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Association of WIC Participation and Growth and Developmental Outcomes in High-Risk Infants

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Abstract

The objective of this study was to describe the association of enrollment in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC), the Supplemental Nutrition Assistance Program (SNAP), and infant growth and neurodevelopmental outcomes. Z scores and Bayley Scales of Infant and Toddler Development–Third Edition (Bayley-III) and

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Author Contributions

Dr Lakshmanan made substantial contributions to designing the study, analyzing the data, and interpreting the results. Dr Lakshmanan wrote the first draft of the manuscript. Ms Song contributed to the data analysis. Dr Flores-Fenlon and Ms Parti assisted with data collection and manuscript preparation. Drs Vanderbilt, Friedlich, Williams, and Kipke made substantial contributions to designing the study, interpreting the results, and critically revising the manuscript. All authors reviewed and approved the final version of the manuscript.

Declaration of Conflicting Interests

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Authors' Note

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Vineland Adaptive/Behavior Scale–II (VABS-II) scores represented primary outcomes. We conducted bivariate analyses and linear regression. Children who were enrolled in WIC or WIC/SNAP had weight *z* scores U (95% confidence interval [CI]) that were 1.32 (0.42–2.21) or 1.19 (0.16–2.23) units higher. Enrollment in WIC or WIC/SNAP was associated with a higher score (95% CI) of 11.7 U (1.2–22.2 U) or 11.5 (0.1–22.9) for Bayley-III cognitive score and 10.1 U (1.9–19.1 U) or 10.3 (0.9–19.7) for the VABS-II composite score. These findings support increased advocacy for participation in WIC or WIC/SNAP for families with high-risk infants.

Keywords

Growth; development; WIC; outcomes

Introduction

A recent policy statement by the American Academy of Pediatrics, "Advocacy for improving nutrition in the first 1000 days to support childhood development and adult health," supports that adequate maternal and child nutrition during this period is foundational for children's growth and development.[1] Unfortunately, many preterm infants who are hospitalized in neonatal intensive care units (NICUs) face considerable nutritional insufficiency.[1] Provision of important macro- and micronutrients at certain points in development after discharge are crucial for growth and brain development.[2,3] Therefore, possible malnutrition that concurs with a period of brain growth may explain why preterm infants have a higher risk of cognitive delay.[4] Fortification of breast milk and nutrient-enriched formula has been recommended to address issues of postnatal growth and development.[5] Caring for children with special medical and nutritional needs may burden families with financial consequences, which often disproportionately affect those who are low income and minorities, making it harder for them to receive the nutritional support they may need.[6,7]

Food assistance programs such as the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) provide "nutritional supplementation, health care referrals, and nutrition education to low-income children younger than 5 years and pregnant, breastfeeding, and postpartum mothers meeting financial and nutritional eligibility criteria."[8,9] WIC serves "8 million low-income women and young children" each month, which makes it the most important public food assistance program for young children.[9,10] WIC often also sponsors reimbursements for therapeutic formulas such as nutrient-rich (calorie-dense) formulas for premature infants.[8,9] Additionally, WIC centers and educators serve as a primary medical resource for under-served communities by recognizing early developmental delays and issues with child health.[11] Many families enrolled in WIC are also enrolled in the Supplemental Nutrition Assistance Program (SNAP), which provides financial support to buy food at retail outlets to eat at home.[10]

Prenatal assessments have shown that maternal involvement in WIC is associated with decreased risk for neonatal prematurity and mortality.[12–14] Infants and toddlers receiving WIC demonstrate faster weight gains during infancy[15] and diets with more exposure to iron and zinc.[13,16] However, there has been limited evaluation linking WIC participation for preterm infants in terms of growth or developmental outcomes. Our research question was, “Is enrollment in publically funded food assistance programs associated with improved growth and developmental outcomes of preterm infants after discharge from the NICU *independent* of other risk factors?” The specific aims of this work were (1) to describe the prevalence of enrollment in food assistance programs and (2) to evaluate whether enrollment in food assistance programs is associated with improved growth and developmental outcomes of preterm infants after discharge from the NICU in this analytic sample.

Methods

Study Design and Participants

This cross-sectional study consisted of a questionnaire/survey administered to participants. As in previous work conducted, the survey contained validated components in English and Spanish and queried families about the use of community services, medication use, feeding patterns, quality of life, and financial burden.[17] We enrolled 1 caregiver of a preterm (<37-week gestation) infant attending a high-risk infant follow-up clinic at a quaternary urban hospital between 2013 and 2015. We included English- or Spanish-speaking parents of infants who were up to 24 months corrected age with completed developmental assessments. Consent was obtained when the parent agreed to complete the questionnaire, which was self-administered via laptop, or via an in-person or telephone interview. Participants were provided a small incentive to complete the survey. The Human Subjects Protection Program approved the study protocol. Of the 199 eligible participants, 169 enrolled (85% response rate), and 71 completed the developmental assessments and had growth data available (Figure 1).

