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Pregnancy-related weight among immigrant and US-born mothers: The role of nativity, maternal duration of residence, and age at arrival

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Abstract

Objectives: The goals of this study were to examine the associations between nativity and pregnancy-related weight and to assess the associations between maternal duration of residence and age at arrival in the United States on pregnancy-related weight among immigrants.

Methods: Using logistic regression and data from the Early Childhood Longitudinal Study–Birth Cohort, we assessed differences in preconception weight and gestational weight gain between US-born and immigrant women (N = 7000). We then analyzed differences in both outcomes by duration of residence among immigrants (n = 1850) and examined whether the identified relationships varied by age at arrival in the United States.

Results: Compared to US-born mothers, immigrants were less likely to be classified as obese prior to pregnancy (odds ratio 0.435, 95% confidence interval, 0.321–0.590) or experience excessive gestational weight gain (odds ratio 0.757, 95% confidence interval, 0.614–0.978). Among the immigrant sub-sample, living in the United States for 10–15 years (odds ratio 2.737, 95% confidence interval, 1.459–5.134) or 16+ years was positively associated with both preconception obesity (odds ratio 2.918, 95% confidence interval, 1.322–6.439) and excessive gestational weight gain (odds ratio 1.683, 95% confidence interval, 1.012–2.797, 16+ years only). There was some evidence that the duration of residence was positively associated with preconception obesity, but only among women who had moved to the United States at age 18 years and older.

Conclusion: In sum, while immigrants are less likely than US-born mothers to experience preconception obesity or excessive gestational weight gain, these outcomes vary among the former group by duration of US residence.

Keywords

gestational weight gain, immigrants, preconception obesity

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Introduction

In the United States, more than half of all mothers are classified as overweight or obese prior to pregnancy. Furthermore, over two-thirds of pregnant women do not meet recommended clinical prenatal weight gain targets.[1,2] These patterns may have important implications for maternal and child health. For example, prior research has found that preconception obesity and excessive gestational weight gain (GWG)[3,4] are linked to adverse pregnancy

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outcomes including gestational diabetes and preterm birth.[5,6] Similarly, both underweight and inadequate GWG are associated with a greater risk of low birth weight.[7] Importantly, it is unclear whether these links are causal. Nevertheless, individual-level (e.g. clinical) interventions have largely failed to significantly impact preconception obesity or GWG, particularly among racial/ethnic minority groups and women classified as overweight or obese.[8,9] This lack of success highlights the need for additional research on how social and environmental factors shape weight outcomes among childbearing women.

One promising approach to identifying the role of social factors in shaping weight-related outcomes is to study these outcomes among immigrants (i.e. individuals born outside the United States). Immigrants are a growing demographic group in the United States; in 2017, the immigrant population (44.4 million people) made up approximately 13.6% of the overall population.[10] Upon arrival in the United States, immigrants have lower obesity rates than their US-born counterparts.[11] However, the obesity rate among immigrants tends to increase with duration of residence in the United States.[11–13] While the mechanisms underlying this pattern are not fully understood, researchers have suggested that increased duration of US residence is linked to changes in diet (e.g. increased consumption of calorie-dense foods), which can lead to weight gain over time.[13,14] Prior evidence also suggests that the timing of migration matters for the relationship between duration of residence and weight-related outcomes: the associations between obesity and duration of US residence are stronger among immigrants who arrived before adulthood than those who arrived later in the life course.[12,13,15] Differences based on the timing of migration may emerge because immigrants who migrate as children are particularly susceptible to obesity-related influences in the United States (e.g. widespread availability of energy-dense foods) during critical periods of habit formation whereas immigrants who migrate as adults have likely already established health-related habits.[13]

While there is extensive research on the links between immigrant characteristics and weight outcomes in the general population, scholars have paid comparatively less attention to parallel patterns in weight outcomes among childbearing women (i.e. pregnancy-related weight). In an exception to this general pattern, several recent studies have shown that the risk of excessive GWG varies by both nativity status[16–18] and duration of US residence.[17,19,20] For example, a study of teenage mothers in New York found that foreign-born teenagers who had resided in the United States for 10 or more years were more likely to experience excessive GWG than their counterparts who had resided in the United States for 5 or fewer years.[17] Despite the importance of these initial findings, this emerging body of research is limited because most studies rely on samples from a single US state or city[16–20] and/or focus exclusively on Hispanic populations.[18,20] Furthermore, despite increasing obesity rates among reproductive-aged women in general and childbearing women in particular,[21,22] to our knowledge, no studies have investigated whether the timing of migration is linked to GWG or preconception weight outcomes.

