RESEARCH

Research Brief

Prenatal WIC Is Associated with Increased Birth Weight of Infants Born in the United States with Immigrant Mothers

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ABSTRACT

Background The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) improves health outcomes for participating mothers and children. Recent immigration policy changes increased chilling effects on WIC access and utilization. Associations between WIC participation and neonatal outcomes among infants born to immigrant parents—23% of all births in the United States—are understudied.
Objective Our aim was to examine relationships between prenatal participation in WIC and birth weight among infants of income-eligible immigrant mothers.
Design The study design was repeat cross-sectional in-person surveys.
Participants/setting Participants were 9,083 immigrant mothers of publicly insured or uninsured US-born children younger than 48 months accessing emergency departments or primary care in Baltimore, MD; Boston, MA; Little Rock, AR; Minneapolis, MN; and Philadelphia, PA interviewed from 2007 through 2017.
Main outcome measures Outcomes were mean birth weight (in grams) and low birth weight (<2,500 g).
Statistical analyses Multivariable linear regression assessed associations between prenatal WIC participation and mean birth weight; multivariable logistic regression examined association between prenatal WIC participation and low birth weight.
Results Most of the immigrant mothers (84.6%) reported prenatal WIC participation. Maternal ethnicities were as follows: 67.4% were Latina, 27.0% were Black non-Latina, 2.2% were White non-Latina, and 3.5% were other/multiple races non-Latina. Infants of prenatal WIC-participant immigrant mothers had higher adjusted mean birth weight (3,231.1 g vs 3,149.8 g; $P < .001$) and lower adjusted odds of low birth weight (adjusted odds ratio 0.79, 95% CI 0.65 to 0.97; $P = .02$) compared with infants of nonparticipants. Associations were similar among groups when stratified by mother's length of stay in United States.
Conclusions Prenatal WIC participation for income-eligible immigrant mothers is associated with healthier birth weights among infants born in the United States, including for those who arrived most recently.
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INFANT BIRTH WEIGHT IS AN IMPORTANT INDICATOR OF maternal prenatal health and a predictor of children's future health and development.[1,2] Infants with low birth weight (LBW, <2,500 g) have significantly longer hospitalizations after birth and accrue higher perinatal health care costs compared with infants with birth weight ≥2,500 g. Children with LBW are at increased risk for mortality and morbidity, including developmental delays, cerebral palsy, blindness, deafness, and hydrocephaly.[3] LBW is also associated with multiple chronic adult medical conditions.[3-6] Ongoing treatment for adverse conditions associated with LBW contribute to high educational and health costs over time,[7] particularly for children with the lowest birth weights. For commercially insured infants born with LBW in 2016, the 6-month after-birth costs averaged $114,437 per infant compared with $6,743 for infants with normal birth weight.[8] Medicaid finances nearly one-half of all births in the United States. Analyses of Medicaid spending for complicated newborn hospital stays demonstrated increasing costs over

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time.[9] Cost for infants both preterm and LBW reached more than $3.6 billion in 2009.[9]

In 2017, nearly 1 in every 4 infants born in the United States had at least 1 immigrant parent.[1,2,10] The term *immigrant* is defined broadly as people who were not US citizens at birth, including people with statuses ranging from naturalized US citizens to lawful permanent residents to refugees and asylees, and people without documentation.[11] Birth weight among infants of immigrant mothers in the United States is, on average, similar to or greater than birth weight among infants of US-born mothers.[12] However, analyses that disaggregate data found a more nuanced pattern. Compared with infants born to US-born non-Latina mothers, the risk of LBW may be higher or lower according to the mothers' region of birth.[13] In addition, other studies have found longer duration of US residence increases the risk of having infants with LBW.[14,15]

For households with income <185% of the federal poverty guidelines, the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) provides food; prenatal and child health care referrals; breastfeeding support; and nutrition education for pregnant, nursing, and postpartum women who are at nutritional risk and for their infants and young children up to age 5 years.[16,17] Eligibility is not dependent on immigration or documentation status. Mothers' participation in WIC during pregnancy is associated with healthier birth weights on average and lower rates of LBW,[18,19] particularly for Black and Latina mothers. WIC has also been shown to buffer participants against food insecurity (ie, inadequate access to enough food for all household members to lead healthy, active lives[20]) and to increase access to nutritious foods,[21] both of which may protect against multiple adverse birth outcomes, including LBW.[22] Immigrant families with young children, particularly families recently arrived in the United States, have rates of food insecurity higher than families whose members are all US-born.[23]

Centers for Disease Control and Prevention analyses have suggested that nearly 40% of all infants born in the United States are born to mothers who participated in WIC during pregnancy.[24] Since 2011, until the COVID-19 pandemic, WIC participation experienced a decline, attributed in part to improving economic conditions and falling birth rates.[25] The decline may also reflect, in recent years, increasing avoidance among immigrant families of publicly funded programs due to chilling effects caused by the Public Charge Rule, regardless of their actual eligibility based on program regulations and income.[26] There are few available data on this issue because WIC personnel neither inquire about nor record immigration status of recipients.[27] However, there is concern that declining WIC participation by income-eligible immigrant mothers may increase the prevalence of LBW among their US-born infants.[19,28]

Without data, it is not known whether previously documented benefits of WIC participation on birth outcomes[19,29] are also experienced by immigrant mothers. The goal of this study was to specifically elucidate the association of prenatal WIC participation with birth weight within US-born infants of WIC-eligible immigrant mothers.