Measurements

Measurements of primary outcomes and enrollment in food assistance programs are summarized below.

Anthropometrics.—Birth weight was obtained from the infants’ medical records. Current weight, length, and head circumference were obtained at the clinic visit. Subjects were weighed on a standard electronic scale to the nearest gram, and length was measured to the nearest centimeter on an infant length growth board. Head circumference (centimeters) was obtained with a standard clinical tape measure. Birth-weight z scores were calculated using the 2013 Fenton growth charts.[18] All subsequent weight, length, and head circumference z scores were calculated from the World Health Organization reference data.[19]

Neurodevelopmental Assessment.—An occupational therapist, a physical therapist, or a member of the research team administered the cognitive and motor subscales of the Bayley Scales of Infant and Toddler Development, third edition (Bayley-III) and the Vineland Adaptive Behavioral Scales, second edition (VABS-II) in English and Spanish. The Bayley-III is the most widely used tool for assessing early development.[20] Currently in its third edition, the Bayley Scales’ primary objective is “to identify children with developmental delay and to provide information for intervention planning” via individually administered assessment of children aged 1 to 42 months.[20,21] The Bayley-III has an age-corrected mean score of 100 with a standard deviation of 15; higher scores indicate better development.

We assessed social skills and communication using the VABS-II by interviewing caregivers who were Spanish speaking.[22] Specifically, the

> VABS-II assesses adaptive behavior in four domains: Communication, Daily Living Skills, Socialization and Motor Skills. It also provides a composite score that summarizes an individual's performance across all four domains. The VABS-II has an age-corrected mean score of 100 and a standard deviation of 15; higher scores indicate better function.[22–24]

Clinical Data.—We obtained information from medical records regarding delivery and complications during neonatal hospitalization. We asked the parents questions about their infants' health status since discharge, and we queried about the use of durable medical equipment and the administration of prescription medications.[25]

Enrollment in Public Assistance Programs.—Participants were asked yes/no questions about their eligibility and use of community-based developmental resources such as early intervention programs, use of social services such as food assistance programs (enrollment in WIC or WIC/SNAP). Self-report for enrollment in public assistance programs has been validated in other studies.[6,26] These questions were adapted from HelpSteps. Help-Steps.com is survey designed to identify health-related social problems. Details about the HelpSteps survey have been detailed in previous studies.[25,27–30]

Statistical Analysis

We described the characteristics of the study population using means and proportions. We compared the frequency of covariates (race/ethnicity, maternal education, language, income level, infant birth weight, neonatal comorbidities, postdischarge diagnoses, and medical technology) across developmental scores (Bayley-III, VABS-II). *P* values were obtained from *t*-tests for 2-category comparison and analysis of variance if there were more than 2 categories.

As per previous literature,[6,26] we modeled food assistance as enrollment in either WIC or WIC *and* SNAP (WIC/SNAP).

We used least squares adjusted difference of means to quantify the effects of enrollment in food assistance programs on growth, adjusting for covariates. These covariates included race/ethnicity, maternal education, language, birth weight, neonatal comorbidity, and post-discharge diagnosis. This method has been used previously.[31]

Linear regression was used to evaluate the association between food assistance and neurodevelopmental scores. Covariates that changed the β coefficients by 10% were retained in the multivariable models. To evaluate goodness of fit of the linear multivariable model, we evaluated the *F* test and R^2 for the linear models and found no differences from fit. To identify whether income assistance or infant chronologic age was an effect modifier for food assistance (stratified analysis), we fit linear regression models containing a multiplicative interaction term.

A sample size of at least 71 with unequal groups (52:19) achieves 99% power to reject the null hypothesis of equal means when the population difference is 10 with a standard deviation (SD) of 10 with a significance level (α) of .05 using a 2-sided, 2-sample equal variance *t* test (summary statement generated in PASS).

All of the statistical analyses were carried out using SAS, v. 9.4 (SAS Institute, Cary, NC).

Results

As outlined in Table 1, 73% of eligible families were enrolled in WIC and 21% were enrolled in WIC/SNAP. Most of our sample was Hispanic (81%), 73% of participants were non-English speaking and 93% had an annual income less than $40 000. All the subjects were enrolled in Medicaid. The median (interquartile range [IQR]) birth weight and gestational age of the infants was 1168 g (654 g) and 28 weeks (4 weeks), respectively, and their median (IQR) chronologic age was 14 months (8 months). Thirty-eight percent had a postdischarge diagnosis such as global developmental delay or cerebral palsy, and 24% used some sort of medical equipment such as supplemental oxygen, tracheostomy, a wheelchair, an adaptive stroller, or a feeding tube.