To address these knowledge gaps, the present study uses data from a nationally representative survey to investigate the links between maternal immigrant status, duration of US residence, age at time of arrival, and pregnancy-related weight (preconception obesity and GWG). We first examine the differences in pregnancy-related weight between US-born and immigrant mothers. Next, we assess the patterns of variation in these outcomes among immigrant mothers, specifically, whether pregnancy-related weight is associated with the duration of residence in the United States, and whether this relationship varies by age at arrival.

Methods

Data

This study uses data from the Early Childhood Longitudinal Study–Birth Cohort (ECLS-B), a longitudinal, nationally representative cohort study of infants born in 2001 (https://nces.ed.gov/ecls/birth.asp). Surveys were conducted when the children were approximately 9 months old, 2 years old, 4 years old/pre-school age, and in kindergarten. The ECLS-B oversampled Asian and Native American infants, multiple births, and infants born at low and very low birth weights. Interviewers surveyed mothers about their preconception weight, gestational weight gain, and (for immigrants) maternal age at arrival in the United States. To our knowledge, the ECLS-B is the only nationally representative survey that allows an investigation of the relationships between pregnancy-related weight, maternal immigrant status, duration of US residence, and age at time of arrival.

Sample derivation

The original eligible sample consisted of approximately 8100 US-born and immigrant mothers who gave birth to a single child in 2001. (To comply with National Center for Education Statistics confidentiality guidelines, we rounded all observations to the nearest 50.) We restricted the sample to singleton births because the Institute of Medicine's (IOM) guidelines for GWG for multiple pregnancies are based on limited data and considered "provisional."[23] We excluded several groups of women: those born in US territories, because they may be more similar to US-born women than to immigrants[24]; Native Hawaiian, American Indian, and multiracial women, due to insufficient sample sizes; mothers with missing information on place of birth and (for immigrants) age at time of arrival ($n \approx 400$); those with missing or implausible values of preconception weight, height, and GWG ($n \approx 700$); and mothers with

missing information on any independent covariates such as race/ethnicity, parity, and preconception smoking ($n < 50$). The final sample includes approximately 5150 US-born and 1850 immigrant mothers ($N \approx 7000$).

Measures

The main outcomes of interest were preconception obesity and GWG adequacy. In the first wave of the survey (when children were approximately 9 months old), interviewers queried mothers about their height and weight just prior to conception. We used this information to determine whether a mother was classified as obese (body mass index (BMI) $\geqslant 30$) and then created a categorical outcome measure of preconception weight status (obese vs not obese). We calculated GWG by subtracting maternal self-reported preconception weight from self-reported weight at the time of delivery. Subsequently, we calculated adequacy according to the 2009 IOM guidelines for GWG, which are based on preconception weight categories: underweight (28–40 pounds), normal weight (25–35 pounds), overweight (15–25 pounds), and obese (15–20 pounds).[23] To account for differences in pregnancy duration that might have influenced total GWG (e.g. preterm birth), we followed prior work, calculating the ratio of observed weight gain to expected weight gain at the time of delivery. We classified weight gain ratios below, within, and above the target range as inadequate (less than 85%), adequate (85%–122%), and excessive (greater than 122%), respectively.[25,26] Adequate weight gain serves as the reference group for analyses of inadequate and excessive weight gain, respectively.

The main explanatory variables were immigrant status, duration of US residence, and age at time of arrival. During the second-wave interview (when children were approximately 2 years old), interviewers asked mothers whether they were born in another country and, if so, how old they were when they first moved to the United States. We classified mothers as immigrants if they reported being born outside the United States. For these mothers, we calculated duration of US residence by subtracting age at time of migration from age at time of the focal child's birth. We then categorized the results using intervals similar to those used in prior research (0–4 years, 5–9 years, 10–15 years, 16 or more years).[13] Because obesity risk is higher among women who arrive in the United States prior to adulthood,[12,13] we created a dichotomous indicator of whether a mother migrated before age 18 or at age 18 or later.