RESEARCH SNAPSHOT

Research Question: Is prenatal participation in the Special Supplemental Nutrition Program for Women, Infants, and Children associated with higher birth weight and lower odds of low birth weight among infants born in the United States to immigrant mothers after covariate adjustment?

Key Findings: In a unique all-immigrant, 5-city sample of 9,083 mothers, prenatal Special Supplemental Nutrition Program for Women, Infants, and Children participation was associated with significantly higher adjusted mean birth weight (in grams) and significantly lower adjusted odds of low birth weight compared with infants of nonparticipants, especially among immigrant mothers with less than 5 years of US residence.

METHODS

Data were collected as part of Children's HealthWatch (www.childrenshealthwatch.org), an ongoing repeat cross-sectional survey monitoring the health and well-being of infants, toddlers, and preschoolers and their families. Caregivers of children younger than 48 months were interviewed while seeking medical care for the child in emergency departments or primary care clinics in the following 5 US cities: Baltimore, MD; Boston, MA; Little Rock, AR; Minneapolis, MN; and Philadelphia, PA. Eligibility included immigrant caregiver; consent; English, Spanish or Somali (Minneapolis only) speakers; state residency; knowledge of the child's health and household; and not interviewed previously.[16] Infants who were critically ill or injured, involved in a child maltreatment investigation, or whose caregiver was fleeing domestic violence were not approached (all based on clinicians' reports). Maternal nativity was defined by self-reported country of birth—US-born included mothers born in any US state or territory or born overseas of US-citizen parents. Immigrant was defined by all other countries of birth.

Of 50,918 caregivers approached between January 2007 and December 2017, there were 37,632 (73.9%) who did not meet study criteria (US-born n = 32,414, other criteria n = 5,218) and were ineligible for this analysis. To ensure comparable household incomes between exposure groups, the current analysis included only children with public or no health insurance as a marker of potential income eligibility for WIC.[16] Therefore, children with private insurance were excluded (n = 684), as well as those who had missing WIC participation data (n = 155), leaving a final study sample of 9,083 immigrant mother and US-born child pairs (Figure) who provided informed consent. Institutional Review Board approval was obtained at each of the 5 study sites before data collection and was renewed annually.

Measures

The independent variable was mothers' report of participation in WIC during pregnancy with the index child, whether or not they participated in WIC postpartum. Participants were categorized into the following 2 groups: no prenatal WIC participation (reference group) and prenatal WIC participation group, which included mothers who participated in WIC at any point in their pregnancy. Maternal race and ethnicity were self-identified using questions from the US Census asking separately about Latina and Hispanic

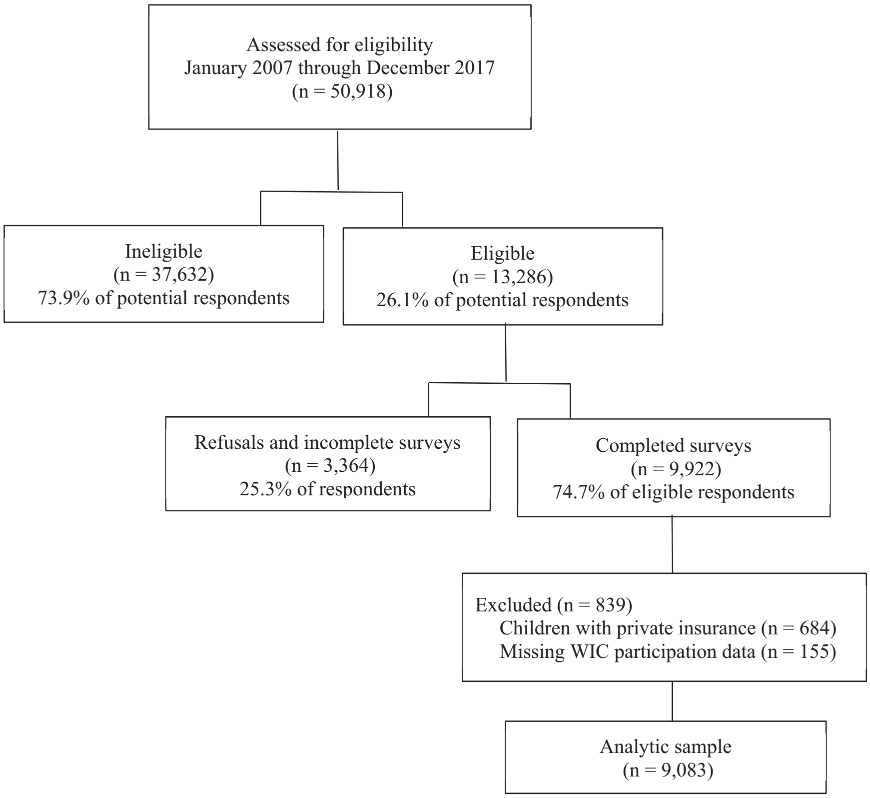

Figure. Study sample selection diagram of prenatal participation in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) among immigrant mothers with US-born children (Children's HealthWatch data).

heritage and race. Answers were combined into the following categories: Latina—all races, Black—non-Latina, White—non-Latina, and other/multiple races—non-Latina, which was composed of multiple races or groups too small in this sample to analyze independently (Asian and Native American). Immigrant mothers' length of stay in the United States was ascertained by asking in what year they arrived in the United States and calculating the total number of years from date of interview—categorized in analysis as <5 years and ≥5 years length of stay in United States. Potential covariates were identified based on prior associations with WIC participation and/or birth weight (further described below in Statistical Techniques). The outcome variable was birth weight in grams, ascertained by maternal report. Birth-weight outliers, as defined by the Centers for Disease Control and Prevention's Pediatric Nutrition Surveillance System,[30] for biologically implausible values were verified by medical record review when available. A binary indicator of LBW (<2,500 g) vs birth weight (≥2,500 g) was also examined.