Anthropometric measures at the clinic visit differed between the groups who were enrolled in food assistance programs and those who were not (Table 2). Specifically, children who were enrolled in food assistance programs (WIC or WIC/SNAP) had weight *z* scores U (95% CI) that was either 1.32 (0.42–2.21) or 1.19 (0.16–2.23) higher than those children who were not; enrollment in WIC/SNAP was associated with length *z* scores U (95% CI) that was 1.42 (0.19–2.65) higher than those children who were not (Table 2 and Figure 2). Finally, we identified that WIC or WIC/SNAP enrollment was associated with a change weight *z* score U (95% CI) from birth to current by 1.15 (95% CI = 0.10–2.20) or 1.2 (95% CI = 0.13–2.28), independent of other risk factors (Figure 3).

When we examined differences in development between groups using bivariate analysis as a function of enrollment in food assistance programs (Table 3), we did not find any.

After adjusting for race/ethnicity, maternal education, primary language, language, birth weight, neonatal comorbidities, postdischarge diagnoses, the use of medical equipment, and enrollment in early intervention, we identified that enrollment in WIC or WIC/SNAP was associated with a higher score (95% CI) of 11.7 U (1.2–22.2 U) or 11.5 (0.1–22.9) for Bayley-III cognitive score and 10.1 U (1.9–19.1 U) or 10.3 (0.9–19.7) for the VABS-II composite score (Figure 4).

All of the interaction terms were nonsignificant when stratified by income assistance (food assistance × income assistance) or by chronologic age (food assistance × chronologic age) in all models. Therefore, neither income assistance nor infant chronologic age were effect modifiers of food assistance.

Discussion

In a vulnerable population of low-income, minority families with high-risk infants after NICU discharge, we found that enrollment in food assistance programs, independent of risk factors, was associated with higher weight and length *z* scores for the children of families enrolled in food assistance and found a change in weight *z* score from birth weight to follow-up when families were enrolled in WIC or WIC/SNAP. We also identified enrollment was associated positive neurodevelopmental outcomes, specifically cognitive and communication/adaptive behavior scores.

We found that participation in WIC was positively associated with growth, which may be due to a variety of reasons. Infants may receive direct benefit from the food supplements and nutritional recommendations that their families received. The WIC food package including items such as specifically therapeutic (calorie- and nutrient-rich formula especially designed for premature babies) formula that may be beyond the food budget of low-income families.[32] Moreover, a recent qualitative study found that caregivers *valued* the WIC infant package and were influenced by the high cost of formula.[33] Other studies have demonstrated that WIC participants are more likely to use preventative health services even beyond infant care.[34]

Furthermore, we found that use of WIC services was associated with better neurodevelopmental outcomes. Previous studies have found that intervention in early nutritional deficiency can be effective.[1,35] Nutrients that affect

> early brain development are (1) macronutrients such as protein, long-chain polyunsaturated fatty acids (LC-PFAs), and glucose; (2) micronutrients such as zinc, copper, iron, iodine, selenium; and (3) vitamins and cofactors such as B-vitamins, vitamin A, vitamin K, folate, and choline.[1]

Prenatal and early infancy iron deficiency can be associated with long-term behavioral changes that may not be reversible.[36] Long-chain polyunsaturated fatty acids, which include docosahexaenoic acid and archidonic acid, are important for vision and neurocognitive development.[3] Food packages from WIC often provide more balanced nutrition that includes these nutrients. In addition, participation in WIC may suggest better follow-up with other programs such as enrollment in neurodevelopmental follow-up (such as early intervention and high-risk infant follow-up programs).[37]

While not adequately powered in post hoc analysis or presented in this article, we found that 48% of families cited difficulty enrolling in food assistance (WIC or SNAP) due to transportation, lack of information, or burdensome paperwork. Unfortunately, many low-income and minority families do not receive many of the follow-up services prescribed.[38–41] This incongruence can be attributed to several factors: Minority and immigrant mothers often utilize safety-net health care for themselves and may not be aware of the services for which their child is eligible; the prevalence of parenting stress, and postpartum depression.[42,43] If more eligible families enrolled in food assistance programs, we believe that our results would have only been more positive (ie, we underestimated our presented results). Unfortunately, many children and families do not qualify for WIC services. Children whose families are on the edge for qualifying for WIC may liver on cheaper, less nutritionally sound diets. Many families fail to take advantage of the program after the first year because of the challenge of access or the contents of the WIC food packages.[33] Keeping families in the program longer will make supplemental food available to growing toddlers and support neurodevelopment. Addressing these barriers to participation will be crucial to assisting these families improve outcomes.