We also included a set of demographic, economic, and health-related variables that prior research has shown to be associated with weight-related outcomes.[1,2,13,16,19,27] These variables included maternal race/ethnicity (non-Hispanic (NH) White, NH Black, NH Asian, Hispanic), age at child's birth, number of prior live births (0, 1, 2, 3, or more), education (less than high school, high school, some college, college graduate), poverty status (<100% of federal poverty level (FPL), 100%–129% FPL, 130%–185% FPL, and greater than 185% FPL), marital status, and region of residence (Northeast, Midwest, South, West). In regression models of preconception weight, we also included an indicator for preconception smoking (smoked 3 months prior to the beginning of pregnancy). Similarly, in regression models of GWG adequacy, we included indicators for prenatal smoking (smoked during the last 3 months of pregnancy). Because the categorization of GWG adequacy is conditional on mother's preconception weight status,[23] we followed prior studies and included preconception weight status (i.e. underweight, normal weight, overweight, obese) in models of GWG adequacy.[26,27]

Methods

The study compared pregnancy-related weight and other independent characteristics (1) between US-born and immigrant mothers and (2) among immigrants by duration of US residence and age at arrival, using t-tests and χ^2 tests for continuous and categorical variables, respectively. In addition, we used logistic regression to investigate the associations between immigration-related characteristics and weight-related outcomes. We first estimated the relationships between nativity status and pregnancy-related weight outcomes, controlling for all relevant covariates. Using the immigrant sub-sample, we then estimated the associations between pregnancy-related weight and duration of migration, first for all immigrants and then separately by age at arrival in the United States (younger than 18 years vs age 18 years and older). In each step of the analysis, we employed appropriate sampling weights to account for the sampling structure of the ECLS-B and we calculated robust standard errors to address any non-constant variance in the error terms. We used STATA 12 (StataCorp, College Station, TX) to perform all statistical analyses. Finally, this study was deemed exempt from review by the Virginia Commonwealth University Institutional Review Board (IRB) because it relied on deidentified secondary data.

The IRB did not require us to obtain informed consent because our study did not involve human subjects research.

Results

Table 1 shows that rates of preconception obesity (15.20% vs 9.80%, $p < 0.01$) and excessive GWG (56.50% vs 46.10%, $p < 0.01$) were higher among US-born mothers than immigrant mothers. In contrast, immigrants were more likely than US-born mothers to experience inadequate GWG (25.40% vs 17.90%, $p < 0.01$). Among immigrants, relative to those who moved to the United States very recently (0–4 years of residence), those with 5–9 years of residence generally had similar preconception weight outcomes while those with the longest durations of US residence (10–15 years and 16 or

Table 1. Summary statistics, immigrant and US-born sample (N = 7000) stratified by age at arrival in the United States, Early Childhood Longitudinal Study–Birth Cohort.

Variables	US-born[a]	Immigrants	Immigrants only			
			Duration of US residence, in years			
			0–4[a]	5–9	10–15	16 or more
	n = 5150	n = 1850	n = 600	n = 450	n = 350	n = 400
Pre-pregnancy weight						
Underweight	4.90	6.10	9.00	4.80**	5.90	2.90***
Normal weight	56.00	57.70	57.80	58.90	54.50	59.20
Overweight	24.00	26.40	27.50	29.60	23.00	24.30
Obese	15.20	9.80***	5.70	6.70	16.50***	13.60***
Gestational weight gain adequacy						
Inadequate	17.90	25.40***	28.10	29.00	23.00	19.30**
Adequate	25.60	28.50	30.10	29.90	28.70	24.00
Excessive	56.50	46.10***	41.80	41.00	48.30	56.70***
Duration of US residence						
0–4 years	–	34.30	100.00	–	–	–
5–9 years	–	24.20	–	100.00	–	–
10–15 years	–	20.20	–	–	100.00	–
16 or more years	–	21.30	–	–	–	100.00
Age at arrival						
18 or more years	–	60.80	89.70	73.70***	50.00***	9.80***
Race/ethnicity						
NH White	72.40	13.50***	12.60	12.10	10.70	19.00
NH Black	16.20	6.80***	7.10	5.70	6.50	7.80
Hispanic	10.90	64.80***	66.20	67.30	68.70	56.00**
NH Asian	0.50	15.00***	14.10	14.90	14.10	17.30
Maternal age (in years) (mean)[b]	27.20	27.98***	26.33	27.98***	29.21***	29.45***
Number of prior live births						
0	41.10	41.80	57.50	33.20***	30.20***	37.40***
1	34.10	30.00**	28.10	38.40***	23.30	29.80
2	16.00	17.40	8.70	17.80***	29.40***	19.50***
3 or more	8.90	10.80***	5.80	10.60	17.10***	13.30***
Maternal education						
Less than high school	14.80	33.60***	37.90	37.30	38.00	18.40
High school	31.50	31.30	31.30	34.00	28.10	31.30
Some college	26.70	15.90***	10.80	12.90	19.20	24.50***
College grad	27.00	19.10***	20.00	15.80	14.70***	25.80***
Poverty level						
<100 FPL	21.10	30.00***	40.10	29.50***	23.10***	20.80***
100%–129% FPL	9.70	18.20***	19.10	17.80	22.80	13.10***
130%–185% FPL	11.70	14.80***	11.80	19.90**	16.10	12.40
>185 FPL	57.50	37.00***	29.10	32.80	37.90***	53.70***
Number of household members	4.16	4.63***	4.50	4.65	4.97***	4.49***
Employed during pregnancy	76.30	56.10***	41.00	56.50***	63.00***	73.60***
Married	67.60	71.80**	68.50	74.80	71.70	73.90
Health behaviors						
Smoked before pregnancy	13.30	1.60***	1.50	0.40	1.50	3.20**
Smoked last 3 months of pregnancy	27.90	5.70***	3.60	3.50	8.10	9.40
Region						
West	19.60	35.10***	29.40	36.80	48.60***	29.60
Northeast	15.90	20.50**	23.40	18.00	17.10	21.80

