WIC and the Nutrient Intake of Children.

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Abstract

After controlling for self-selection bias, participation in the WIC program (Special Supplemental Nutrition Program for Women, Infants, and Children) has a significant positive effect on children's intakes of iron, folate, and vitamin B-6. Iron is one of the five nutrients targeted by the program, the others being protein, calcium, vitamin A, and vitamin C. Folate and vitamin B-6, along with zinc, were recommended by a 1991 USDA study as nutrients that the program should also target. The data set used, the 1994-96 Continuing Survey of Food Intake by Individuals, reflects the dramatic increase during the 1990's in the number of children in the program.

Keywords: WIC, nutrient intake, self-selection bias.

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Summary

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) grew significantly during the 1990's. Children now comprise the fastest growing group of WIC recipients. Because a large proportion of higher priority pregnant woman and infants already participated in the program, program expansion has allowed WIC to serve more children. Most analyses of the WIC program have focused on birth outcomes of pregnant women. This research has shown that participation in WIC reduces the incidence of low-birthweight infants thereby providing health care savings that substantially exceed program costs. Few studies have examined the impact of WIC on the nutritional outcomes of children. One premise of the WIC program is that food intervention during critical times of childhood growth and development can help prevent future medical and developmental problems. This study contributes to this issue by examining the effect of participation in WIC on the nutrient intake of children.

The data set used in this analysis, the 1994-96 Continuing Survey of Food Intake by Individuals (CSFII), captures the dramatic increase in the number of children in the program that took place during the 1990's. The nutrients of interest included the five targeted by the WIC program—iron, protein, calcium, vitamin A, and vitamin C—as well as three additional nutrients recommended for targeting in the WIC program—folate, vitamin B-6, and zinc. Nearly all children, regardless of whether or not they participated in WIC, met the Recommended Dietary Allowance (RDA) for protein and folate, and a large percentage of children met the RDA for vitamin C (81 percent) and vitamin A (75 percent). However, nearly half or more of all children, regardless of whether or not they participated in WIC, did not meet the RDA for iron, calcium, and zinc, and a third did not meet the RDA for vitamin B-6.

Using a least squares regression model, WIC was found to be associated with a significant increase in the intake of iron, vitamin C, vitamin A, vitamin B-6, and folate. However, there is the risk that unobservable differences between WIC children and income-eligible nonparticipants due to self-selection may result in biased findings. That is, the results will not accurately reflect the "true" impact of WIC on nutrient intake. For example, the parents of WIC children may be more motivated to improve their child's nutritional status than parents who choose not to participate in the program. Even in the absence of the WIC program, the WIC children might be more likely to receive nutritious meals (and therefore have high nutrient intake) than nonparticipating children. After controlling for possible self-selection bias by restricting the analysis to children residing in households in which another adult or infant household member was on WIC, participation in WIC was found to significantly increase a child's intake of iron, folate, and vitamin B-6.

Significant effects from WIC were found despite several factors that could understate WIC's impact on nutrient intake. First, children on WIC must demonstrate nutritional risk while income-eligible nonparticipating children are less likely to be at nutritional risk, thereby resulting in a negative bias against the program. Second, possible spillover effects, whereby another household member's participation in WIC positively affects the nutrient intake of a nonparticipating child, may also underestimate the program's impact. Results of the univariate analysis showed that the intake levels of iron, protein, and folate for children enrolled in the WIC program were significantly greater than those for children who, because of their high incomes, were not eligible for WIC. Together, these results indicate that participation in the WIC program has a positive effect on the nutrient intake of children.

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Introduction and Overview

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is designed to improve the health of low-income, nutritionally at-risk infants, children, and pregnant, postpartum, and breast-feeding women by providing supplemental food, nutrition education, and health care referrals. This study examines the nutrient intake of children, who constitute over half of all participants in the program, to determine WIC's effect on their health. An underlying assumption is that improved diets lead to better health in the long run. Several different analyses are utilized. First, a univariate analysis is used to compare the socioeconomic characteristics and nutrient intake of WIC children both to income-eligible nonparticipants and to children whose high household incomes make them ineligible to participate in WIC. Second, a multivariate analysis is used to control for observable differences between WIC children and income-eligible nonparticipants. Third, an alternative multivariate analysis is used to address the greatest difficulty in designing evaluations of the WIC program—identifying a comparison group of children to control for selection bias. The analyses are based on the most recent available national intake data that reflect the period of rapid growth in the child component of WIC.

The WIC program, administered by USDA's Food and Nutrition Service, was established as a pilot program in 1972 and made permanent in 1974. The program is based on two premises: (1) that the inadequate nutritional patterns and health behavior of low-income women and children make them especially vulnerable to adverse health outcomes; and (2) that food intervention programs during critical times of growth and development can help prevent future medical and developmental problems (Rush 1986).

Eligibility in the WIC program is limited to pregnant women, women up to 6 months postpartum who are not breastfeeding, breastfeeding women up to 12 months postpartum, infants up to 1 year of age, and children up to their 5th birthday. To be eligible, family income must fall below 185 percent of the poverty guidelines.[1] Persons who participate in the Food Stamp Program, Medicaid, or Temporary Assistance for Needy Families Program (TANF) automatically meet the income eligibility. WIC recipients must also be individually determined to be at "nutritional risk" by a health professional. Four major types of nutritional risk are recognized for WIC eligibility: (1) detrimental or abnormal nutritional conditions detectable by biochemical or anthropometric measurements, such as anemia, low maternal weight gain, or inadequate growth in children; (2) nutritionally related medical conditions, such as nutrient deficiency diseases, some specific obstetrical risks, or gestational diabetes; (3) dietary deficiencies that impair or endanger health, such as highly restrictive diets, inadequate diet, or inappropriate infant feeding; and (4) conditions, such as homelessness and migrancy, that predispose persons to inadequate nutritional patterns or nutritionally related medical conditions.[2]

Most WIC participants receive checks or vouchers each month that allow them to purchase a monthly food package designed to supplement their diets at authorized foodstores. A few locations use alternative food delivery systems. The WIC food package is not intended to meet the total nutritional needs of the participants, and participants are educated on ways to obtain the balance of the necessary nutrients from other food sources. WIC provides foods that are high

[1] WIC regulations define family as "a group of related or nonrelated individuals who are living together as one economic unit" (7 CFR Subpart A, Section 246.2).

[2] State agencies are not required to use all of the nutritional risk criteria on the national list.

in five target nutrients—protein, calcium, iron, and vitamins A and C. These nutrients are frequently lacking in the diets of the program's target population, which may result in adverse health consequences. The WIC food packages also provide vitamin D, folate, and vitamin B-6 (pyridoxine) (USDA 1991). Local WIC agencies prescribe the types and quantities of supplemental foods appropriate for each participant, based on their age and individual needs and preferences.[3] The food package for children 1 to 5 years old consists of milk or cheese, iron-fortified cereal, 100-percent fruit and/or vegetable juice, eggs, and peanut butter or dry beans/peas (children with special dietary needs may receive a different food package). This food package is expected to reduce the prevalence of iron-deficiency anemia, improve diets, and improve physical and mental growth and development (Institute of Medicine, 1996). The average monthly cost of the WIC food package for children in 1996 ranged from $32.45 to $46.20 across regions (USDA 1998c).

WIC service providers are required to offer participants (or their parent, guardian, or proxy) at least two nutrition education sessions during each certification period, which usually lasts 6 months (USDA 1998c). Education may include counseling on the importance of WIC foods in preventing and overcoming the specific risk conditions identified at the time of certification and the need to select a complete diet from a variety of nutritious WIC and non-WIC foods. WIC recipients also receive referrals to other social services and needed health care, such as immunizations.

An average of 7.4 million persons per month participated in the WIC program in fiscal 1998, including 3.7 million children (USDA 1998b). WIC is not an entitlement program and the number of people served by the program is limited by funding levels established by Congress. Because these funds have not been sufficient to serve all eligible persons, the program directs benefits to persons most in need and those most likely to benefit from participation. When funds are insufficient to serve all eligible applicants, local WIC agencies fill vacancies based on a priority system. Priority is given to persons demonstrating medically based nutritional risks over dietary-based nutritional risks, and to pregnant and breastfeeding women and infants over children (see box, next page). As a result, the participation rates for children have traditionally been lower than those of women and infants.[4]

However, children comprise the fastest growing group of WIC recipients. While overall participation in WIC increased by 63 percent from 1990 to 1998, child participation increased by 81 percent, compared with 67 percent for women and 33 percent for infants (fig. 1). Since a large proportion of the higher priority pregnant women and infants already participated in WIC, the program's expansion in recent years has allowed the program to serve more lower-priority children.