Our study was one of the first to examine preterm infant outcomes among minority, low-income families who receive WIC. The analysis was appropriately powered and minimized chances of a type II error. Furthermore, the results are reproducible and generalizable to similar populations. However, there are limitations to the study. One is that it is cross-sectional, which makes it difficult to infer causality. Our study may also be prone to selection bias, specifically self-selection or volunteer bias. However, on examination of the source population (eligible patients from the high-risk infant follow-up clinic), we found the patient variables were very comparable with our analytic population, which increased the internal validity of our results. Although our outcomes and exposure measures have been well validated, there is some concern that Bayley-III may overinflate developmental scores compared with the previous edition of this scale.[20] In such a case, the effect of enrollment in WIC may be underestimated.

Conclusions/Implications

We found that enrollment in food assistance programs was associated, independent of risk factors, with positive growth and neurodevelopmental outcomes. Specifically, we identified higher weight and length *z* scores for families enrolled in food assistance and found a change in weight *z* score from birth weight to follow-up when families were enrolled in WIC or WIC/SNAP. Moreover, cognitive and communication/adaptive behavior scores were higher for infants whose families were enrolled in WIC or WIC/SNAP.

The WIC and SNAP programs help 45 million low-income Americans (half of them children) pay for food each month.[9,10] WIC is a federal grant program, not an entitlement program. Questions about the effectiveness of WIC and concerns about cost-effectiveness have endangered the existing program.[14] Recently, the Agricultural Improvement Act of 2018 (Farm Bill) reauthorized SNAP and largely preserved benefits and eligibility but did not greatly increase the budget.[44] The findings from this study only strengthen the platform that these food assistance programs should be protected and expanded to help infants and especially preterm infants after discharge from the NICU.

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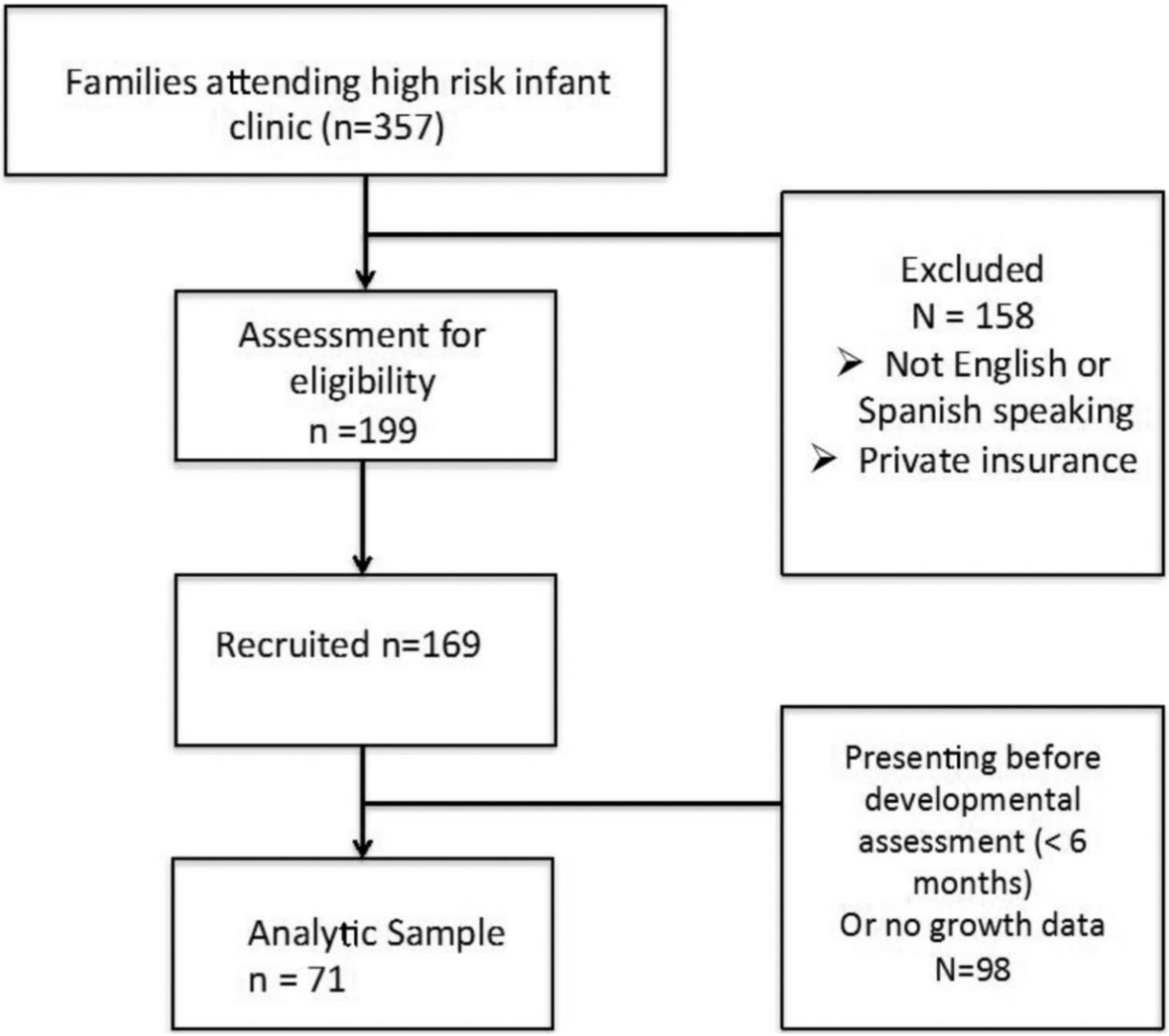