(Continued)

Table 1. (Continued)

Variables	US-born[a]	Immigrants	Immigrants only			
			Duration of US residence, in years			
			0–4[a]	5–9	10–15	16 or more
	n = 5150	n = 1850	n = 600	n = 450	n = 350	n = 400
Midwest	25.20	11.80***	16.30	8.40***	12.00	8.30***
South	39.20	32.60**	30.90	36.80	22.20**	40.30

NH: non-Hispanic; FPL: federal poverty line. Sample sizes rounded to nearest 50. Gestational weight gain adequacy categorized using the "adequacy ratio" method that is based on the 2009 Institute of Medicine guidelines and adjusting for gestational age.
[a]Reference group for bivariate analyses of statistically significant differences among subgroups using χ^2 test.
[b]Student's t-test used for testing statistical differenecs.
**$p < 0.05$, ***$p < 0.01$.

Table 2. Summary statistics, immigrant sample (N = 1850) stratified by age at arrival in the United States, Early Childhood Longitudinal Study–Birth Cohort.

	Immigrants only	
	Age of arrival to the United States	
	0–17 years[a]	18 or more years
Observations	650	1200
Pre-pregnancy weight (%)		
Underweight	5.60	6.40
Normal weight	58.50	57.20
Overweight	23.70	28.20
Obese	12.20	8.20
Gestational weight gain adequacy (%)		
Inadequate	23.00	27.00***
Adequate	25.80	30.30***
Excessive	51.20	42.80***

NH: non-Hispanic; FPL: Federal Poverty Line. Sample sizes rounded to 50 as instructed by Department of Education. Gestational weight gain adequacy categorized using the "adequacy ratio" method that is based on the 2009 Institute of Medicine guidelines and adjusting for gestational age.
[a]Reference group for bivariate analyses of statistically significant differences among subgroups.
***$p < 0.01$.

more years) had much higher obesity rates (16.50% and 13.60%, respectively, $p < 0.01$). GWG adequacy did not differ among immigrants by duration of US residence, with one exception: Mothers who had lived in the United States for 16 or more years were less likely to have inadequate GWG (19.30%, $p < 0.05$) and more likely to have excessive GWG (56.70%, $p < 0.01$) than the most recent immigrants. Finally, the results in Table 2 show that there were no differences in preconception obesity by maternal age at time of arrival in the United States. However, mothers who arrived in the United States at age 18 or older had higher rates of both inadequate and adequate GWG and lower rates of excessive GWG than those who migrated before age 18 ($p < 0.01$).

Table 3 presents the results of regression analyses examining the associations between nativity and pregnancy-related weight after controlling for relevant demographic characteristics. Relative to US-born mothers, immigrant mothers were less likely to be classified as obese prior to conception (odds ratio (OR) 0.435, 95% confidence interval (CI), 0.321–0.590) and less likely to experience excessive GWG (OR 0.775, 95% CI, 0.614–0.978). However, there were no statistically significant differences between the two groups with respect to inadequate GWG.