The growth of WIC was the result of cost containment measures and increased Congressional funding fueled in part by favorable evaluations of the program that have shown WIC to be a successful and cost-effective program.[5] For example, in a review of 17 studies, the General Accounting Office concluded that WIC reduced low birthweights by 25 percent and reduced the rate of very low birthweight by 44 percent (General Accounting Office 1992). GAO reported that each Federal dollar invested in WIC benefits returns an estimated $3.50 of savings in Federal, State, local, and private health care costs. However, most of the research examining the effect of the WIC program has focused on birth outcomes.[6] Reasons cited for the relatively few studies on WIC children include controversy in determining what constitutes program success, problems in measuring the effects of a change in nutrition in childhood over a short time period, and the difficulties in finding a comparable control group (Rush 1986).

[3]WIC regulations specify the maximum quantities of supplemental foods that may be prescribed to WIC recipients (7 CFR Subpart D, Section 246.10).

[4]USDA estimated that about 69 percent of all eligible children participated in the WIC program in 1996, compared with about 85 percent of all eligible women and virtually all eligible infants (USDA 1998e).

[5]Reflecting a leveling off of funding for the program, total participation in WIC decreased by less than 1 percent in fiscal 1998, the first decrease since the program's establishment in 1974.

[6]USDA had planned and field-tested a major evaluation of WIC's impact on children in the early 1990's. However, legislation enacted in 1992 specifically directed USDA not to undertake the study.

Nutritional Risk Priority System

Priority

I Pregnant women, breastfeeding women, and infants at nutritional risk as demonstrated by hematological or anthropometric measurements, or other documented nutritionally related medical conditions which demonstrate the need for supplemental foods.

II Except those infants who qualify for Priority I, infants up to 6 months of age of Program participants who participated during pregnancy, and infants up to 6 months of age born of women who were not Program participants during pregnancy but whose medical records document that they were at nutritional risk during pregnancy due to nutritional conditions detectable by biochemical or anthropometric measurements or other documented nutritionally related medical conditions which demonstrated the person's need for supplemental foods.

III Children at nutritional risk as demonstrated by hematological or anthropometric measurements or other documented medical conditions which demonstrate the child's need for supplemental foods.

IV Pregnant women, breastfeeding women, and infants at nutritional risk because of an inadequate dietary pattern.

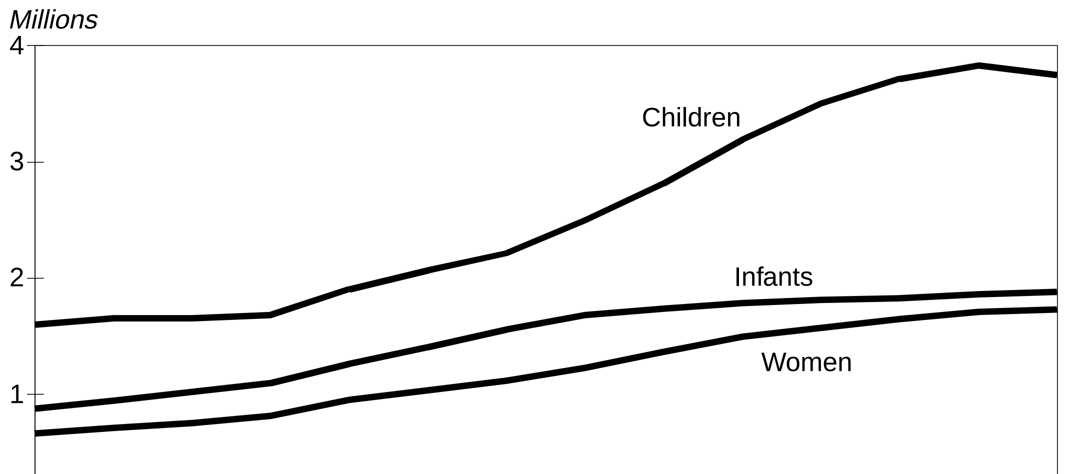
V Children at nutritional risk because of an inadequate dietary pattern.

VI Postpartum women at nutritional risk.

VII Individuals certified for WIC solely due to homelessness or migrancy and, at State agency option, previously certified participants who might regress in nutritional status without continued provision of supplemental foods.

Source: 7 CFR Subpart C, Section 246.7.

Figure 1
Participation in WIC, fiscal 1985-98



The Data Set

The data set used in this analysis is the 1994-96 Continuing Survey of Food Intake by Individuals (CSFII), conducted by USDA's Agricultural Research Service (ARS) (USDA 1998a). The CSFII is based on a stratified, multistage area sampling design. Each of the 3 years of data comprise a nationally representative sample of noninstitutionalized persons residing in the United States (persons who lived in group quarters or institutions, resided on military installations, or were homeless were excluded). The dietary data consist of 2 nonconsecutive days of nutrient intake that were collected through in-person interviews using 24-hour recalls between January 1994 and January 1997. Adult proxies, preferably the person responsible for preparing the child's meals, provided the nutrient intake data for children. Respondents described both the types and amounts of food consumed during this period. A nutrient database containing the nutrient values of foods was used to calculate the total nutrient intake of the food consumed by the individual.

Only children 1 to 4 years of age who had 2 days of nutrient intake data were included in this analysis. Since the CSFII does not contain information on the nutrient contribution of the breast milk consumed by children, breastfeeding children were excluded from the analysis, as were children whose WIC status could not be determined.

To be eligible for WIC, family income must fall below 185 percent of the poverty guideline (or the child must participate in the Food Stamp, Medicaid, or TANF Programs) and the child must also be individually determined to be at "nutritional risk" by a health professional.[7] CSFII data do not allow for the determination of nutritional risk; therefore, for this study, WIC eligibility for children not participating in the program was proxied solely by income eligibility, as determined by the annual income of the household. Past research suggests that WIC income eligibility estimates based on annual income may underestimate actual income eligibility for WIC (USDA 1997).[8] To include all children who were likely to have met the WIC income-eligibility criteria at some point during the year, this report considered children in households with annual income at or below 200 percent of the poverty guideline to be income-eligible for WIC, while children in households with annual income above 200 percent of the poverty guideline were deemed to be ineligible for WIC.[9] Children who were authorized to receive food stamps, or who lived in a household that received income from the AFDC program, were considered to be WIC eligible regardless of income.[10]

Useable data were available from 2,280 (86.4 percent) of the 2,640 children age 1 to 4 included in the CSFII. These children were assigned to one of three mutually exclusive groups—WIC recipient (n=439), WIC income eligible but did not participate (n=767), and income ineligible (n=1,074).[11]

This study focuses on eight nutrients, the five targeted by the WIC program—protein, calcium, iron, vitamin

[7]Prior to 1997, applicants participating in the Aid to Families with Dependent Children Program (AFDC) were automatically income eligible for WIC. The Personal Responsibility and Work Opportunity Reconciliation Act of 1996 replaced AFDC with the TANF Program.

[8]WIC regulations state that in determining the income eligibility of an applicant, State WIC agencies "may instruct local agencies to consider the income of the family during the past 12 months and the family's current rate of income to determine which indicator more accurately reflects the family's status" (7 CFR Subpart C, Section 246.7).

[9]This analysis follows the convention established by Fraker et al. (1990) who set the income eligibility cutoff point at 200 percent of poverty in their earlier work on WIC's impact on nutrient intake.

[10]At the time of the survey, participation in the AFDC, Medicaid, and Food Stamp Programs automatically granted income eligibility to participants. However, the CSFII did not contain information on an individual's participation in the Medicaid program. The question on the CSFII regarding AFDC participation asked whether any household member received income from AFDC, general assistance, or other public assistance program. It is assumed that among households with children, AFDC accounted for the vast majority of positive responses to this item.

[11]Of the 439 children who reported that they were participating in the WIC program, 31 were seemingly income ineligible; that is, they did not participate in the Food Stamp Program and resided in households with annual incomes above 200 percent of the poverty guidelines that did not participate in the AFDC program. However, these children may have legitimately participated in WIC. For example, they may have participated in the Medicaid program or they may have been certified for WIC at a time when their household incomes were within WIC guidelines.

A, and vitamin C—as well as folate, vitamin B-6, and zinc. In an independent examination of the WIC food package conducted for USDA in 1991, a panel of experts concluded that these three additional nutrients may be of concern for vulnerable population groups and recommended that they be included for targeting in the WIC program (USDA 1991). In addition, food energy was examined in order to determine if changes in nutrient intake were due to changes in nutrient density or to changes in the energy intake of WIC recipients.

Univariate Analysis

Univariate statistics were used to examine the characteristics and the nutrient intake of the three groups of children—WIC recipients, income-eligible nonrecipients, and income-ineligibles. It is recommended that the calculation of standard errors for descriptive statistics based on the CSFII take into account its complex sample design (USDA 1998a). As a result, this analysis used the SURVEYMEANS procedure in Version 7 of SAS to produce survey population means and estimates of their variances (An and Watts 1998).[12]

Characteristics of Children by WIC Status

The demographic and socioeconomic characteristics of children are shown in table 1. In general, WIC recipients were not significantly different from the group of income-eligible nonparticipating children. However there were several notable exceptions.