Statistical Techniques

Descriptive statistics included mothers' demographic characteristics, smoking history, and birth outcomes for the overall sample and stratified by prenatal WIC participation. Bivariate associations were assessed using χ^2 analyses or Student *t* test, as appropriate. Covariates for final models were selected based on significant association with WIC participation or birth weight (ie, study site, mothers' race and ethnicity, marital status, education, employment, length of stay in the United States, and age) or chosen *a priori* (eg, smoking during pregnancy). Multivariable linear regression analyses adjusting for all covariates assessed the association between prenatal WIC participation and the continuous measure of birth weight in grams. To evaluate associations between mothers' prenatal WIC participation and the dichotomous measure of LBW, multivariable logistic regression analyses were conducted, adjusting for the same covariates. Adjusted means and standard errors are reported for linear regression models, and adjusted odds ratios (AOR) and 95% CIs are reported for the logistic regression model. All analyses were conducted using 2-sided tests and a significance level of .05. Sensitivity analyses examined associations with WIC participation by maternal US length of stay, and interaction terms tested whether associations with WIC participation varied by maternal US length of stay. Statistical analyses were performed using SAS software, version 9.4.[31]

RESULTS

Table 1 depicts the sociodemographic characteristics of the study sample, stratified by prenatal WIC participation. Of the total sample of 9,083 immigrant mothers, 84.6% (n = 7,686) reported WIC participation during pregnancy with the index child. More than 80% of the total sample of mothers were from the following countries and regions of origin: Mexico, West Indies and Caribbean, Africa, and Central and South America. In the prenatal WIC participation group compared with the no prenatal WIC participation group, there was a significantly greater proportion of Latina mothers ($P < .001$), approximately equal proportions of Black/African diaspora

Table 1. Demographic characteristics of 9,083 mother—child pairs comprising immigrant mothers and US-born children stratified by maternal prenatal participation in WIC[a] (Children's HealthWatch data from January 1, 2007 to December 31, 2017)

Variable[b]	Overall	No prenatal WIC participation	Prenatal WIC participation	*P* value
Total, n (%)	9,083 (100)	1,397 (15.4)	7,686 (84.6)	—
Site, n (%)				<.001
Baltimore, MD	193 (2)	62 (4)	131 (2)	
Boston, MA	3,174 (34.9)	393 (28.1)	2,781 (36.2)	
Little Rock, AR	995 (11.0)	237 (17.0)	758 (9.9)	
Minneapolis, MN	3,851 (42.4)	546 (39.1)	3,305 (43.0)	
Philadelphia, PA	870 (9.6)	159 (11.4)	711 (9.3)	
Child sex, n (%)				.54
Female	4,242 (46.7)	642 (46.0)	3,600 (46.8)	
Male	4,841 (53.3)	755 (54.0)	4,086 (53.2)	
Child age at interview, mo				<.001
Mean ± standard deviation	13.5 (12.6)	14.8 (13.8)	13.3 (12.3)	
Median (25th, 75th)	9.9 (3, 21)	10.9 (2, 24)	9.8 (3, 21)	
Child gestational age at birth, n (%)				.11
<34 wk	335 (3.7)	64 (4.6)	271 (3.5)	
34-36 wk	602 (6.7)	97 (7.0)	505 (6.6)	
≥37 wk	8,084 (89.6)	1217 (88.3)	6,867 (89.8)	
Mother race and ethnicity, n (%)				<.001
Latina	6,076 (67.4)	841 (60.9)	5,235 (68.6)	
Black, non-Latina	2,429 (27.0)	381 (27.6)	2,048 (26.8)	
White, non-Latina	194 (2.2)	54 (3.9)	140 (1.8)	
Other/multiple races, non-Latina	312 (3.5)	104 (8)	208 (2.7)	
Mother country/region of origin, n (%)				<.0001
Mexico	3,230 (36.0)	503 (36.9)	2,727 (35.8)	
West Indies and Caribbean	1,696 (18.9)	199 (14.6)	1,497 (19.7)	
Africa	1,550 (17.3)	270 (19.8)	1,281 (16.8)	
Central America	1,265 (14.1)	146 (10.7)	1,119 (14.7)	
South America	858 (9.5)	121 (8.9)	737 (9.7)	
Asia	177 (2.0)	75 (5.5)	102 (1.3)	
Europe	156 (1.7)	38 (2.8)	118 (1.6)	
Middle East	38 (0.4)	12 (0.9)	26 (0.3)	
Married/partnered, n (%)				.002
Yes	5,425 (59.9)	886 (63.5)	4,539 (59.2)	
Mother education, n (%)				<.001
Some high school or less	3,539 (39.3)	471 (34.0)	3,068 (40.2)	
High school graduate	3,331 (36.9)	457 (33.0)	2,874 (37.7)	
Technical school/college graduate	2,146 (23.6)	458 (33.0)	1,688 (22.1)	
Mother's age, y				.24
Mean ± standard deviation	29.5 (6.1)	29.7 (6.2)	29.5 (6.0)	
Median (25th, 75th)	29.0 (25, 34)	29.0 (25, 34)	29.0 (25, 34)	