Table 4 displays the results of regression analyses examining the associations between duration of US residence and pregnancy-related weight among immigrant mothers. Residing in the United States for 10–15 or 16 or more years was positively associated with preconception obesity (OR 2.737, 95% CI, 1.459–5.134, and OR 2.918, 95% CI, 1.322–6.439, respectively). In contrast, there were no significant differences in preconception obesity between women who had lived in the United States for 5–9 years and those who had lived in the United States for 0–4 years. In general, there was little variation in GWG adequacy by maternal duration of residence. However, the longest-residing immigrants were an important exception: those who had resided in the United States for 16 or more years were more likely to have excessive GWG than those who had lived in the United States for 0–4 years (OR 1.683, 95% CI, 1.012–2.797).

Finally, Table 5 displays the results of regression analyses examining how the association between duration of US residence and pregnancy-related weight outcomes varied by age at time of arrival (under age 18 vs age 18 or older). Among immigrant mothers who arrived in the United States prior to age 18, duration of residence was not significantly associated with preconception obesity. However, among immigrants who arrived at age 18 or older, those living in the United States for 10–15 years were more likely to be obese prior to pregnancy than those living in the United States for 0–4 years (OR 3.454, 95% CI, 1.286–9.278). Finally, duration of residence in the United States

Table 3. Regression analyses (N = 7000) associations between immigrant status and pregnancy-related weight, Early Childhood Longitudinal Study–Birth Cohort.

	Obese	Inadequate GWG	Excessive GWG
	OR	OR	OR
	CI	CI	CI
Observations	7000	3300[a]	5400[b]
Immigrant status (ref: US-born)			
Immigrant	0.435***	1.116	0.775**
	(0.321–0.590)	(0.822–1.514)	(0.614–0.978)
Pre-pregnancy weight status (ref: normal weight)			
Underweight		1.282	0.670**
		(0.872–1.885)	(0.456–0.983)
Overweight		0.881	2.205***
		(0.701–1.107)	(1.869–2.600)
Obese		2.561***	4.560***
		(1.708–3.840)	(3.352–6.205)
Race/ethnicity (ref: NH White)			
NH Black	1.534***	1.366**	0.832
	(1.216–1.934)	(1.068–1.747)	(0.663–1.043)
Hispanic	1.536***	1.135	0.911
	(1.159–2.034)	(0.831–1.552)	(0.725–1.143)
NH Asian	0.282***	1.395	0.876
	(0.180–0.441)	(0.915–2.128)	(0.645–1.190)
Maternal age (in years)	1.046***	1.006	1.012
	(1.027–1.066)	(0.984–1.029)	(0.997–1.028)
Number of prior live births (ref: 0 prior births)			
One	0.976	1.003	0.749***
	(0.803–1.186)	(0.821–1.225)	(0.611–0.918)
Two	0.967	1.204	0.721***
	(0.740–1.262)	(0.896–1.617)	(0.565–0.921)
Three or more	1.025	1.191	0.741
	(0.724–1.451)	(0.779–1.820)	(0.523–1.050)
Smoking			
Smoked before pregnancy	1.013		
	(0.824–1.245)		
Smoked during pregnancy		1.094	1.070
		(0.794–1.510)	(0.817–1.403)
Marital status (ref: unmarried)			
Married	1.042	0.807	0.660***
	(0.835–1.300)	(0.635–1.027)	(0.533–0.818)
Maternal education (ref: less than high school)			
High school	0.904	1.097	1.114
	(0.710–1.152)	(0.824–1.460)	(0.904–1.373)
Some college	0.983	0.977	1.024
	(0.744–1.298)	(0.689–1.385)	(0.799–1.313)
College graduate	0.412***	0.871	0.853
	(0.287–0.591)	(0.560–1.354)	(0.653–1.116)
Poverty level (ref: <100% FPL)			
100%–129% FPL	0.953	1.098	1.031
	(0.697–1.302)	(0.829–1.453)	(0.764–1.392)
130%–185% FPL	1.086	1.028	0.959
	(0.824–1.433)	(0.757–1.396)	(0.744–1.235)
>185 FPL	0.701**	0.811	0.941
	(0.506–0.971)	(0.631–1.044)	(0.755–1.173)

(Continued)

Table 3. (Continued)

	Obese	Inadequate GWG	Excessive GWG
	OR	OR	OR
	CI	CI	CI
Number of household members	1.084**	1.072	1.022
	(1.014–1.159)	(0.984–1.168)	(0.961–1.088)
Region (ref: West)			
Northeast	1.167	1.091	0.939
	(0.855–1.594)	(0.770–1.547)	(0.742–1.189)
Midwest	1.340**	0.872	1.064
	(1.057–1.699)	(0.672–1.132)	(0.864–1.311)
South	1.238	1.108	1.128
	(1.000–1.533)	(0.882–1.393)	(0.931–1.366)
Constant	0.040***	0.452**	1.666**
	(0.023–0.071)	(0.232–0.882)	(1.032–2.689)

GWG: gestational weight gain; BMI: body mass index; NH: non-Hispanic; FPL: federal poverty line. Sample sizes rounded to 50 as instructed by Department of Education. GWG adequacy categorized using the "adequacy ratio" method that is based on the 2009 Institute of Medicine guidelines and adjusting for gestational age.