WIC recipients, relative to the group of nonparticipating WIC eligibles, were significantly more likely to be 1 year of age, and significantly less likely to be 4 years of age. These findings are in agreement with other studies that have shown that the participation of children in WIC falls as age increases.[13] When resources are not sufficient to serve all eligible WIC applicants, local WIC clinics use a priority system in which enrollees with a non-medical dietary risk are considered a low priority. Within that low priority, many State agencies subprioritize, making older children the lowest priority.

Children participating in WIC were also more likely to live in households that received food stamps than were income-eligible nonrecipient children. Over half (55 percent) of all WIC children participated in the Food Stamp Program, compared with only 32 percent of eligible nonrecipients.

Both WIC recipients and income-eligible nonrecipients were significantly different from the group of income-ineligible children in a number of characteristics. Income ineligibles were more likely to be white, and less likely to be black or Hispanic. As expected, WIC recipients and income-eligible nonrecipients, relative to income ineligibles, were worse off in most measures of socioeconomic status including income, percent of poverty, homeownership, and cash assets. WIC recipients and income-eligible nonrecipients were also more likely to live in a single-headed household, and in a household whose head had fewer years of schooling and who was less likely to have graduated from high school.[14]

Nutrient Intake of Children by WIC Status

By providing participants nutritious, supplemental food and nutrition education, participation in WIC may increase the nutrient intake of children in any of three ways: (1) by increasing the amount of food consumed; (2) by substituting foods of higher nutritional quality (i.e., more nutrient-dense foods) for foods of lower nutritional quality; or (3) by empowering participants (or their parent or guardian) to choose a healthy diet. To more fully describe the distribution of nutrient intake among the three groups of children, we used two different measures—mean nutrient adequacy ratios and the percentage of children who did not meet the RDA.

The nutrient adequacy ratio is the nutrient intake of an individual divided by the 1989 Recommended Dietary Allowance (RDA) for that individual and is expressed as a percent (in this study, an individual's nutrient intake refers to the *average of the 2 days*). RDAs are often used to compare dietary quality among population subgroups. RDAs "represent the amounts of nutrients that are adequate to meet the needs of most healthy people. Although people with average nutrient requirements likely eat adequately at levels below the RDAs, diets that meet RDAs are almost certain to ensure intake of enough essential nutrients by most healthy people" (USDA/U.S. Dept. of Health and

[12]This procedure uses the Taylor expansion method to calculate standard errors of estimates based on complex sampling designs.

[13]For example, a near-census of WIC participants in April 1996 found that 36 percent of all children participating in WIC were 1 year of age, 26 percent were 2 years of age, 22 percent were 3 years of age, and 16 percent were 4 years of age (USDA 1998c).

[14]In dual-headed households, the female head's years of schooling was used to represent educational background since the female head is usually the primary meal preparer.

Table 1--Socioeconomic and demographic characteristics of children by WIC status

	All children (n=2,280)	WIC recipients (n=439)	Income-eligible nonparticipants (n=767)	Income ineligibles (n=1,074)
Individual characteristics				
		Percent		
Race/ethnicity:				
White (non-Hispanic)	62.7	44.4[1]	49.2[1]	79.0
Black (non-Hispanic)	16.6	29.2[1]	22.5[1]	7.8
Hispanic	15.2	19.6[1]	23.1[1]	8.2
Other (non-Hispanic)	5.4	6.8	5.2	5.1
Age:				
1 year	24.2	33.6[1,2]	19.4[1]	23.8
2 year	24.9	28.8	23.5	24.4
3 year	24.5	20.5	26.1	25.0
4 year	26.4	17.2[1,2]	30.9	26.9
Sex:				
Male	50.9	50.9	52.0	50.1
Female	49.1	49.1	48.0	49.9
Household characteristics				
		Mean		
Annual income	$38,656	$17,943[1]	$18,967[1]	$59,917
Percent of poverty	194.1	103.8[1]	111.5[1]	284.7
		Percent		
Own their home	55.3	30.5[1]	34.2[1]	79.2
Have assets over $5,000	34.3	4.7[1]	8.5[1]	63.3
		Persons		
Household size	4.4	4.7[1]	4.7[1]	4.1
		Percent		
Receive Food Stamps	21.0	54.9[1,2]	32.5[1]	0.1[3]
		Dollars		
Monthly value of Food Stamps	262	263	260	NA
		Percent		
Region:				
Northeast	18.8	18.1	14.8	21.7
South	33.7	34.6	32.3	34.3
Midwest	23.9	27.0	22.2	23.9
West	23.6	20.4	30.6	20.1
Urbanization:				
Central city	34.1	40.9	39.4	27.9
Suburbs	47.5	34.4[1]	40.5[1]	57.4
Rural	18.3	24.7[1]	20.1	14.6
Household structure:				
Dual headed	80.4	61.8[1]	69.7[1]	94.6
Single head	19.6	38.2[1]	30.3[1]	5.4
		Years of schooling		
Education of head	12.7	11.1[1]	11.5[1]	14.1
		Percent		
Completed high school	82.0	65.6[1]	70.6[1]	95.8

Notes: Weighted data.
NA=Not applicable.
[1]Significantly different from income ineligibles at the 95-percent confidence level.
[2]Significantly different from income eligible nonparticipants at the 95-percent confidence level.
[3]Households in which someone other than the child received food stamps.

Source: 1994-96 CSFII based on 2-day nutrient intake.

Human Services 1995). The RDAs for children are determined solely by age: children 1 to 3 years of age have the same RDA while children 4 to 6 years of age share a different RDA. A nutrient adequacy ratio above 100 indicates that the child's nutrient intake exceeded the RDA while a ratio below 100 indicates that the child's nutrient intake was below the RDA.

The mean nutrient adequacy ratio for all nutrients except zinc was close to or above 100 percent (indicating that average nutrient intake of the group met the RDA) regardless of WIC status (table 2). WIC recipients had greater mean nutrient adequacy ratios for all of the nutrients and energy than did the income-eligible nonparticipant group, but the differences were not statistically significant. Relative to the group of income-ineligible children, WIC recipients had significantly greater mean nutrient adequacy ratios for iron, protein, and folate. Eligible nonrecipients, on the other hand, had a significantly lower mean nutrient adequacy ratio for vitamin A than income ineligibles.

Because children with intakes below the RDA may not be adequately described by estimates of the mean, the percentage of children who did not meet the RDA was also estimated (table 2).[15] Virtually all children, regardless of WIC status, met the RDA for protein and folate. However, for some of the other nutrients, a substantial percentage of children did not meet the RDA. Nearly half or more of all children did not meet the RDA for iron, calcium, zinc, and food energy and one-third of all children did not meet the RDA for vitamin B-6. WIC recipients were significantly more likely to have met the RDA for iron than both eligible nonrecipients and income ineligibles. These results indicate that although the mean intakes of most nutrients were near or above the RDA, a substantial percentage of the children did not meet the RDA for some nutrients.

[15]Presenting information on the percentage of children with intakes below the RDA provides information about the nutrient intake of the three groups that estimates of the mean cannot provide. However, caution is required in interpreting the results, since these estimates may be biased. Because an individual's nutrient intake can vary greatly from day to day, estimates of an individual's usual nutrient intake based on only 2 days of data probably will not accurately reflect an individual's usual nutrient intake. That is, the estimate may be higher or lower than usual. For the population as a whole, the 2-day average nutrient intake that is greater than usual for some people will be offset by other people whose 2-day average is less than usual. Therefore, individual variation in nutrient intake should have no effect on the sample mean nutrient intake (although the standard deviation will be greater). However, this individual variation may affect the estimated number of people whose average nutrient intake falls below the RDA.

Table 2--Nutrient intake by WIC status

Nutrient	All children (n= 2,280)	WIC recipients (n=439)	Income-eligible nonpar-ticipants (n=767)	Income ineligibles (n=1,074)
Percent of RDA				
		Mean		
Iron	112.0	121.7[1]	110.2	109.4
	(1.34)	(3.94)	(2.00)	(1.88)
Calcium	100	102	97.3	101.2
	(1.34)	(3.50)	(1.32)	(1.97)
Vitamin C	227.5	245.6	216.9	227.7
	(4.25)	(8.85)	(6.15)	(5.94)
Vitamin A	173.7	181.6	159.2[1]	180.5
	(3.44)	(15.43)	(4.66)	(3.31)
Protein	285.2	301.9[1]	290.7	275.0
	(2.93)	(8.23)	(4.60)	(4.32)
Vitamin B-6	127.7	133.2	127.4	125.9
	(1.52)	(4.45)	(2.05)	(1.81)
Folate	344.8	371.3[1]	348.9	331.7
	(5.15)	(12.35)	(7.53)	(5.91)
Zinc	76.5	81	78.4	73.4
	(.96)	(2.56)	(1.12)	(1.38)
Food energy	98.8	101.7	99.0	97.5
	(.89)	(2.44)	(1.59)	(1.12)
Percent of children failing to meet 100 percent of the RDA				
		Percent		
Iron	48.7	40.5[1, 2]	50.1	50.9
	(1.31)	(2.56)	(1.86)	(2.05)
Calcium	55.2	54.5	56.9	54.2
	(1.39)	(3.71)	(1.70)	(2.14)
Vitamin C	19.0	15.9	22.1	18.0
	(1.24)	(2.27)	(1.89)	(1.73)
Vitamin A	24.5	24.2	29.3[1]	21.3
	(1.05)	(2.41)	(1.73)	(1.54)
Protein	1.2	0.6	1.3	1.4
	(.28)	(.44)	(.49)	(.46)
Vitamin B-6	33	30.1	34.2	33.4
	(1.37)	(3.76)	(1.91)	(1.72)
Folate	1.7	1.7	2.0	1.5
	(.31)	(.83)	(.59)	(.37)
Zinc	82.2	77.4	79.8	85.6
	(1.27)	(2.67)	(1.67)	(1.55)
Food energy	57	54.1	56.4	58.5
	(1.14)	(2.93)	(2.31)	(2.01)

Notes: Weighted data. Numbers in parentheses are the standard errors of the mean.
[1]Significantly different from the corresponding coefficient for income ineligibles at the 95-percent confidence level.
[2]Significantly different from the corresponding coefficient for income-eligible nonparticipants at the 95-percent confidence level.