(*continued on next page*)

Table 1. Demographic characteristics of 9,083 mother—child pairs comprising immigrant mothers and US-born children stratified by maternal prenatal participation in WIC[a] (Children's HealthWatch data from January 1, 2007 to December 31, 2017) (*continued*)

Variable[b]	Overall	No prenatal WIC participation	Prenatal WIC participation	*P* value
Mother employment, n (%)				.62
Yes	3,271 (36.0)	495 (35.5)	2,776 (36.2)	
Language, n (%)				<.001
English	3,809 (41.9)	672 (48.1)	3,137 (40.8)	
Spanish	5,149 (56.7)	708 (50.7)	4,441 (57.8)	
Somali	125 (1)	17 (1)	108 (1)	
Smoking during pregnancy,[c] n (%)				.02
No	7,738	1,180 (99.2)	6,558 (99.7)	
Yes	30	10 (0.8)	20 (0.3)	
Length of stay in United States				<.001
<5 y	1,683 (18.5)	378 (32.5)	1,305 (19.3)	
5-10 y	3,251 (35.8)	390 (33.5)	2,861 (42.4)	
>10 y	2,983 (32.8)	395 (34.0)	2,588 (38.3)	

[a]WIC = the Special Supplemental Nutrition Program for Women, Infants and Children.
[b]Analyses conducted using χ^2 and Student *t* tests, as appropriate.
[c]The sample size for this question is smaller (n = 7,768) because it was included in the survey starting in October 2007.

mothers, and fewer non-Latina White mothers and mothers of other races and ethnicities. Compared with the prenatal WIC participation group, the no prenatal WIC participation group was more likely to be married or partnered (59.2% vs 63.5%; *P* = .002) and have education beyond high school (22.1% vs 33.0; *P* < .001). Mothers in the no prenatal WIC participation group were more likely than mothers in the prenatal WIC participation group to acknowledge smoking cigarettes during the index pregnancy (0.7% vs 0.3%; *P* = .02), although the overall prevalence of acknowledged cigarette smoking was low. A greater proportion of the no prenatal WIC participation group than the prenatal WIC participation group had been in the United States for less than 5 years. Children in the prenatal WIC participation group were younger than those in the no prenatal WIC participation group (13.3 vs 14.8 months). There were no statistically significant differences between groups for category of infants' prematurity (ie, preterm, late preterm, and term) according to mothers' report. There were no group differences in mean maternal age (29.5 ± 6.1 years) or employment at the time of interview (36% were employed).

In bivariate analyses, mean birth weight was lower among the no prenatal WIC participation compared with the prenatal WIC participation group (3,139.5 vs 3,234.9 g; *P* < .001). Prevalence of LBW was 13.1% among the no prenatal WIC participation group and 10.1% among the prenatal WIC participation group (*P* = .001) (Table 2).

After controlling for covariates, adjusted mean infant birth weight was 81.3 g higher in the prenatal WIC participation group (*P* < .001) than the no prenatal WIC participation group. (Table 3). Adjusted logistic regression analysis demonstrated that prenatal WIC participation was associated with lower adjusted odds of LBW (AOR 0.79; 95% CI 0.65 to 0.97; *P* = .02) compared with no prenatal WIC participation (Table 4).

In sensitivity analyses, no significant interaction was found between length of stay and prenatal WIC participation (*P* = .66), indicating that the associations between WIC participation and birth weight/LBW are similar for immigrants regardless of their time in the United States. In analyses stratified by maternal US length of stay, among immigrant mothers with less than 5 years in the United States, mean infant birth weights were significantly higher in the prenatal WIC participation group (3,219.4 vs 3,106.5 g; *P* < .001) (Table 5; available at www.jandonline.org) and had lower odds of being born with LBW (AOR 0.63; 95% CI 0.43 to 0.90; *P* = .01) compared with the no prenatal WIC participation group (Table 6; available at www.jandonline.org). Among immigrant mothers with 5 years or more in the United States, mean infant birth weights were significantly higher in the prenatal WIC participation group (3,234.9 vs 3,161.9 g; *P* < .001) compared with the no prenatal WIC participation group (Table 7; available at www.jandonline.org). The adjusted odds for LBW were in the expected direction, but not statistically significant (AOR 0.86; 95% CI 0.68 to 1.10; *P* = .23) (Table 8; available at www.jandonline.org).

DISCUSSION

Among a diverse sample of immigrant mothers, infants of mothers who participated in WIC prenatally had higher birth weights and lower odds of LBW compared with infants of mothers who did not participate in WIC prenatally. Stratified analyses by length of stay demonstrated a strong association for immigrant mothers present in the United States for a shorter period (less than 5 years), and the nonsignificant

Table 2. Unadjusted birth weight outcomes stratified by maternal prenatal participation in WIC[a] among 9,083 US-born infants of immigrant mothers (Children's HealthWatch data from January 1, 2007 to December 31, 2017)

Variable[b]	Overall	No prenatal WIC participation	Prenatal WIC participation	*P* value
Total, n (%)	9,083 (100)	1,397 (15.4)	7,686 (84.6)	—
Birth weight (g)				<.001
Mean ± standard deviation	3,220.5 ± 656.5	3,139.5 ± 691.3	3,234.9 ± 649.1	
Median (25th, 75th)	3,260.3 (2,892, 3,629)	3,175.2 (2,835, 3,572)	3,288.6 (2,920, 3,629)	
Low birth weight (<2,500 g), n (%)				.001
No	7,839 (89.4)	1151 (86.9)	6,688 (89.9)	
Yes	927 (10.6)	173 (13.1)	754 (10.1)	