Figure 1.
Patient recruitment.

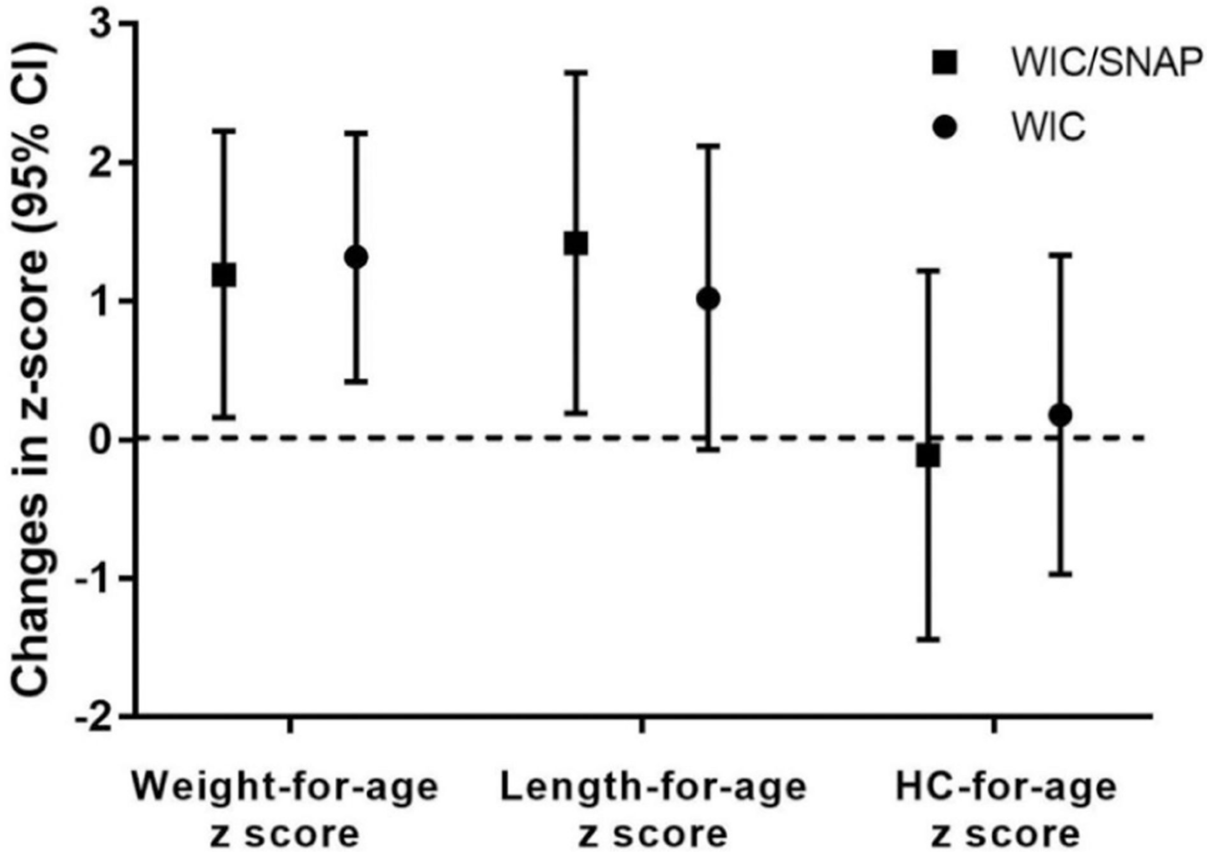

Figure 2.

Adjusted difference of means of growth parameters and enrollment in food assistance (N = 71). WIC, Women, Infants, and Children.

*Adjusted difference of means after adjusting for race/ethnicity, maternal education, language, birth weight, neonatal comorbidity, post discharge diagnosis, and enrollment in early intervention (reference, no enrollment in WIC).

