security status								
Household full food security	Ref		Ref		Ref		Ref	
Household marginal food security	-0.04	(0.27)	0.52	(0.36)	-0.53	(0.34)	-0.18	(0.37)
Household low food security	-0.05	(0.33)	0.24	(0.36)	0.01	(0.29)	-0.14	(0.28)
Household very low food security	0.38	(0.46)	0.46	(0.41)	0.34	(0.48)	0.15	(0.46)
Observations (n)	1,508		1,508		1,508		1,508	

Note: Sample includes National Health and Nutrition Examination Survey (NHANES) respondents aged 2–4 with a complete day 1 dietary recall. Income-eligible nonparticipants were defined as individuals from households with monthly family income less than or equal to 185 percent of the relevant Federal Poverty Guidelines, and higher income nonparticipants were individuals from households with monthly income greater than 185 percent of the relevant Federal Poverty Guidelines. Estimates were calculated using ordinary least squares regressions and were adjusted for the NHANES cycle and calculated using pooled NHANES dietary day 1 sample weights. Significant differences in estimates are noted by *p < .05, **p < .01, or ***p < .001.

β = beta; GED = general education diploma; HEI = Healthy Eating Index; Ref = reference group; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children

Sources: NHANES 2011–2016 dietary recalls and demographic data

3. Health Outcomes

Table I.9. Regression-Adjusted Association of WIC Participation With Overweight or Obesity Among Young Children Aged 2–4, 2011–2016

Characteristic	Overweight or Obese	
	Est	(SE)
Program participation		
WIC participant	0.02	(0.04)
Income-eligible nonparticipant	Ref	
Higher income nonparticipant	0.09	(0.07)
Age (years)	0.04	(0.02)
Race/ethnicity		
Asian, non-Hispanic	-0.09	(0.06)
Black, non-Hispanic	0.01	(0.04)
White, non-Hispanic	Ref	
Hispanic	0.07	(0.05)
Other race, multiracial	0.02	(0.07)
Educational attainment for household reference person		
Less than high school	Ref	
High school diploma or GED	-0.06	(0.06)
Some college or Associate's degree	-0.12	(0.06)
College graduate or above	-0.17 *	(0.08)
Marital status of household reference person		
Never married	Ref	
Widowed, divorced, or separated	0.04	(0.05)
Cohabitating	0.04	(0.06)
Married	0.05	(0.04)
Household income-to-poverty ratio	-0.00	(0.02)
Household size (people per household)	-0.02	(0.02)
Household food security status		
Household full food security	Ref	
Household marginal food security	0.04	(0.06)
Household low food security	-0.04	(0.05)
Household very low food security	0.06	(0.05)

Characteristic	Overweight or Obese	
	Est	(SE)
Time breastfed		
Less than 6 months	Ref	
More than 6 months	-0.02	(0.04)
Covered by health insurance	-0.04	(0.08)
Observations (n)	1,029	

Note: Sample includes National Health and Nutrition Examination Survey (NHANES) respondents aged 2–4 with a complete day 1 dietary recall. Income-eligible nonparticipants were defined as individuals from households with monthly family income less than or equal to 185 percent of the relevant Federal Poverty Guidelines, and higher income nonparticipants were individuals from households with monthly income greater than 185 percent of the relevant Federal Poverty Guidelines. See appendix A, table A.1 for definition of reference values and recommendations for blood biomarkers. Estimates were calculated using logistic regressions with average marginal effects and were adjusted for the NHANES cycle and calculated using pooled NHANES dietary day 1 sample weights. Significant differences in estimates are noted by *p < .05, **p < .01, or ***p < .001.

Est = estimate; GED = general education diploma; Ref = reference group; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children

Sources: NHANES 2011–2016 dietary recalls and demographic data

Table I.10. Regression-Adjusted Association of WIC Participation With Hemoglobin Among Young Children Aged 1–4, 2011–2016

Characteristic	Hemoglobin, Low		Hemoglobin, Continuous	
	Est	(SE)	β	(SE)
Program participation				
WIC participant	0.00	(0.01)	-0.07	(0.08)
Income-eligible nonparticipant	Ref		Ref	
Higher income nonparticipant	0.00	(0.01)	-0.12	(0.11)
Age (years)	0.01	(0.00)	0.10 ***	(0.03)
Race/ethnicity				
Asian, non-Hispanic	-0.00	(0.01)	0.04	(0.16)
Black, non-Hispanic	0.05 **	(0.02)	-0.54 ***	(0.10)
White, non-Hispanic	Ref		Ref	
Hispanic	0.01	(0.01)	-0.09	(0.10)
Other race, multiracial	-0.01	(0.01)	-0.16	(0.09)
Educational attainment for household reference person				
Less than high school	Ref		Ref	
High school diploma or GED	0.02	(0.01)	-0.13	(0.10)
Some college or Associate's degree	-0.01	(0.01)	-0.08	(0.08)
College graduate or above	-0.00	(0.02)	-0.09	(0.11)
Marital status of household reference person				
Never married	Ref		Ref	
Widowed, divorced, or separated	0.00	(0.01)	-0.10	(0.10)
Cohabitating	0.03	(0.02)	-0.01	(0.11)
Married	0.01	(0.01)	0.07	(0.08)
Household income-to-poverty ratio	0.00	(0.01)	-0.04	(0.03)

Characteristic	Hemoglobin, Low		Hemoglobin, Continuous	
	Est	(SE)	β	(SE)
Household size (people per household)	-0.01	(0.00)	-0.02	(0.02)
Household food security status				
Household full food security	Ref		Ref	
Household marginal food security	-0.01	(0.01)	-0.01	(0.08)
Household low food security	0.01	(0.02)	-0.01	(0.07)
Household very low food security	0.00	(0.02)	-0.13	(0.10)
Covered by health insurance	^		0.27 *	(0.13)
Treated for anemia	0.11	(0.10)	-0.68 **	(0.22)
Observations (n)	1,393		1,392	

^This covariate was omitted from the regression outcome denoted in the column header because of collinearity with the outcome. No uninsured children have low hemoglobin.

Note: Sample includes National Health and Nutrition Examination Survey (NHANES) respondents aged 1–4 with a complete day 1 dietary recall. Income-eligible nonparticipants were defined as individuals from households with monthly family income less than or equal to 185 percent of the relevant Federal Poverty Guidelines, and higher income nonparticipants were individuals from households with monthly income greater than 185 percent of the relevant Federal Poverty Guidelines. See appendix A, table A.1 for definition of reference values and recommendations for blood biomarkers. Estimates for low hemoglobin were calculated using logistic regressions with average marginal effects. Estimates for continuous hemoglobin were calculated using ordinary least squares regression. All estimates were adjusted for the NHANES cycle and calculated using pooled NHANES dietary day 1 sample weights. Significant differences in estimates are noted by *p < .05, **p < .01, or ***p < .001.

Est = estimate; GED = general education diploma; Ref = reference group; SE = standard error; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children

Sources: NHANES 2011–2016 dietary recalls and demographic data