[a]WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.
[b]Analyses conducted using χ^2 and Student *t* tests, as appropriate.

interaction term suggested that the association is similar for both those with shorter and longer stays and confirmed the beneficial association among mothers with shorter lengths of stay. This finding is in line with other studies focused on a variety of outcomes among more recently arrived immigrants.[23,32,33]

WIC does not record or report the immigration status of participating mothers. Therefore, the study sample, recruited postnatally in non-WIC health care settings, presents a unique opportunity to examine differences by prenatal WIC participation in birth weight among infants born to immigrant mothers using information not available from administrative data sources. Findings are in line with a robust body of evidence demonstrating WIC's positive effect on birth weight in the US maternity population overall, regardless of mothers' country of birth.[19,34]

Although research has consistently documented a "Healthy Immigrant Effect" and protective factors associated with lower risk of LBW among immigrant mothers, the present study's findings demonstrate that WIC may further support healthy birth weights among infants of immigrant mothers. The extension beyond the reduction of LBW risk may not only buffer infants from other hardships rooted in poverty, including stress and food insecurity, that WIC has been found to mitigate, but may also promote infants' long-term health and well-being.[1,2,13,15,16,35] From a population perspective, the additional 81.3 g in birth weight among infants of immigrant mothers who participated in prenatal WIC alter the distribution of birth weight toward healthy areas and could have significant positive implications for neonatal health and long-term well-being. Combined with the existing evidence base on the high cost to society of LBW and the cost savings associated with WIC, this study's findings imply that ensuring eligibility for WIC and supporting prenatal WIC access through culturally sensitive outreach and streamlined processes would benefit both immigrant women and their US-born infants, as well as society at large.[36]

Furthermore, as noted, although WIC eligibility is not dependent on immigration status or documentation, other federal assistance programs in the United States require immigrants with eligible status to reside in the United States for at least 5 years before they are able to access support. Notably, SNAP (Supplemental Nutrition Assistance Program)—the nation's largest nutrition program—bars participation in the first 5 years in the United States for certain immigrants who would otherwise be eligible. The significant, positive birth-weight findings associated with WIC participation among recently arrived immigrants in this study suggest the importance of nutrition support and eliminating barriers to participation for these immigrants in particular.[37]

Positive birth-weight outcomes and WIC participation among households with at least 1 immigrant member may be constrained by the sociopolitical climate. Reports from scientists and news publications raise alarms that sociopolitical stressors precipitated by anti-immigrant rhetoric and fear of deportation may adversely affect birth outcomes on a population level, particularly among immigrant and Latina mothers.[38] In addition to these stressors, recent decreased participation in public health care and nutrition programs, predating the COVID-19 pandemic, by immigrant mothers and those from households with immigrant members may contribute to a higher risk of adverse birth outcomes.[39,40] Further research is needed to assess whether COVID-19 pandemic and relief measures beyond WIC that excluded immigrants may have further intensified this risk,[41,42] despite efforts by federal and state WIC administrators to reach all income-eligible women.[43]

Important sources of sociopolitical stress predating the pandemic include not only hostile rhetoric, but also increasing enforcement of immigration law and changes in regulations related to "public charge."[44] *Public charge* is a term that has been used in US immigration law since the late 1990s and signifies that a person is likely to become dependent on public benefits in the future.[45] Before 2019, only cash benefits and long-term government-funded care were relevant to this determination; changes to regulation enacted between 2019 and 2020 added publicly funded health care, housing subsidies, and SNAP to the list.[46,47] The possibility of becoming a public charge is used to determine whether immigrants may enter or re-enter the United States and whether those already here may adjust their status to lawful permanent resident, a common pathway to citizenship.[27] Although WIC was not included in the final public charge rule, scientists, health care providers, nutrition and public health experts, and the Department of Homeland Security

Table 3. Adjusted mean birth weight among 9,083 mother—child pairs composed of US-born children of immigrant mothers comparing those with and without prenatal WIC[a] participation (Children's HealthWatch data from January 1, 2007 to December 31, 2017)

Continuous outcome: birth weight (g)[b]	No prenatal WIC[b] participation
No prenatal WIC[b] participation, total n (%)	1,397 (15.4)
Prenatal WIC participation, total n (%)	7,686 (84.6)
No prenatal WIC participation	
Adjusted mean***	3,149.8
SEM[c]	20.1
Prenatal WIC participation	
Adjusted mean***	3,231.1
SEM	8.1
	Birth weight (g), β (95% CI); standard error
No prenatal WIC participation	Reference
Prenatal WIC participation **	81.37 (38.62 to 124.11); 21.81
Site	
Baltimore, MD	Reference
Boston, MA**	193.02 (82.96 to 303.08); 56.14
Little Rock, AR**	181.92 (64.13 to 299.71); 60.09
Minneapolis, MN**	199.52 (87.31 to 311.73); 57.24
Philadelphia, PA***	196.07 (78.25 to 313.88); 60.10
Mother's race/ethnicity	
Hispanic	Reference
Black, non-Hispanic	−37.53 (−76.71 to 1.65); 19.99
White, non-Hispanic	67.62 (−36.19 to 171.42); 52.95
Other*	−97.63 (−185.18 to −10.07); 44.66
Mother's marital status	
Married	2.82 (−28.23 to 33.87); 15.84
Mother's education	
Less than high school	Reference
High school	−9.63 (−43.89 to 24.63); 17.47
Technical school/college	−18.72 (−62.18 to 24.75); 22.17
Mother's employment	
Employed**	57.47 (24.60 to 90.33); 16.77
Smoking during pregnancy	
No smoking	Reference
Smoked during pregnancy	−158.14 (−411.00 to 94.72); 128.99
Length of stay in United States	
<5 y	Reference
5-10 y	21.3 (−19.08 to 61.70); 20.60
>10 y	−5.00 (−47.03 to 37.02); 21.44
Mother's age*	3.30 (0.74 to 5.86); 1.31