[a]Sample includes mothers with adequate and inadequate GWG.

[b]Sample includes mothers with adequate and excess GWG.

**$p < 0.05$, ***$p < 0.01$.

was not significantly associated with excessive or inadequate GWG among either women who migrated prior to age 18 or those who migrated at age 18 and older.

Discussion

To our knowledge, this study was the first to examine differences in both preconception weight and GWG by maternal immigrant status, duration of US residence, and age at time of arrival. The findings show that compared to US-born women, immigrant women were less likely to be classified as obese prior to pregnancy and less likely to experience excessive GWG. However, further analyses revealed important variation among immigrant mothers such that pregnancy-related weight varied significantly by duration of US residence. Specifically, relative to immigrants who had been in the United States for 0–4 years, those who had lived in the United States for longer periods of time were more likely to be classified as obese prior to pregnancy. Furthermore, the longest-residing women were more likely than recent arrivals to gain an excessive amount of weight during pregnancy. Finally, there was some evidence that the positive association between duration of residence and preconception obesity was significant only among women who had moved to the United States at age 18 or older.

Our finding that immigrants were less likely than US-born mothers to be classified as obese prior to pregnancy and to experience excessive GWG is consistent with evidence from prior studies.[11,16–19] Many immigrant women migrate to the United States from countries with comparatively lower obesity rates,[28] and immigrants often have even lower obesity rates than their counterparts who remain behind in their respective countries of origin.[29] Furthermore, there is evidence that immigrants of reproductive age are more likely than their US-born counterparts to engage in behaviors consistent with maintaining a lower BMI. For example, a study of low-income reproductive-age women found that foreign-born women were more likely than US-born women to consume fruits and vegetables.[30] Another study of low-income pregnant women found that compared to women of Mexican descent born in the United States, Mexican-born women had lower preconception weights and lower average GWG, even though they had a higher average caloric intake.[31] The authors speculated that differences in dietary quality and physical activity may have led to these differences; for example, the Mexican-born women consumed higher levels of key micronutrients (e.g. vitamin A and folate).[31] Although data limitations prevented us from investigating how dietary quality and physical activity affect nativity-based differences in pregnancy-related weight in the current study, future research should consider these potential mechanisms among diverse immigrant samples.

The results also show that while immigrants are less likely than US-born mothers to be classified as obese prior to pregnancy or to experience excessive GWG, these outcomes vary significantly among immigrant mothers by duration of US residence. For example, among immigrants, residing in the United States for 10–15 or 16 or

Table 4. Regression analyses (n = 1850) associations between immigrant status and pregnancy-related weight, immigrants only, Early Childhood Longitudinal Study–Birth Cohort.