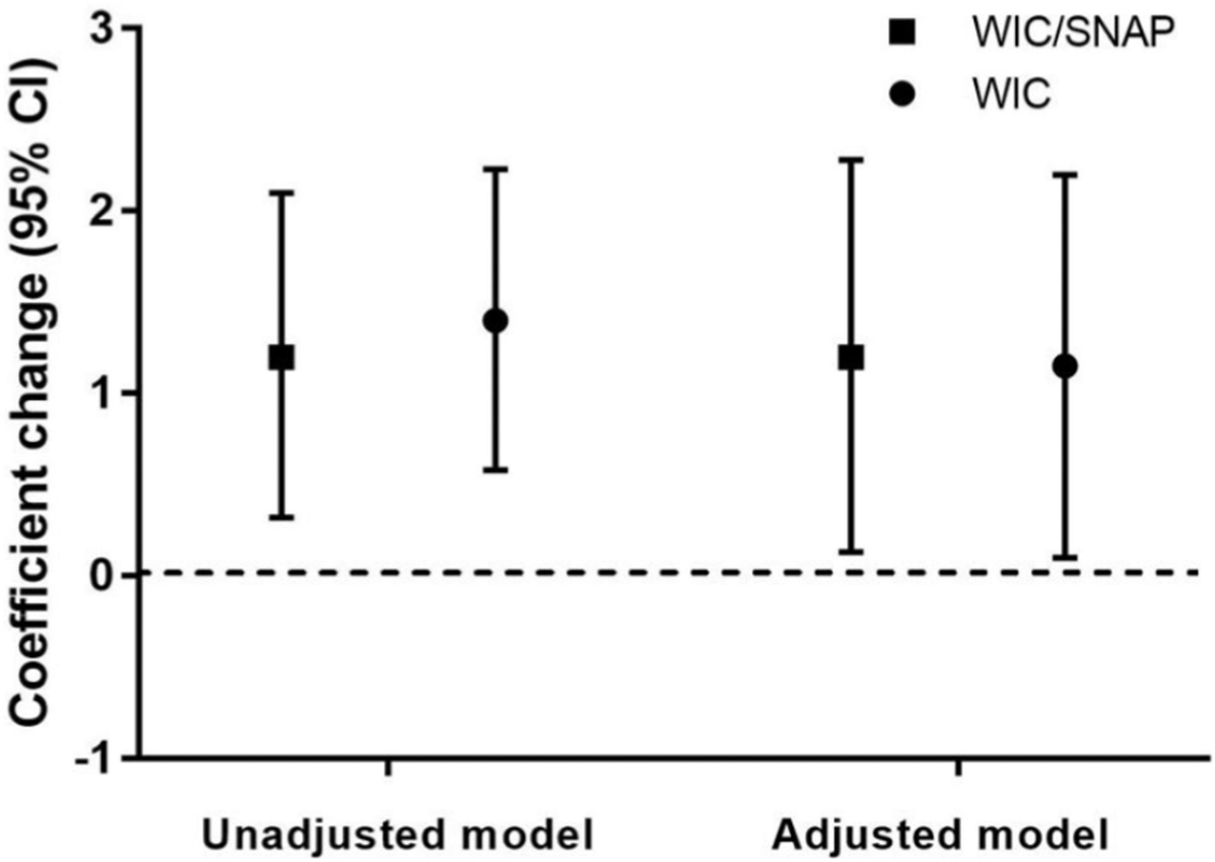

Figure 3.

Association of enrollment in food assistance programs (WIC or WIC and SNAP) and *z*-score change from birth to follow-up (N = 71). WIC, Women, Infants, and Children; SNAP, Supplemental Nutrition Assistance Program.

*Model adjusted for infant age in months, race/ethnicity, maternal education, language, neonatal comorbidity, post discharge diagnosis, use of medical equipment, and enrolment in early intervention.