[a]WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.
[b]Analyses conducted using multivariable linear regression; adjusted for site, mother's race/ethnicity, marital status, education, employment, smoking during pregnancy, length of stay in United States, and age.
[c]SEM = standard error of the mean.
*$P < .05$.
**$P < .01$.
***$P < .001$.

Table 4. Adjusted odds of low birth weight among 9,083 mother–child pairs composed of US-born children of immigrant mothers comparing those with and without prenatal WIC[a] participation (Children's HealthWatch data: January 1, 2007, to December 31, 2017)

Variable	Low birth weight (<2,500 g), Adjusted odds ratio (95% CI)
No prenatal WIC participation[b]	Reference
Prenatal WIC participation*	0.79 (0.65-0.97)
Site	
Baltimore, MD	Reference
Boston, MA**	0.46 (0.30-0.70)
Little Rock, AR***	0.44 (0.28-0.71)
Minneapolis, MN***	0.47 (0.31-0.73)
Philadelphia, PA*	0.47 (0.29-0.75)
Mother's race/ethnicity	
Hispanic	Reference
Black, non-Hispanic*	1.21 (1.00-1.47)
White, non-Hispanic	1.03 (0.62-1.71)
Other	1.08 (0.71-1.64)
Mother's marital status	
Married	0.99 (0.85-1.17)
Mother's education	
Less than high school	Reference
High school	1.11 (0.93-1.32)
Technical school/college	1.13 (0.91-1.40)
Mother's employment	
Employed**	0.78 (0.66-0.92)
Smoking during pregnancy	
No smoking during pregnancy	Reference
Smoking during pregnancy	1.03 (0.31-3.49)
Length of stay in United States	
$<$ 5 y	Reference
5-10 y	0.91 (0.75-1.12)
$>$10 y	1.00 (0.81-1.23)
Mother's age*	1.02 (1.00-1.03)

[a]WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.
[b]Analyses conducted using multivariable logistic regression; adjusted for site, mother's race and ethnicity, marital status, education, employment, smoking during pregnancy, length of stay in United States, and age.
*$P < .05$.
**$P < .01$.
***$P < .001$.

itself raised concerns about the expected adverse health impacts of these changes in regulation—especially given months of uncertainty and concern while the rule change was being drafted.[48]

Several studies have found that immigrants, regardless of whether or not they are actually subject to public charge determination, report fear of being deemed a public charge as the reason for avoiding participation in public programs, even programs that do not impact their immigration status, such as WIC and prenatal care.[26,27] This phenomenon is known as the "chilling effect."[44] At least 1 study demonstrated a measurable decline in WIC participation among children as a result of the public charge rule change announcement.[27] Another found that fear of deportation is associated with decreased WIC participation among mixed immigration status families, especially families of Mexican origin.[40] In contrast, another study showed citizen children of mothers who were likely eligible for DACA (Deferred Action for Childhood Arrivals) and thus at decreased risk of deportation, were more likely to participate in WIC than children born to mothers not protected by DACA.[49] Although the public charge rule was suspended during the COVID-19 pandemic and the change was vacated in March 2021,[50] the chilling effect continues.[51]

This study has multiple strengths. The unique multisite, multi-ethnic, multilingual hard-to-reach sample of immigrant mothers with infants provides an opportunity to examine the role of WIC among a group not possible to identify with administrative datasets. There are also several limitations to this study. Shared method variance is potentially an issue, given that mothers reported prenatal WIC participation, infant birth weight, and some of the covariates. There is also the potential of random reporting error for the mothers' report of birth weight, although maternal recall of birth weight has been shown to be accurate, particularly during the first years of life.[52,53] Since 2 of our study sites were children's hospitals that did not have maternity records, birth weight in the medical records was available inconsistently to the authors' research group. Although gestational age at time of initiating WIC participation could potentially be related to low birth weight, it does not apply in this analysis because the main exposure variable—prenatal WIC participation—was a dichotomous indicator for pregnancy as a whole. Duration and time of initiation of prenatal WIC participation were not documented; longer duration of prenatal WIC participation has been associated with better outcomes.[54] Social desirability bias could be present if mothers were reluctant to report that they participated in WIC, resulting in underreporting of WIC participation. Future research could assess a dose–response relationship between prenatal WIC participation and birth weight among infants of immigrant mothers. Although the sample is racially and geographically diverse, it is neither random nor nationally representative and therefore caution is recommended in generalizing the results to other immigrant populations. Information is not available about women whose sole language proficiency was not English, Spanish, or Somali. Information on mothers' specific immigration status (eg, permanent resident, refugee, or undocumented) was not available. Exclusion of children with severe illness, injuries, or children with concerns for maltreatment may have influenced the results because LBW is associated with increased risk for these conditions. These exclusion criteria might have altered the estimate of prenatal WIC participation on birth weight. Although important confounding effects were statistically controlled, there may be other unmeasured confounders. For example, although other substances used during pregnancy have been associated with LBW and prematurity, the survey includes questions about prenatal tobacco exposure only.[55] The increased odds of LBW among infants of mothers not participating in WIC were robust after controlling for mothers' recall of smoking. Smoking rates during pregnancy were lower than the national average of 7.5% in both WIC participants and nonparticipants in this entirely immigrant sample, consistent with national data regarding differences in health habits during pregnancy among immigrant and US-born mothers.