	Obese	Inadequate GWG	Excessive GWG
	OR	OR	OR
	CI	CI	CI
Observations	1850	1100[a]	1350[b]
Duration of US residence (ref: 0–4 years)			
5–9 years	1.029	0.845	0.954
	(0.434–2.438)	(0.473–1.509)	(0.599–1.519)
10–15 years	2.737***	0.670	1.093
	(1.459–5.134)	(0.379–1.185)	(0.663–1.803)
16 or more years	2.918***	0.791	1.683**
	(1.322–6.439)	(0.449–1.392)	(1.012–2.797)
Pre-pregnancy weight status (ref: normal weight)			
Normal weight (reference)			
Underweight		1.294	0.858
		(0.677–2.472)	(0.461–1.599)
Overweight		0.640	1.812***
		(0.382–1.073)	(1.181–2.781)
Obese		1.158	3.484***
		(0.480–2.792)	(1.824–6.653)
Race/ethnicity (ref: NH White and Black[c])			
Hispanic	0.639	0.761	0.721
	(0.347–1.177)	(0.402–1.440)	(0.413–1.261)
NH Asian	0.134***	0.899	0.643
	(0.064–0.279)	(0.491–1.647)	(0.370–1.117)
Maternal Age (in years)	1.045	1.006	1.004
	(0.995–1.097)	(0.966–1.048)	(0.971–1.037)
Number of prior live births (ref: 0 prior births)			
One	1.974	1.419	0.885
	(0.950–4.104)	(0.914–2.202)	(0.566–1.383)
Two	1.763	1.231	0.671
	(0.791–3.934)	(0.697–2.175)	(0.398–1.133)
Three or more	1.274	1.020	0.527
	(0.539–3.012)	(0.397–2.623)	(0.232–1.194)
Smoking			
Smoked before pregnancy	0.700		
	(0.255–1.921)		
Smoked during pregnancy		0.205	0.315
		(0.029–1.427)	(0.088–1.126)
Marital status (ref: unmarried)			
Married	0.817	0.789	0.895
	(0.448–1.491)	(0.542–1.150)	(0.556–1.441)
Maternal education (ref: less than high school)			
High school	0.571**	1.302	1.402
	(0.342–0.952)	(0.872–1.944)	(0.852–2.306)
Some college	0.488	0.899	1.210
	(0.234–1.018)	(0.458–1.766)	(0.657–2.230)
College graduate	0.290**	0.890	0.803
	(0.105–0.800)	(0.415–1.908)	(0.407–1.584)
Poverty level (ref: <100% FPL)			
100%–129% FPL	1.772	1.437	1.275
	(0.807–3.889)	(0.752–2.747)	(0.683–2.380)
130%–185% FPL	1.346	1.434	1.190

(Continued)

Table 4. (Continued)

	Obese	Inadequate GWG	Excessive GWG
	OR	OR	OR
	CI	CI	CI
	(0.555–3.261)	(0.812–2.533)	(0.721–1.964)
>185 FPL	1.116	1.126	1.067
	(0.476–2.617)	(0.622–2.040)	(0.639–1.783)
Number of household members	1.223**	1.116	1.079
	(1.039–1.440)	(0.957–1.301)	(0.947–1.230)
Region (ref: West)			
Northeast	0.682	0.734	0.818
	(0.321–1.450)	(0.397–1.358)	(0.478–1.398)
Midwest	2.084**	0.419***	0.569**
	(1.153–3.767)	(0.255–0.687)	(0.350–0.927)
South	1.450	1.151	0.807
	(0.819–2.566)	(0.722–1.834)	(0.536–1.215)
Constant	0.009***	0.676	1.213
	(0.001–0.061)	(0.150–3.054)	(0.362–4.067)

GWG: gestational weight gain; BMI: body mass index; NH: non-Hispanic; FPL: federal poverty line. Sample sizes rounded to 50 as instructed by Department of Education. GWG adequacy categorized using the "adequacy ratio" method that is based on the 2009 Institute of Medicine guidelines and adjusting for gestational age.

[a]Sample includes mothers with adequate and inadequate GWG.

[b]Sample includes mothers with adequate and excess GWG.

[c]NH White and NH Black racial groups collapsed due to small sub-sample sizes.

**$p < 0.05$, ***$p < 0.01$.

more years was significantly associated with a greater risk of obesity. This finding aligns with those of prior studies showing that a longer time in the United States is associated with increases in obesity rates, particularly among women.[32] Dietary changes are one likely reason that pregnancy-related weight varies by duration of residence. For example, a study of Hispanic immigrants found that the relationship between time in the United States and dietary changes (e.g. greater consumption of "junk food") was particularly strong for women.[14] Other studies have found that immigrants who have lived in the United States for longer periods are more likely to report experiencing stressors (e.g. discrimination) that may be associated with increases in obesity,[32,33] although there is some evidence that this may be true only for women.[32] However, these relationships are complex and vary across racial/ethnic groups.[32,33] For example, the overall risk of preconception obesity was significantly lower among NH Asian immigrants compared to all other immigrant subgroups. However, this result is consistent with prior research that finds comparatively lower rates of overweight/obesity and slower changes in diet and weight gain over time in the United States among non-pregnant NH Asian immigrants.[12,13] Future research should seek to gain a more thorough understanding of the extent to which duration of residence is a proxy for changes in diet, stress, and environmental influences (e.g., neighborhood food availability and socioeconomic status) among childbearing women.