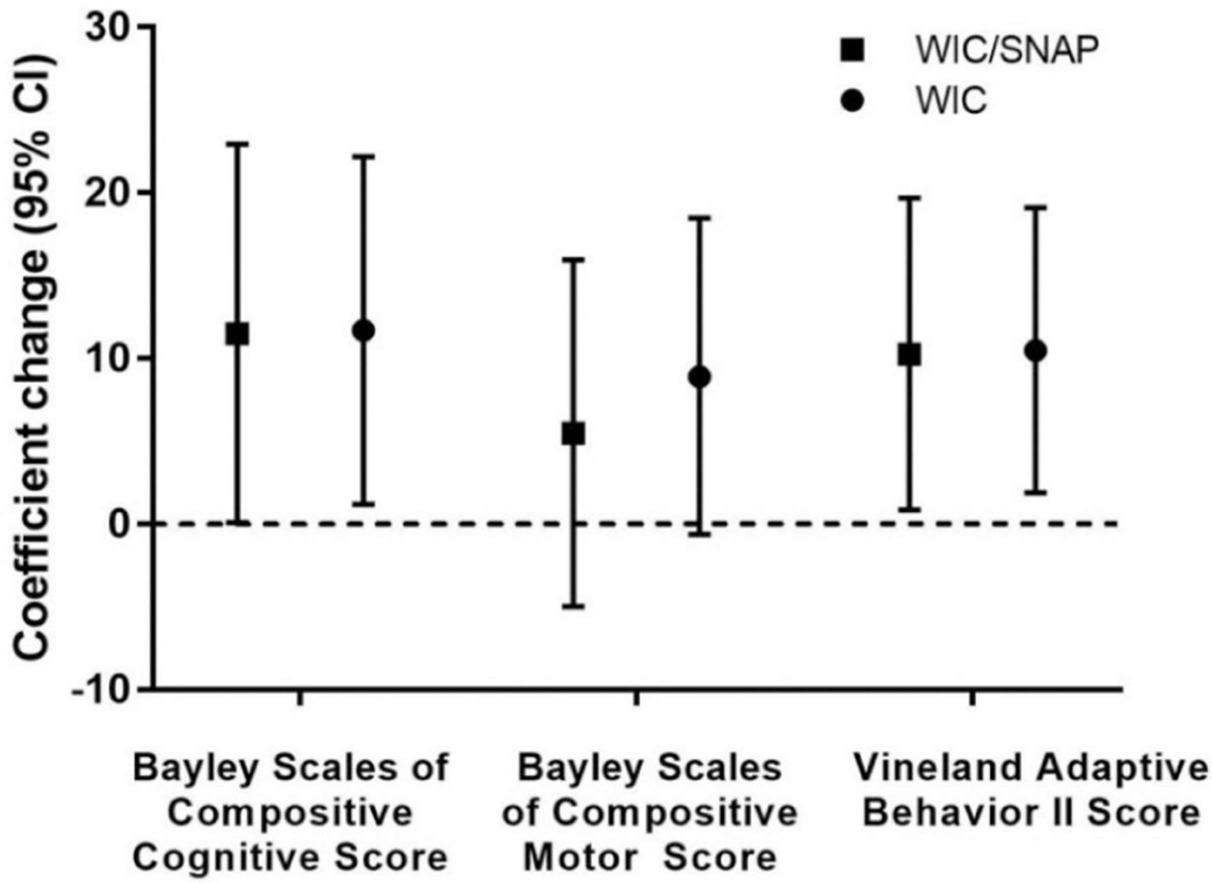

Figure 4.

Adjusted association of food assistance (enrollment in WIC or WIC and SNAP) and neurodevelopmental outcomes (N = 71). WIC, Women, Infants, and Children; SNAP, Supplemental Nutrition Assistance Program.

*Model adjusted for infant age in months, race/ethnicity, maternal education, language, birth weight, neonatal comorbidity, postdischarge diagnosis, use of medical equipment, and enrolment in early intervention.

Table 1.

Characteristics of Eligible for the WIC Families (N = 71).

		Enrolled in WIC, n (%)	Eligible, But Not Enrolled in WIC, n (%)	*P*
		52 (73)	19 (27)	
Socio-demographic characteristics				
Race/ethnicity				
White non-Hispanic	3 (4)	2 (4)	1 (6)	.04
Black non-Hispanic	6 (9)	6 (12)	0 (0)	
Hispanic	56 (81)	43 (82)	13 (76)	
Other	4 (6)	1 (2)	3 (18)	
Maternal education				
≤High school	23 (35)	19 (40)	4 (24)	.23
Some college	42 (65)	29 (60)	13 (76)	
Primary language				
English	20 (29)	13 (25)	7 (39)	.26
Non-English	50 (71)	39 (75)	11 (61)	
Annual household family income ($)				
<40 000	65 (93)	50 (96)	15 (83)	.10
≥40 000–<80 000	4 (6)	2 (4)	2 (11)	
≥80 000	1 (1)	0 (0)	1 (6)	
SNAP recipient				
Yes	17 (24)	15 (29)	2 (11)	.13
No	54 (76)	37 (71)	17 (89)	
Enrollment in income assistance programs				
Supplemental Security Income recipient				
Yes	25 (35)	22 (42)	3 (16)	.04
No	46 (65)	30 (58)	16 (84)	
Temporary assistance to needy families recipient				
Yes	2 (3)	2 (4)	0 (0)	.99
No	69 (97)	50 (96)	19 (100)	
Enrollment in other public assistance programs				