Contemporaneous measures about mothers' stress or health habits or food security in mothers' households were not available during the index pregnancy, prohibiting us from investigating these mechanisms that may underlie the positive WIC association on birth weight among US-born infants of immigrants. This topic may be the focus of future research, but even in the absence of delineation of mechanisms, the clinical and public policy implications are clear: immigrant mothers' prenatal participation in WIC is associated with higher birth weights and lower rates of LBW among their US-born infants. Thus, it is important to not only protect the right to WIC participation among immigrant mothers, but also to promote it.[40,56] In particular, WIC outreach and advocacy sensitive to political and social context are vital to maternal and child health. Concrete actions to support WIC participation include enhancing online and remote access and certification[57]—implemented successfully during the COVID-19 pandemic—and advocacy at the state and federal policy levels to ensure that WIC remains accessible to all pregnant women who meet income and nutritional risk eligibility criteria, regardless of immigration status. Given the strong body of research on health care costs of LBW, facilitating prenatal WIC participation, especially for recent immigrants, may lead to substantial national health care cost savings.[8]

CONCLUSIONS

Given this study's findings of higher birth weights and lower odds of LBW associated with prenatal WIC participation, particularly among infants of immigrant mothers living in the United States for less than 5 years, nutrition and public health professionals, health care advocates, obstetricians and gynecologists, pediatricians, and policy makers should work to remove barriers to WIC participation. Future research could examine effects of WIC participation among immigrants during the COVID-19 pandemic and how best to deliver culturally sensitive outreach to low-income and marginalized immigrant communities to support prenatal WIC participation for better birth outcomes.

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

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AUTHOR CONTRIBUTIONS

D. A. Frank, M. Mbamalu, and S. Ettinger de Cuba conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the manuscript. A. Bovell-Ammon provided policy expertise, assisted in drafting the manuscript, and critically reviewed the manuscript for important intellectual content. S. M. Coleman and L. J. Rateau conducted the data analysis and reviewed and revised the manuscript for important intellectual content. T. C. Heeren oversaw the design and methods and reviewed and revised the manuscript for important intellectual content. D. B. Cutts, M. M. Black, E. R. Ochoa Jr, M. Sandel, and F. Lê-Scherban supervised data collection and critically reviewed the manuscript for important intellectual content. A. Poblacion provided clinical expertise and critically reviewed the manuscript for important intellectual content. C. Bruce managed data collection and critically reviewed the manuscript for important intellectual content. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Table 5. Adjusted mean birth weight among 1,683 mother−child pairs composed of US-born children of immigrant mothers living in the United States for <5 years comparing those with and without prenatal WIC[a] participation (Children's HealthWatch data: January 1, 2007 to December 31, 2017)

Continuous outcome: birth weight (g)[b]	No prenatal WIC[b] participation	Prenatal WIC participation
Total, n (%)	378 (22.5)	1,305 (77.5)
Adjusted mean (standard error of mean)**	3,106.5 (37.7)	3,219.4 (19.5)
	Birth weight (g), β (95% CI)	**Standard error**
No prenatal WIC[b] participation	Reference	—
Prenatal WIC participation**	112.89 (28.75 to 197.04)	42.89
Site		
Baltimore, MD	Reference	—
Boston, MA	65.50 (−199.97 to 330.97)	135.34
Little Rock, AR	94.26 (−189.95 to 378.48)	144.89
Minneapolis, MN	30.35 (−238.68 to 299.39)	137.16
Philadelphia, PA	168.89 (−120.08 to 457.86)	147.32
Mother's race/ethnicity		
Hispanic	Reference	—
Black, non-Hispanic	31.63 (−53.54 to 116.81)	43.42
White, non-Hispanic	83.95 (−167.15 to 335.05)	128.01
Other	−101.09 (−304.28 to 102.10)	103.59
Mother's marital status		
Married	21.39 (−52.07 to 94.85)	37.45
Mother's education		
Less than high school	Reference	—
High school	0.21 (−79.94 to 80.35)	40.86
Technical school/college	−4.10 (−98.77 to 90.57)	48.26
Mother's employment		
Employed	48.30 (−31.96 to 128.55)	40.91
Smoking during pregnancy		
No smoking	Reference	—
Smoked during pregnancy	−228.61 (−1,181.73 to 724.51)	485.91
Mother's age	3.27 (−2.80 to 9.34)	3.09

[a]WIC = Special Supplemental Nutrition Program for Women, Infants and Children

[b]Analyses conducted using multivariable linear regression; adjusted for site, mother's race/ethnicity, marital status, education, employment, smoking during pregnancy, and age.