Source: 1994-1996 CSFII based on 2-day nutrient intake.

Multivariate Regression Analysis

The primary objective of this report is to determine the effect of WIC participation on the nutrient intake of children by comparing the nutrient intake of children participating in WIC to a comparison group of income-eligible nonparticipants. The lack of statistically significant differences in mean nutrient intake between WIC recipients and income-eligible nonparticipants in the univariate analysis shown in table 2 does not necessarily mean that the WIC program had no effect on nutrient intakes. There may be differences between WIC recipients and WIC-eligible nonparticipants that influence nutrient intake; that is, in the absence of WIC, the children now on WIC may have had significantly lower nutrient intake than the group of income-eligible nonparticipants. For example, since children on WIC must be at nutritional risk in order to participate, they may be at poorer nutritional status to begin with than children not in the WIC program. The effect of WIC may have been to reduce initial differences between the groups.

The Model

To control for observable differences between participants and nonparticipants, a single-equation multivariate regression analysis was used where the dependent variable was the nutrient adequacy ratio. It is assumed that the lower a subpopulation's nutrient adequacy ratio, the greater the risk of inadequate nutrient intake. An alternative probit regression model that uses a fixed cutoff (e.g., 100 percent of the RDA) as the dependent variable could also have been used. However, since the RDA is set above the nutritional needs of most healthy people, intakes below the RDA do not necessarily indicate inadequate diets. The use of any other cutoff (e.g., 75 percent of the RDA) is arbitrary and difficult to interpret (Fraker et al., 1990). In addition, because an individual's nutrient intake can vary substantially from day to day, estimates of intakes below the RDA, or some other cutoff, based on only 2 days may be biased. Two-day intake measures, on the other hand, should give an accurate measure of the mean.

A number of socioeconomic characteristics thought to influence nutrient intake were included as independent variables:

Characteristics of the child: The main variable of interest for this analysis was WIC status, that is, whether or not the child participated in the WIC program. Variables representing sex, race/ethnicity, and age of the child were also constructed. Age-of-child variables were included in the model for three reasons. First, WIC participation declines as children's age increases (see table 1). This decline may be due, in part, to rationing, in which younger children may be given higher priority than older children when funds are not sufficient to serve all eligible children. This decline may also be due to the participation decisions of households: parents of younger children may choose to apply or reapply for WIC to a greater degree than parents of older children.[16] Second, because children 1 to 3 years old share the same RDA, the nutrient adequacy ratio (which uses the RDA as the denominator) will not totally account for the increase in food consumption as children age.[17] Third, the tastes and preferences of children (and/or the allocation of food by parents) change over time regardless of whether the children participate in WIC.

Household characteristics:[18] Since a lack of money may restrict the purchase of nutritious foods, a variable representing the annual income of the household expressed as a percentage of the poverty threshold was included as an independent variable.[19] Since the household's assets may affect its ability to withstand unexpected decreases in income, two measures of household wealth were considered—homeownership, since a home is the largest asset for most households; and whether the household had cash assets of more

[16]Consider two similar households (in which only the age of the child differs) that are now eligible to participate in WIC but were not eligible previously. The first household, with a child 18 months old, may decide to participate because they anticipate that they will be able to receive WIC benefits for several years. The second household, with a child 4 years old, may decide not to participate because they could not receive WIC benefits for more than 1 year.

[17]Children 4 years old have the same RDA as children 5 and 6 years old.

[18]The CSFII defines a household as all persons who regularly share a house, an apartment, a room, or a group of rooms used as separate living quarters.

[19]Poverty thresholds are based on household income and household size. A ratio of income to poverty threshold above 100 indicates that a household's income was above the poverty threshold, while a ratio below 100 indicates that a household was in poverty.

than $5,000. Household structure as measured by whether it was a dual-headed or single-headed household may influence the amount of time available to prepare meals. Single-headed households may have less time to spend shopping for nutritious foods and preparing better quality meals. A variable indicating whether the household received food stamps was also included.

Geographic characteristics: Variables based on region of residence and metropolitan status were constructed to account for regional differences in food consumption practices and prices.

Characteristics of the household head: Number of years of schooling completed by the head of household was included in the model as a proxy for nutrition knowledge.

Year of the survey: A variable based on the year of the survey was constructed to account for the increase in the participation of children in WIC due, in part, to increased Congressional funding between 1994 and 1996.[20]

Definitions of the variables used in the regression model are presented in appendix A.

The regression analysis was restricted to children who were income eligible for WIC, proxied by income less than 200 percent of poverty or participation in the Food Stamp or AFDC Programs. Of the 1,206 WIC child recipients and income-eligible nonparticipating children in the original sample, 31 WIC recipients were dropped from this analysis because they reported household income above 200 percent of the poverty threshold.[21] An additional 40 children were dropped because of missing data for one or more independent variables. Of the remaining 1,135 children in the data set used in this analysis, 396 participated in the WIC program and 739 were income-eligible nonparticipants.

[20]Expenditures for WIC increased from $3.2 billion in fiscal 1994 to $3.7 billion in fiscal 1996, an increase of 16.6 percent. At the same time, average costs (including food and administrative costs) per recipient increased by only 5.1 percent (USDA 1998d).

[21]Since the group of WIC income-eligible but nonparticipating children was limited to children with incomes at or below 200 percent of poverty, the inclusion of WIC children with incomes above 200 percent of poverty could have resulted in a biased sample. The authors also ran a regression model that included these 31 children in the group of WIC participants. Results were similar to those found when excluding WIC participants with incomes above 200 percent of poverty from the analysis.

Since the use of sampling weights in regression models can lead to inefficient analysis, an unweighted regression model that included variables used to determine sampling rates, including socioeconomic characteristics, geographic location, and degree of urbanization, was utilized. A least squares regression model was estimated separately for each of the five targeted WIC nutrients, and for the three nutrients recommended as WIC target nutrients, as well as for food energy.

Results

The results of the regression analysis for each of the nine dependent variables are shown in table 3. Regression coefficients were considered to be significantly different from zero at $P<.05$.

After controlling for differences in socioeconomic characteristics, children receiving WIC had significantly higher intake of three of the WIC-targeted nutrients—iron, vitamin C, and vitamin A. Although WIC's effect on protein was insignificant, results from table 2 indicated that virtually all of the children, regardless of WIC status, attained the RDA, thereby indicating more than adequate intake of the nutrient.

Among the three additional nutrients recommended to be included for targeting in the program, WIC participation was associated with a significantly higher intake of vitamin B-6 and folate. At the same time, WIC participation was associated with a negative, although statistically insignificant, effect on food energy. Thus, the significant increase in the intakes of iron, vitamin C, vitamin A, vitamin B-6, and folate occurred as a result of increased nutrient density and not increases in the amount of food energy consumed.

Among the other independent variables included in the models, residence in a nonmetro area had a statistically significant negative effect on the consumption of calcium, vitamin A, vitamin B-6, and folate. Boys had a significantly positive coefficient for protein and food energy compared with girls. The variables related to age of child were significant to a large degree, but the sign was inconsistent across the nutrients. In most cases, the coefficients for the age variables increased as age increased (relative to children 4 years of age), reflecting increased consumption relative to the RDA by older children.

In a separate analysis, a model including interaction effects of age of child and WIC participation was also estimated for each of the nutrients. These interaction models indicate whether age has an independent effect on the impact of WIC on nutrition or if age has an effect only through its influence on the WIC participation decision. Except for a negative interaction of 1-year-old children and WIC participation on the intake of protein, there was no evidence of significant interaction effects of WIC participation and age on the nutrient intake of children.