		Enrolled in WIC, n (%)	Eligible, But Not Enrolled in WIC, n (%)	*P*
Early Intervention Program				
Yes	35 (49)	24 (46)	11 (58)	.38
No	36 (51)	28 (54)	8 (42)	
Reliance on energy assistance (Low-Income Home Energy Assistance Program)				
Yes	3 (4)	2 (4)	1 (5)	.99
No	68 (96)	50 (96)	18 (95)	
Infant characteristics				
Birth weight (g), median (IQR)	1168 (654)	1110 (515)	1195 (835)	.18
Gestational age, median (IQR)	28 (4)	28 (4)	30 (4)	.10
Chronologic age, median (IQR)	14 (8)	14 (7)	14 (10)	.77
Neonatal comorbidities[a]				
Yes	55 (77)	40 (77)	15 (79)	.99
No	16 (23)	12 (23)	4 (21)	
Post discharge diagnoses[b]				
Yes	27 (38)	19 (37)	8 (42)	.67
No	44 (62)	33 (63)	11 (58)	
Use of medical equipment[c]				
Yes	17 (24)	7 (13)	10 (53)	.001
No	54 (76)	45 (87)	9 (47)	

Abbreviations: WIC, Women, Infants, and Children; SNAP, Supplemental Nutrition Assistance Program; IQR, interquartile range.

[a]Neonatal comorbidities include at least 1 diagnosis of fetal growth restriction, surfactant deficiency, necrotizing enterocolitis, intraventricular hemorrhage grade 3 or 4, patent ductus arteriosus, and retinopathy of prematurity.

[b]Postdischarge diagnoses include at least 1 diagnosis of attention deficit hyperactivity disorder, autism, global developmental delay, and cerebral palsy.

[c]Use of medical equipment includes oxygen, tracheostomy, wheelchair, adaptive stroller, and feeding tube.

Table 2.

Growth Parameters and Enrollment in Food Assistance Programs (N = 71).

	Weight-for-Age *z* Score			Length-for-Age *z* Score			Head Circumference-for-Age *z* Score		
	Mean (SE)[a]	**Adjusted Difference**[b]	***P*** [c]	**Mean (SE)**[a]	**Adjusted Difference**[b]	***P*** [c]	**Mean (SE)**[a]	**Adjusted Difference**[b]	***P*** [c]
Enrollment in the Supplemental Nutrition Program for Women, Infant, and Children (WIC)									
Yes	−1.13 (0.18)	1.32 (0.42 to 2.21)	.005	−2.64 (0.23)	1.02 (−0.07 to 2.12)	.07	−1.53 (0.24)	0.18 (−0.97 to 1.33)	.76
No	−1.91 (0.32)			−3.15 (0.35)			−1.65 (0.36)		
Enrollment in the Supplemental Nutrition Assistance Program (SNAP)									
Yes	−1.38 (0.39)	0.17 (−0.73 to 1.1)	.71	−2.34 (0.36)	0.77 (−0.24 to 1.77)	.14	−1.40 (0.35)	−0.18 (−1.18 to 0.82)	.71
No	−1.32 (0.18)			−2.90 (0.23)			−1.61 (0.24)		
Enrollment in WIC and SNAP									
Yes	−1.20 (0.18)	1.19 (0.16 to 2.23)	.03	−2.66 (0.22)	1.42 (0.19 to 2.65)	.03	−1.56 (0.23)	−0.11 (−1.44 to 1.22)	.87
No	−1.78 (0.35)			−3.16 (0.22)			−1.58 (0.41)		

Abbreviation: SE = standard error.

[a]Expressed as unadjusted mean (SE).

[b]Adjusted difference of means after adjusting for race/ethnicity, maternal education, language, birth weight, neonatal comorbidity, and postdischarge diagnosis.

[c]*P* value for the adjusted difference.

Table 3.

Unadjusted Association of Enrollment Food Assistance Programs and Neurodevelopmental Outcomes (n = 71).

		Bayley Scales of Infant Development III Composite Cognitive Score		Bayley Scales of Infant Development III Composite Motor Score		Vineland Adaptive Behavior II Score	
Food Assistance	**Total, n (%)**	**Mean (SD)**	***P***	**Mean (SD)**	***P***	**Mean (SD)**	***P***
Enrollment in the Supplemental Nutrition Program for Women, Infant and Children (WIC)							
Yes	52 (73)	90 (17)	0.14	82 (21)	0.35	82 (15)	.20
No	19 (27)	84 (18)		77 (24)		77 (17)	
Enrollment in the Supplemental Nutrition Assistance Program (SNAP)							
Yes	17 (24)	94 (19)	0.09	87 (22)	0.07	82 (15)	.51
No	54 (76)	87 (17)		80 (21)		80 (16)	
Enrollment in WIC and SNAP							
Yes	15 (29)	90 (17)	0.20	81 (21)	0.67	81 (15)	.30
No	37 (71)	84 (18)		79 (24)		77 (17)	