**$P < .01$.

***$P < .001$.

Table 6. Adjusted odds of low birth weight among 1,683 mother−child pairs composed of US-born children of immigrant mothers living in the us for <5 years comparing those with and without prenatal WIC[a] participation (Children's HealthWatch data: January 1, 2007, to December 31, 2017)

Variable	Low birth weight (<2,500 g), adjusted odds ratio (95% CI)
No prenatal WIC participation[b]	Reference
Prenatal WIC participation[* and **]	0.63 (0.43-0.90)
Site	
Baltimore, MD	Reference
Boston, MA	0.60 (0.21-1.68)
Little Rock, AR	0.53 (0.17-1.68)
Minneapolis, MN	0.73 (0.26-2.08)
Philadelphia, PA	0.47 (0.14-1.56)
Mother's race/ethnicity	
Hispanic	Reference
Black, non-Hispanic	1.02 (0.68-1.53)
White, non-Hispanic	1.47 (0.53-4.10)
Other	0.92 (0.34-2.46)
Mother's marital status	
Married	0.99 (0.70-1.40)
Mother's education	
Less than high school	Reference
High school	1.01 (0.69-1.48)
Technical school/college	0.96 (0.61-1.50)
Mother's employment	
Employed	0.80 (0.54-1.19)
Smoking during pregnancy[c]	
No smoking during pregnancy	Reference
Smoking during pregnancy	Undefined
Mother's age	1.03 (1.00-1.05)

[a]WIC = Special Supplemental Nutrition Program for Women, Infants and Children.
[b]Analyses conducted using multivariable logistic regression; adjusted for site, mother's race/ethnicity, marital status, education, employment, and age.
[c]Insufficient sample size when stratified to include as covariate.
*$P < .05$,
**$P < .01$.

Table 7. Adjusted mean birth weight among 6,234 mother–child pairs composed of US-born children of immigrant mothers living in the United States for ≥5 years comparing those with and without prenatal WIC[a] participation (Children's HealthWatch data: January 1, 2007, to December 31, 2017)

Continuous outcome: birth weight (g)[b]	No prenatal WIC[b] participation	Prenatal WIC participation
Total, n (%)	785 (12.6)	5,449 (87.4)
Adjusted mean (standard error of mean)***	3,161.9 (23.8)	3,234.9 (8.9)
Variable	**Body weight (g), β (95% CI)**	**Standard error**
No prenatal WIC participation	Reference	—
Prenatal WIC participation**	73.00 (22.99 to 123.01)	25.51
Site		
Baltimore, MD	Reference	—
Boston, MA***	229.17 (108.43 to 349.92)	61.59
Little Rock, AR**	206.10 (76.89 to 335.30)	65.91
Minneapolis, MN***	244.24 (120.96 to 367.52)	62.88
Philadelphia, PA**	208.49 (79.66 to 337.32)	65.72
Mother's race/ethnicity		
Hispanic	Reference	—
Black, non-Hispanic*	−56.56 (−101.02 to −12.10)	22.68
White, non-Hispanic	65.34 (−48.67 to 179.35)	58.16
Other*	−103.22 (−200.34 to −6.10)	49.54
Mother's marital status		
Married	−1.92 (−36.14 to 32.31)	17.46
Mother's education		
Less than high school	Reference	—
High school	−13.78 (−51.72 to 24.16)	19.35
Technical school/college	−24.76 (−73.94 to 24.42)	25.09
Mother's employment		
Employed***	61.98 (25.81 to 98.14)	18.45
Smoking during pregnancy		
No smoking	Reference	—
Smoked during pregnancy	−151.62 (−411.80 to 108.55)	132.72
Mother's age	2.38 (−0.42 to 5.18)	1.43

[a]WIC = Special Supplemental Nutrition Program for Women, Infants and Children.
[b]Analyses conducted using multivariable linear regression; adjusted for site, mother's race/ethnicity, marital status, education, employment, smoking during pregnancy, and age.
*$P < .05$.
**$P < .01$.
***$P < .001$.

Table 8. Adjusted odds of low birth weight among 6,234 mother–child pairs composed of US-born children of immigrant mothers living in the United States for ≥5 years comparing those with and without prenatal WIC[a] Participation (Children's HealthWatch data: January 1, 2007, to December 31, 2017)

Variable	Low birth weight (<2,500 g), adjusted odds ratio (95% CI)
No prenatal WIC participation[b]	Reference
Prenatal WIC participation	0.86 (0.68-1.10)
Site	
Baltimore, MD	Reference
Boston, MA***	0.43 (0.27-0.68)
Little Rock, AR***	0.42 (0.25-0.70)
Minneapolis, MN***	0.42 (0.26-0.67)
Philadelphia, PA**	0.46 (0.27-0.76)
Mother's race/ethnicity	
Hispanic	Reference
Black, non-Hispanic	1.26 (1.01-1.56)
White, non-Hispanic	0.93 (0.52-1.67)
Other	1.14 (0.71-1.81)
Mother's marital status	
Married	1.00 (0.84-1.19)
Mother's education	
Less than high school	Reference
High school	1.14 (0.93-1.39)
Technical school/college	1.18 (0.92-1.51)
Mother's employment	
Employed***	0.77 (0.64-0.93)
Smoking during pregnancy	
No smoking during pregnancy	Reference
Smoking during pregnancy	1.18 (0.35-4.03)
Mother's age*	1.02 (1.00-1.03)

[a]WIC = Special Supplemental Nutrition Program for Women, Infants and Children.
[b]Analyses conducted using multivariable logistic regression; adjusted for site, mother's race and ethnicity, marital status, education, employment, and age.
*$P < .05$.
**$P < .01$.
***$P < .001$.