Table 3—Results of multiple regression models on WIC income-eligible children

	Iron	Calcium	Vit. C	Vit. A	Protein	Vit. B-6	Folate	Zinc	Food energy
Intercept	107.86*	103.78*	223.27*	137.22*	226.26*	127.76*	262.60*	73.07*	79.02*
	(10.70)	(12.29)	(7.35)	(5.40)	(11.35)	(11.61)	(7.32)	(11.74)	(13.62)
WIC recipient	17.33*	3.21	29.54*	28.20*	-5.05	9.49*	28.00*	1.34	-0.75
	(4.88)	(1.08)	(2.76)	(3.15)	(.72)	(2.45)	(2.21)	(.61)	(.37)
Percent of poverty	.01	-0.03	-0.15	-0.03	-.14*	-0.00	0.08	-0.03	-0.04
	(.35)	(1.15)	(1.38)	(.38)	(2.01)	(.02)	(.68)	(1.62)	(1.74)
Food Stamp recipient	-6.47	-2.01	-17.93	-9.71	5.50	-7.20	-23.98	1.41	-0.06
	(1.60)	(.60)	(1.47)	(.95)	(.69)	(1.63)	(1.67)	(.57)	(.03)
Assets of $5,000	.22	3.60	4.79	10.02	-2.70	-1.48	13.63	1.14	-2.15
	(.03)	(.65)	(.24)	(.60)	(.21)	(.20)	(.58)	(.28)	(.56)
Homeownership	-6.74	.38	-2.37	-13.22	-1.32	-4.13	-10.89	-1.84	1.96
	(1.81)	(.12)	(.21)	(1.41)	(.18)	(1.02)	(.82)	(.80)	(.91)
Male	5.79	4.18	4.84	8.42	12.48*	4.47	14.57	2.52	5.63*
	(1.80)	(1.55)	(.50)	(1.04)	(1.97)	(1.28)	(1.28)	(1.27)	(3.05)
Black	3.30	-10.36*	1.42	-35.07*	3.22	-5.77	-12.04	3.70	-1.86
	(.69)	(2.59)	(.10)	(2.91)	(.34)	(1.10)	(.71)	(1.25)	(.68)
Hispanic	-10.62*	-2.06	22.28	4.43	1.50	4.15	21.94	-3.98	-4.69
	(2.31)	(.53)	(1.61)	(.38)	(.16)	(.83)	(1.34)	(1.40)	(1.77)
Other racial/ethnic	-21.41*	-4.33	12.99	.44	-14.72	-7.76	-21.09	-5.95	-10.66*
	(2.92)	(.71)	(.59)	(.02)	(1.02)	(.97)	(.81)	(1.32)	(2.53)
Midwest	1.22	-2.59	-3.90	18.31	15.77	3.03	11.92	7.43*	6.24*
	(.22)	(.57)	(.24)	(1.34)	(1.47)	(.51)	(.62)	(2.21)	(1.99)
South	-4.59	-10.07*	-27.20	1.76	-5.59	-7.15	-11.43	-0.59	-2.65
	(.91)	(2.39)	(1.80)	(.14)	(.56)	(1.30)	(.64)	(.19)	(.92)
West	-2.23	-3.70	-27.67	-2.22	-6.68	-4.56	3.35	1.59	-3.66
	(.42)	(.82)	(1.71)	(.16)	(.63)	(.78)	(.18)	(.48)	(1.19)
Metro-central city	3.48	-3.36	11.90	-4.71	-10.84	0.06	9.42	-.32	0.61
	(.89)	(1.03)	(1.01)	(.48)	(1.40)	(.01)	(.68)	(.13)	(.27)
Nonmetro	-8.45	-10.02*	-18.47	-42.30*	-5.00	-15.13*	-45.38*	-2.05	-2.25
	(1.95)	(2.76)	(1.41)	(3.87)	(.58)	(3.19)	(2.94)	(.77)	(.90)
Age-1 year	-19.92*	15.38*	15.86	15.56	76.69*	-2.74	63.32*	-10.33*	13.80*
	(4.27)	(3.94)	(1.13)	(1.32)	(8.31)	(.54)	(3.81)	(3.59)	(5.14)
Age-2 years	-11.24*	-7.46*	47.24*	10.21	86.11*	6.74	108.23*	-6.93*	21.80*
	(2.48)	(1.96)	(3.45)	(.89)	(9.60)	(1.36)	(6.71)	(2.47)	(8.35)
Age-3 years	-1.43	-5.53	37.40*	16.45	91.61*	12.11*	143.05*	-2.92	27.71*
	(.29)	(1.34)	(2.52)	(1.33)	(9.40)	(2.25)	(8.16)	(.96)	(9.77)
Head's education (years)	.90	0.62	-0.26	2.45	1.87	0.46	.76	0.58	0.60
	(1.65)	(1.37)	(.16)	(1.79)	(1.73)	(.78)	(.39)	(1.74)	(1.93)
Single headed household	6.60	-6.12	-13.27	5.64	-.03	2.92	6.12	1.34	2.35
	(1.58)	(1.75)	(1.05)	(.54)	(.00)	(.64)	(.41)	(.52)	(.97)
Year95	2.66	1.03	19.08	.95	-6.26	-2.81	2.40	7.36*	.26
	(.70)	(.32)	(1.66)	(.10)	(.83)	(.68)	(.18)	(3.13)	(.12)
Year96	.02	3.30	13.33	-.64	-.83	-3.21	-5.73	5.99*	1.80
	(.01)	(.97)	(1.09)	(.06)	(.10)	(.73)	(.40)	(2.40)	(.77)

Notes: The dependent variable is the nutrient intake of children expressed as a percentage of the RDA. Numbers in parentheses are the t values. *=Significant at the 95-percent confidence level. Sample size=1,135 observations.

Self-Selection and Rationing Issues

Although the multivariate least squares regression model accounts for observable differences between WIC recipients and income-eligible but nonparticipating children, a problem exists if WIC recipients differ in unobservable ways from income-eligible nonparticipants, and if these unobservable differences influence nutrient intake. These unobservable differences, the result of either self-selection or rationing, may bias the regression estimates of WIC's effect on nutrient intake. Table 4 lists the most likely causes of possible biases affecting the full-sample regression model.

Biases due to self-selection can be upward, that is, in favor of WIC's effects on nutrient intake, or downward, against WIC's effects on nutrient intake. In example 1, a self-selection bias may occur when parents are unaware that their child is eligible to receive WIC benefits. These parents may be less knowledgeable about the importance of nutrition for a child's health than are parents of children who actively seek out sources of nutrition assistance. In this scenario, self-selection would result in a upward bias of the WIC program estimate.[22]

An upward bias may also result when the parents of a child who is eligible for WIC choose not to enroll the child in the program because they perceive that the stigma, cost, and/or time involved in applying for the program, picking up the food vouchers, and attending nutrition education sessions exceed the program's benefits (example 2). This may be an indication that these parents, relative to parents who do apply for WIC, are not very concerned about their child's nutritional status or motivated to improve the child's nutritional status.

However, a downward bias could result for at least two reasons. First, the parents of an eligible child could choose not to participate because their child has a low nutritional risk and they do not perceive that there is much to be gained from participating in WIC (example

[22]This would happen because, after controlling for the observable differences in the characteristics of the children, their households, and geographic region, but not for these differences in nutritional knowledge, as in the full-sample regression model, the difference in nutrient intake between the two groups of children would be attributed to the effects of the WIC program. However, the group of children whose parents were not aware that their child was eligible for WIC might be less likely to receive nutritious meals (and therefore more likely to have low nutrient intake) than the children in WIC even in the absence of the WIC program.

Table 4—Possible biases affecting the full-sample regression model

Cause of bias	Type of bias	Expected direction of effect	Adjusted for in the selection bias model?
1. Parent is not aware that child is eligible for WIC	Self-selection	Upward	Yes
2. Parent chooses not to enroll eligible child in WIC due to stigma, costs, or time involved	Self-selection	Upward	Yes
3. Parent chooses not to enroll eligible child in WIC because parent perceives child not to be at a high level of risk	Self-selection	Downward	Yes
4. Parent chooses not to enroll eligible child in WIC because parent anticipates future increase in income	Self-selection	Downward	Yes
5. Child is not eligible for WIC because child does not demonstrate nutritional risk	Rationing	Downward	No
6. Child is eligible for WIC but cannot participate due to a lack of available slots	Rationing	Downward	No

3). That is, WIC participants may be more likely to be at greater nutritional risk than nonparticipants. If this is the case, then comparisons with WIC children would result in a downward bias of WIC. Second, the parents of an eligible child could choose not to participate because they anticipate future income increases (example 4).[23] These households may therefore be more similar to higher income households despite their current low incomes. Insofar as higher income households have characteristics that are correlated with higher nutrition, this will also lead to a downward bias of WIC participation.

Biases can also occur due to rationing. The WIC program limits participation in the program to persons demonstrating nutritional risk (example 5). However, since the nutritional status of children in this study is not known, WIC eligibility is proxied solely by income eligibility. Presumably, some income-eligible children are not nutritionally at risk and are therefore not eligible to participate in the program. In this case, rationing leads to a downward bias, since nonparticipating income-eligible children who are not at nutritional risk are compared with WIC children who have demonstrated nutritional risk.

[23]Blank and Ruggles (1996) showed that many nonparticipants in the AFDC and Food Stamp Programs do not participate because they predicted (largely correctly) future income increases.

Rationing may also lead to a downward bias when WIC funds are not sufficient to serve all eligible applicants and the program rations limited slots among children judged to be the most at risk (example 6).[24] That is, children who are accepted into the WIC program have poorer nutritional status than eligible children not accepted into the program. In this case, rationing would again lead to a downward bias, since the nonparticipating children demonstrate less nutritional risk than children participating in WIC.[25]

[24]Children with detrimental or abnormal nutritional conditions detectable by hematological or anthropometric measurements or other documented medical conditions have a higher priority than children at risk because of an inadequate dietary pattern or with conditions that predispose children to inadequate nutritional patterns (see box, p. 3).

[25]Rationing can also theoretically lead to an upward bias. Consider two States, one with high average nutrient intakes, the other with low average nutrient intakes. Suppose, because of limited funds, the State with low average nutrient intake has to ration more than the State with high nutrient intake. If both States ration based on nutritional risk, then the effect of WIC may be overstated because a higher proportion of high-nutrient-intake children entered the program than if rationing had been equal across the States. However, it is expected that the downward biases toward WIC due to rationing are larger than this upward bias, in which case not accounting for differences due to rationing understates the effects of WIC.

Multivariate Regression Analysis Controlling for Selection Bias

In an ideal evaluation, the effects of WIC on children would be obtained by randomly selecting from a group of eligible children some children to receive and some not to receive benefits. On average, the characteristics (both observable and unobservable) of the two groups of children would not differ other than whether or not they participated in the WIC program (assuming that all children selected to receive WIC benefits did so). Differences in nutrient intake between the two groups could be attributed solely to the effects of WIC, and not the result of a bias due to self-selection or rationing. However, because of ethical concerns associated with withholding benefits from needy children, a random assignment design is not possible.

There are statistical techniques that can control for selection bias (for example, see Heckman 1979). However, they require the model to include one or more explanatory variables (or identification variables) that explain program participation (i.e., whether or not a person participates in the WIC program) but do not directly influence nutrition intake.[26] However, because the CSFII does not provide enough information on why some income-eligible children do not participate in the program, we did not use a statistical model that corrects for self-selection bias.[27] Nonetheless, we did use an indirect method to address the issue of self-selection—comparing the nutrient intake of children by WIC status in households in which some person other than a child is participating in WIC, that is, a pregnant woman, a breastfeeding or postpartum mother, or an infant. In this model, since the households already receive WIC, the parents (or proxies) presumably are aware of the program, and are nutritionally concerned and motivated to improve the WIC participant's nutrition. Thus, the biases listed in examples 1, 2, and 4 in table 4 are controlled for. The bias resulting from example 3, whereby a parent does not enroll an eligible child in WIC because the parent does not believe the child has a high nutritional risk, is also controlled for since it is unlikely that a parent, who already takes the time to pick up WIC vouchers for another member of the household, would willingly choose not to enroll an eligible child in the program. Even if the nutritional benefits of participating in WIC for the child in question are small, participating in the program would free up food dollars that could be spent on other nutritionally at-risk household members.[28]

While the alternative model controls for self-selection, it does not control for the biases resulting from rationing (examples 5 and 6 in table 4). Since the biases from rationing are likely to be downward, the results from this analysis will be conservative, understating the effect of WIC.

A total of 191 income-eligible children in the sample resided in households in which some person other than a child was currently participating in WIC. The same regression models specified earlier for the full sample of WIC income-eligible children were run on these children. Eleven of these children were dropped from the analysis because of missing data for one or more independent variables. Of the remaining 180 children in the analysis, 110 participated in WIC and 70 did not.[29] The results of this analysis are shown in table 5.

As with the results based on the full sample of WIC income-eligible children (described in table 3), the estimate of WIC participation on the intake of iron based on this subset of children was positive and statistically significant. Although the coefficients for vitamin C (P=.07) and vitamin A (P=.10) were positive, they were not statistically significant. The lack of statistical significance for these nutrients, however, may be the result of the smaller sample size; also a spillover effect, whereby a person's participation in WIC affects the nutrient intake of other persons in the household, may be a factor. This could happen when: (1) WIC's referrals to Food Stamps and other food-assistance pro-

[26]One such explanatory variable, for example, might be distance to the local WIC office. People who live near a WIC office may be less inconvenienced, and thus more likely to apply for WIC, than people who must travel longer distances.

[27]See (Fraker et al. 1990) for a discussion of the lack of variables in the CSFII that could serve as identifiers in models designed to estimate WIC program effects on dietary outcomes while controlling for selection bias.

[28]Even if parents in households in which someone participates in WIC chose not to enroll their eligible child in the program because they do not perceive their child as having a high level of nutritional risk (example 3 in table 4), the bias would be downward (similar to that due to rationing in examples 5 and 6) and would not affect our conclusions.

[29]The socioeconomic and demographic characteristics of these children by WIC status are shown in appendix table 1 and the nutrient intake of these children by WIC status is shown in appendix table 2.

Table 5—Results of multiple regression models on WIC income-eligible children residing in households in which another adult or infant household member participates in WIC

	Iron	Calcium	Vit. C	Vit. A	Protein	Vit. B-6	Folate	Zinc	Food energy
Intercept	26.68	97.42*	56.00	72.50	213.87*	47.43	-33.14	50.43*	65.28*
	(.94)	(5.04)	(.72)	(1.60)	(4.56)	(1.65)	(.33)	(3.39)	(4.68)
WIC recipient	20.67*	12.67	48.75	26.01	.20	23.49*	91.06*	-3.07	-1.83
	(2.10)	(1.88)	(1.81)	(1.65)	(.01)	(2.34)	(2.61)	(.59)	(.38)
Percent of poverty	.07	.00	-.11	.21	-.22	.09	.21	-.08	-.04
	(.74)	(.02)	(.45)	(1.44)	(1.46)	(.92)	(.66)	(1.57)	(.94)
Food Stamp recipient	1.21	-.59	-41.97	-.89	22.57	1.75	-25.76	3.50	2.07
	(.12)	(.08)	(1.50)	(.05)	(1.33)	(.17)	(.71)	(.65)	(.41)
Assets of $5,000	-17.41	-41.01	89.39	17.12	-69.21	-7.93	57.26	-11.57	-11.20
	(.55)	(1.89)	(1.03)	(.34)	(1.32)	(.25)	(.51)	(.69)	(.72)
Homeownership	-10.05	-1.61	8.51	-27.73	7.72	-6.71	-51.97	-3.40	.94
	(.95)	(.22)	(.29)	(1.63)	(.44)	(.62)	(1.38)	(.61)	(.18)
Male	1.33	21.83*	-21.33	12.18	20.20	12.85	55.37	4.03	8.80*
	(.15)	(3.59)	(.88)	(.85)	(1.37)	(1.42)	(1.75)	(.86)	(2.01)
Black	31.36*	6.19	104.55*	-15.70	57.94*	11.29	37.07	11.16	19.00*
	(2.30)	(.67)	(2.81)	(.72)	(2.56)	(.81)	(.77)	(1.56)	(2.83)
Hispanic	11.92	6.75	134.74*	20.44	47.63*	33.93*	160.57*	9.57	14.08*
	(.98)	(.82)	(4.06)	(1.05)	(2.37)	(2.75)	(3.73)	(1.50)	(2.36)
Other racial/ethnic	-16.14	-36.69*	146.64*	-6.84	-42.94	-13.41	20.43	2.65	-17.01
	(.90)	(2.99)	(2.98)	(.24)	(1.44)	(.73)	(.32)	(.28)	(1.92)
Midwest	6.55	-33.05*	58.04	4.46	-43.49	.52	60.13	13.68	-6.37
	(.35)	(2.60)	(1.14)	(.15)	(1.41)	(.03)	(.91)	(1.40)	(.70)
South	-.37	-25.79*	39.96	-19.96	-69.48*	-3.26	45.98	-5.89	-15.19*
	(.02)	(2.49)	(.96)	(.82)	(2.76)	(.21)	(.86)	(.74)	(2.03)
West	14.02	-14.38	7.68	-24.31	-65.78*	-7.35	30.75	-7.77	-17.91*
	(.93)	(1.40)	(.19)	(1.01)	(2.63)	(.48)	(.58)	(.98)	(2.41)
Metro-central city	16.01	-1.71	34.10	13.73	-19.70	11.53	62.67	3.21	3.78
	(1.50)	(.24)	(1.17)	(.80)	(1.11)	(1.06)	(1.66)	(.57)	(.72)
Nonmetro	1.97	3.46	-13.73	-5.74	-.75	-3.24	8.03	1.15	3.80
	(.15)	(.40)	(.39)	(.28)	(.04)	(.25)	(.18)	(.17)	(.60)
Age-1 year	-6.35	17.90	42.17	36.30	82.09*	13.96	138.99*	-2.10	21.36*
	(.45)	(1.85)	(1.09)	(1.60)	(3.50)	(.97)	(2.77)	(.28)	(3.07)
Age-2 years	10.45	-7.67	85.04*	41.49*	106.76*	28.40*	178.47*	7.17	29.71*
	(.80)	(.87)	(2.40)	(1.99)	(4.96)	(2.15)	(3.88)	(1.05)	(4.65)
Age-3 years	6.64	-7.40	70.60	42.20	99.91*	23.58	167.94*	3.97	31.12*
	(.44)	(.73)	(1.73)	(1.76)	(4.03)	(1.55)	(3.17)	(.51)	(4.23)
Head’s education (years)	4.20*	.26	1.99	2.59	5.07*	2.26	6.89	1.85*	1.68*
	(3.27)	(.29)	(.57)	(1.26)	(2.38)	(1.73)	(1.52)	(2.75)	(2.66)
Single-headed household	-5.52	-14.91	-24.67	1.27	8.05	.02	-1.09	4.96	.21
	(.45)	(1.77)	(.73)	(.06)	(.39)	(.00)	(.03)	(.77)	(.04)
Year95	5.30	-2.07	64.98*	2.06	-19.14	-5.73	-17.54	9.54	-3.13
	(.51)	(.29)	(2.29)	(.12)	(1.11)	(.54)	(.48)	(1.74)	(.61)
Year96	4.09	-12.34	-3.78	-20.62	-40.04	-20.30	-42.21	3.69	-7.15
	(.33)	(1.46)	(.11)	(1.04)	(1.95)	(1.61)	(.96)	(.57)	(1.17)

The dependent variable is the nutrient intake of children expressed as a percentage of the RDA. Numbers in parenthesis are the t values. *=Significant at the 95-percent confidence level. Sample size=180 observations.

grams lead to new-found resources for a household; (2) WIC foods are shared among other non-WIC household members; (3) the nutrition education received by WIC women results in increased dietary quality for all members of the household; or (4) receipt of WIC benefits frees up food dollars that are spent on food for the nonparticipating child.

In addition, another factor could explain the lack of significance for these variables. Limiting the analysis only to children residing in households in which another member participates in WIC controls for self-selection bias; however, it does not address the probable downward bias due to rationing. In households in which the child is not on WIC, but someone else is on WIC, the child probably does not meet the nutritional risk criteria or the child's nutritional risk is low priority. Thus, the exclusion of nutritionally more successful children from the group of participating WIC children will tend to underestimate the effects from participating in WIC.

Among the three nutrients recommended for targeting by WIC, the coefficients for folate and vitamin B-6 were positive and statistically significant. These results are not surprising given the fact that WIC food packages for children are considered to be good sources of both vitamin B-6 and folate (USDA 1991). WIC's effect on the intake of zinc was insignificant. Major sources of zinc, largely red meats, are not included in the WIC food package. Once again, the regression coefficient for energy was negative and insignificant, indicating that the increase in intake of these nutrients occurred as a result of increased nutrient density and not increases in the amount of food energy consumed.

Discussion

There have been only three prior national-level studies that examined the effect of participation in WIC on the nutrient intake of children. While they generally found a positive relationship between WIC participation and nutrient intake, results of the individual studies differed by the significance of various nutrients. The first of these studies, the National WIC Evaluation, was based on data collected during 1983 (Rush 1986). Using linear multiple regression to control for observable differences across the groups, the study found that WIC children had greater mean intake of iron, vitamin C, and vitamin B-6 than did similar children not on WIC (folate and zinc intakes were not examined).

The most in-depth study of WIC's impact on the nutrient intake of children, based on data from the 1985 CSFII, was conducted by Fraker et al. (1990). Using an ordinary least squares regression model, they found that WIC had positive and significant effects on protein and vitamin C intakes (folate and vitamin B-6 intakes were not examined). They also used a bivariate selection model to control for self-selection bias and found that WIC had consistently positive, but statistically insignificant, effects on the nutrient intake of children. They hypothesized that the lack of statistically significant results may have been due to small sample size.

Rose et al. (1998), using a multivariate analysis of data from the 1989-91 CSFII, found that participation in the WIC program was positively associated with a significant increase in the intake of iron and protein (the other WIC-targeted nutrients were statistically insignificant). WIC was also associated with significant increases in intake for all three nutrients recommended as WIC-targeted nutrients. Using a two-stage regression model to control for self-selection bias, the authors found no evidence of selection bias; results from this analysis were not reported, however. A further limitation of this study is that it was restricted to children residing in households that were eligible for the Food Stamp Program; that is, households with monthly income less than 130 percent of poverty and with cash assets less than $2,000. However, the income-eligibility cut-off for WIC is less than 185 percent of poverty and there is no asset test. Therefore, some WIC income-eligible households were excluded from their analysis.

All three of these prior analyses were based on data collected before the dramatic expansion of the child component of the WIC program during the 1990's. Therefore, the results of these studies may not be applicable to the current situation. This study is based on data collected during 1994-96, the tail end of the program's expansionary period.[30] Thus, the data are more comparable to the current situation in which WIC benefits are more widely available to children.

Both Fraker et al. and Rose et al., using earlier versions of the CSFII, attempted to control for possible self-selection bias statistically by using selection bias models. However, as Fraker et al. (1990) states, the lack of identification variables in data sets such as the CSFII that can serve as identifiers in models designed to estimate WIC program effects while controlling for selection bias is problematic. That is, there is no variable in the CSFII that adequately proxies for nutritional awareness or motivation.

This study addresses the issue of self-selection bias by analyzing a subsample of children in the CSFII—those living in a household in which a woman or infant is participating in WIC—thus controlling for nutritional awareness and motivation. However, another limitation of this study (as well as the earlier studies), possible bias from rationing, was not addressed. Rationing bias may occur when the data do not allow for a determination of nutrition risk, one of the criteria for eligibility in WIC. As a result, estimates of WIC's effect generated by the regression analysis may be subject to possible bias due to the effect of rationing in which only children demonstrating nutritional risk can participate in the program while non-WIC children are less likely to have a risk. The degree to which rationing biases the results is unknown. However, the expansion of the WIC program in recent years has allowed a larger proportion of lower risk children to participate in the program. Thus, the results of this study might be less subject to bias against the program due to rationing than the earlier studies that included a greater proportion of high-risk children in the WIC program.

After controlling for self-selection bias by limiting the analysis to children living in a household with an infant or woman on WIC, participation in WIC was found to have a positive and significant ($P<.05$) effect

[30]The number of children participating in WIC in fiscal 1998 was only 1 percent more than in fiscal 1996 (USDA 1998b and USDA 1998d).

on the consumption of iron, folate, and vitamin B-6. The findings regarding iron and vitamin B-6 are especially important since a large percentage of children, regardless of WIC status, failed to meet their RDA for these nutrients.[31] Low intake of iron, which may lead to anemia, is considered to be a current public health issue, while low intake of vitamin B-6, which is associated with neurologic abnormalities, dermatitis, impaired immune function, and anemia, is considered to be a potential public health issue (Federation of American Societies for Experimental Biology 1995).[32]

In addition, the coefficients for vitamin C (P=.07), vitamin A (P=.09), and protein were positive but not statistically significant. These results occurred despite the small sample size, possible spillover effects, and a probable downward bias against WIC (due to the effect of rationing), all of which make finding positive statistical significance more difficult. The regression coefficient for energy was negative and insignificant, indicating that the increase in intake of these nutrients occurred as a result of increased nutrient density and not increases in the amount of food energy consumed.

Results of the univariate analysis, in which the mean nutrient intake of WIC children was compared with that of those who were ineligible to participate because their household income was too high, also support the finding of positive effects from participation in WIC. A relatively large percentage of children participating in WIC, in addition to being poor and at nutritional risk, came from single-headed households and households headed by persons with low education levels, characteristics that, one could argue, would make them especially vulnerable to low nutrient intake (see table 1).[33] In fact, one of the main premises of the WIC program is that the inadequate nutritional patterns and health behavior of some low-income women and children make them especially vulnerable to adverse health outcomes. A review of the dietary, nutritional, and health-related status of the U.S. population completed in 1995 concluded that low-income people are less aware of the relationship between diet and health and are at greater risk of nutrition-related health problems (Federation of American Societies for Experimental Biology 1995). However, in this analysis, the mean intakes of iron, protein, and folate, for the low-income, nutritionally at-risk children who participated in WIC, were found to be significantly greater than those of WIC income-ineligible children (table 2). Intakes of the other WIC-targeted and potential WIC-targeted nutrients were also greater than those of the income-ineligible children, although not statistically significant. These results are consistent with a positive and significant effect of WIC on the nutrient intakes of children.

[31]On the other hand, 98 percent of all children met the RDA for folate.

[32]The classification of nutrients as current or potential public health issues was based on intake levels among the population and evidence of adverse health consequences.

[33]Low education may result in the parent's being less aware of the adverse health outcomes resulting from poor nutrition and less able to plan nutritious meals. Single parents may have less time to plan and make more nutritious meals.

References

An, A., and D. Watts. "New Procedures for Analysis of Sample Survey Data." SAS Institute Inc., *Proceedings of the Twenty-Third Annual SAS User Group International Conference*. Nashville, TN. 1998.

Blank, Rebecca, and Patricia Ruggles. "When Do Women Use Aid to Families With Dependent Children and Food Stamps? The Dynamics of Eligibility Versus Participation." *The Journal of Human Resources.* Volume 31, No. 1. 1996.

Federation of American Societies for Experimental Biology, Life Sciences Research Office. *Third Report on Nutrition Monitoring in the United States: Volume 1*. Washington DC. December 1995.

Fraker, T., S.K. Long, and C. E. Post. *Analyses of the 1985 Continuing Survey of Food Intakes by Individuals. Volume I*. Prepared by Mathematica Policy Research, Inc. Washington, DC. September 27, 1990.

General Accounting Office, Human Resources Division. *Early Intervention: Federal Investments Like WIC Can Produce Savings*. GAO/HRD-92-18. April 1992.

Heckman, J. "Sample Selection Bias as a Specification Error." *Econometrica*. Volume 41, No. 1. 1979.

Institute of Medicine. *WIC Nutrition Risk Criteria: A Scientific Assessment*. National Academy Press, Washington, DC. 1996.

Rose, D., Habicht, J-P., and B. Devaney. "Household Participation in the Food Stamp and WIC Programs Increases the Nutrient Intakes of Preschool Children." *Journal of Nutrition*. Vol. 128. 1998.

Rush, D. *Evaluation of the Special Supplemental Food Program for Women, Infants, and Children (WIC), Volume 1: Summary*. Research Triangle Park, NC. 1986.

U.S. Dept. of Agriculture, Agricultural Research Service. *1994-96 Continuing Survey of Food Intake by Individuals and 1994-96 Diet and Health Knowledge Survey* CSFII/DHKS. CD-ROM. 1998a.

U.S. Dept. of Agriculture, Food and Nutrition Service, Budget Division. *Program Information Report (Keydata): U.S. Summary, September 1998*. December 1998b.

U.S. Dept. of Agriculture, Food and Nutrition Service, Office of Analysis and Evaluation. *Income Variability Among Families with Pregnant Women, Infants, or Young Children*. Prepared by Mathematica Policy Research, Inc. January 1997.

U.S. Dept. of Agriculture, Food and Nutrition Service, Office of Analysis and Evaluation. *Study of WIC Participant and Program Characteristics 1996*. Prepared by Abt Associates. August 1998c.

U.S. Dept. of Agriculture, Food and Nutrition Service, Program Information Division. *Annual Historical Review: Fiscal Year 1996*. June 1998d.

U.S. Dept. of Agriculture, Food and Nutrition Service. *Review of WIC Food Packages: Technical Papers*. November 1991.

U.S. Dept. of Agriculture, Food and Nutrition Service. *Special Supplemental Nutrition Program for Women, Infants, and Children (WIC): Eligibility and Coverage Estimates, 1996 Update*. April 1998e.

U.S. Dept. of Agriculture, U.S. Dept. of Health and Human Services. *Nutrition and Your Health: Dietary Guidelines for Americans*. 1995.

Appendix A
Variable Names and Definitions Used in the Regression Model

Variable	Definition
Child characteristics	
WIC recipient	Equals 1 if child participates in WIC, else 0
Male	Equals 1 if child is male, else 0
Black	Equals 1 if child is a non-Hispanic black, else 0
Hispanic	Equals 1 if child is Hispanic, else 0
Other racial/ethnic	Equals 1 if child is a non-Hispanic other, else 0
White	Omitted base group—child is a non-Hispanic white
Age-1 year	Equals 1 if child is 1 year of age, else 0
Age-2 year	Equals 1 if child is 2 years of age, else 0
Age-3 year	Equals 1 if child is 3 years of age, else 0
Age-4 year	Omitted base group—child is 4 years of age
Household characteristics	
Percent of poverty	Household income as a percent of poverty threshold
Homeowner	Equals 1 if household head owns home, else 0
Assets of $5,000	Equals 1 if household has assets of $5,000 or more, else 0 (Assets include cash, savings or checking accounts, stocks, bonds, and certificates of deposit.)
Food Stamp recipient	Equals 1 if household receives Food Stamps, else 0
Single-headed household	Equals 1 if a single-headed household, else 0
Geographic characteristics	
Midwest	Equals 1 if household is in the Midwest, else 0
South	Equals 1 if household is in the South, else 0
West	Equals 1 if household is in the West, else 0
Northeast	Omitted base group—household is in the Northeast
Central city	Equals 1 if household is in metropolitan area-central city, else 0
Nonmetro	Equals 1 if household is outside a metropolitan area, else 0
Metro-outside	Omitted base group—household is in metropolitan area, outside central city
Characteristics of head of household	
Head's education	Years of schooling completed by head. (In dual-headed households, the head's education refers to the female head.)
Year of survey	
Year95	Survey conducted in 1995
Year96	Survey conducted in 1996
Year94	Omitted base group—survey conducted in 1994

Appendix table 1—Socioeconomic and demographic characteristics of children residing in households in which an adult or infant participates in WIC, by WIC status of the child

	All children (n=180)	WIC participant (n=110)	Nonparticipant (n=70)
Individual characteristics			
		Percent	
Race/ethnicity:			
White (non-Hispanic)	35.2	36.4	33.6
Black (non-Hispanic)	26.7	31.7	19.9
Hispanic	28.5	19.3	40.7
Other (non-Hispanic)	9.7	12.6	5.7
Age:			
1 year	24.5	27.8	20.1
2 years	32.6	40.8[1]	21.7
3 years	21.1	16.9	26.8
4 years	21.7	14.5[1]	31.4
Sex:			
Male	50.6	53.5	46.7
Female	49.4	46.5	53.3
Household characteristics			
		Mean	
Annual income	$16,685	$15,034	$18,898
Percent of poverty	94.7	87.1	104.8
		Percent	
Own their home	29.6	28.9	30.5
Have assets over $5,000	1.4	1.4	1.5
		Persons	
Household size	5.3	5.1	5.5
		Percent	
Receive Food Stamps	54.1	60.0	46.3
		Dollars	
Monthly value of Food Stamps	283.8	288.4	275
Region:		*Percent*	
Northeast	11.5	13.3	9.0
South	38.3	38.6	37.8
Midwest	10.6	15.8[1]	3.5
West	39.7	32.2	49.7
Metropolitan status:			
Central city	46.4	43.6	50.2
Metro-outside	32.1	30.7	34
Nonmetro	21.5	25.7	15.7
Household structure:			
Dual headed	71.2	68.2	75.2
Single head—female	28.8	31.8	24.8
		Years of schooling	
Education of head	10.0	9.7	10.5
		Percent	
Completed high school	54.2	53.3	55.3

Note: Weighted data.
[1]Significantly different from the corresponding nonparticipant coefficient at the 95-percent confidence level.

Appendix table 2—Nutrient intake of children residing in households in which an adult or infant participates in WIC, by WIC status of the child

	All children (n=180)	WIC partifcipant (n=110)	Nonparticipant (n=70)
Nutrient adequacy ratio			
		Mean	
Iron	114.0	119.7	106.4
	(5.19)	(4.33)	(7.42)
Calcium	91.8	94.7	88.0
	(2.46)	(2.03)	(3.22)
Vitamin C	246.4	276.4[1]	206.3
	(10.36)	(11.10)	(17.44)
Vitamin A	147.6	151.2	142.7
	(7.24)	(6.45)	(15.17)
Protein	291.6	304.3	274.7
	(8.34)	(4.41)	(8.88)
Vitamin B-6	119.5	126.4[1]	110.1
	(3.90)	(3.75)	(3.27)
Folate	339.9	372.2[1]	296.6
	(15.26)	(11.61)	(15.26)
Zinc	75.5	76.9	73.8
	(3.06)	(1.82)	(3.03)
Food energy	99.9	101.5	97.9
	(3.16)	(2.01)	(3.44)
Percent of children failing to meet 100 percent of the RDA			
		Percent	
Iron	45.1	40.3	51.5
	(4.57)	(4.35)	(5.95)
Calcium	66.9	64.2	70.6
	(3.51)	(3.53)	(4.93)
Vitamin C	20.1	17.1	24.1
	(3.38)	(3.77)	(4.41)
Vitamin A	36.3	34.8	38.2
	(4.76)	(3.19)	(6.99)
Protein	0.7	0.6	0.8
	(.53)	(.05)	(.87)
Vitamin B-6	35.6	28.6	44.9
	(4.25)	(3.98)	(5.17)
Folate	3.1	4.2[1]	1.7
	(1.89)	(.34)	(.21)
Zinc	82.3	79.9	85.5
	(3.34)	(3.60)	(3.67)
Food energy	54.0	48.5	61.3
	(3.88)	(3.99)	(5.18)

Note: Weighted data.
[1]Significantly different from the corresponding nonparticipant coefficient at the 95-percent confidence level.