The present study extends prior research on immigration and GWG by using more refined duration intervals and nationally representative data. The results show that the relationship between pregnancy-related weight and duration of residence in the United States extends to GWG in the ECLS-B sample: immigrants living in the United States for 16 or more years were more likely to experience excessive GWG than those who had lived in the United States for 0–4 years. This result is consistent with those from prior work, which has generally found that compared to the most recent immigrants (i.e. those with fewer than 5 years of residence), those with at least 10 years of US residence are at greater risk of excessive GWG and experience the highest overall GWG.[17,20] However, unlike prior studies, we did not find that immigrants residing in the United States for fewer than 10 years were more likely to have inadequate weight gain than both US-born mothers and immigrant mothers living in the United States for more than 10 years once we adjusted for relevant covariates.[19] This novel finding strongly suggests that the risks of obesity and GWG outside clinical guidelines are concentrated among the longest-residing immigrant women. Given the differences from previous results in studies with more data limitations, future research should seek to replicate this finding.

Finally, the analyses revealed somewhat unexpected results with respect to how the associations between pregnancy-related weight and duration of residence in the

Table 5. Regression analyses (n = 1850) associations between immigrant status and pregnancy-related weight, immigrants only, <18 and 18 and above, Early Childhood Longitudinal Study–Birth Cohort.

	Obese		Inadequate GWG[a]		Excessive GWG[b]	
	<18	18 and above	<18	18 and above	<18	18 and above
	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
	CI	CI	OR	OR	OR	OR
Observations	650	1200	350	750	500	850
Duration of US residence (ref: 0–4 years)						
5–9 years	0.285	1.308	0.278	1.055	0.930	0.960
	(0.050–1.620)	(0.477–3.586)	(0.077–1.009)	(0.575–1.933)	(0.290–2.977)	(0.570–1.615)
10–15 years	0.667	3.454**	0.473	0.508	1.391	0.953
	(0.161–2.772)	(1.286–9.278)	(0.118–1.902)	(0.227–1.135)	(0.362–5.349)	(0.474–1.918)
16 or more years	1.144	0.184	0.619	0.359	2.913	0.502
	(0.244–5.359)	(0.019–1.757)	(0.190–2.019)	(0.074–1.741)	(0.754–11.253)	(0.148–1.704)
Pre-pregnancy weight status (ref: normal weight)						
Underweight			1.755	0.907	0.572	0.998
			(0.678–4.547)	(0.412–1.997)	(0.156–2.097)	(0.480–2.077)
Overweight			1.101	0.535	3.996***	1.255
			(0.422–2.871)	(0.267–1.075)	(1.874–8.523)	(0.675–2.332)
Obese			0.770	1.380	3.378**	3.467**
			(0.208–2.847)	(0.433–4.398)	(1.153–9.900)	(1.289–9.325)
Race/ethnicity (ref: NH White and Black[c])						
Hispanic	0.522	0.832	1.790	0.475	1.139	0.682
	(0.193–1.411)	(0.300–2.308)	(0.449–7.137)	(0.220–1.028)	(0.508–2.553)	(0.320–1.452)
NH Asian	0.097***	0.148***	1.085	0.849	0.917	0.591
	(0.029–0.328)	(0.044–0.501)	(0.303–3.879)	(0.407–1.773)	(0.371–2.264)	(0.302–1.156)
Maternal age (in years)	1.039	1.107**	0.958	1.023	0.960	1.040
	(0.951–1.134)	(1.010–1.214)	(0.892–1.028)	(0.959–1.090)	(0.904–1.019)	(0.978–1.107)
Number of prior live births (ref: 0 prior births)						
One	6.797***	0.661	3.389***	0.933	1.210	0.678
	(2.721–16.980)	(0.222–1.964)	(1.535–7.484)	(0.518–1.683)	(0.593–2.469)	(0.387–1.187)
Two	3.285	0.834	2.130	1.099	1.143	0.453**
	(0.975–11.063)	(0.254–2.736)	(0.801–5.669)	(0.532–2.272)	(0.533–2.454)	(0.216–0.947)
Three or more	3.058	0.582	1.311	0.890	1.509	0.311**
	(0.768–12.184)	(0.202–1.682)	(0.208–8.265)	(0.296–2.676)	(0.342–6.664)	(0.112–0.864)
Smoking						
Smoked before pregnancy	0.738	0.428				
	(0.150–3.635)	(0.062–2.937)				
Smoked during pregnancy			0.120	0.358	0.182*	0.415
			(0.006–2.446)	(0.039–3.318)	(0.027–1.238)	(0.069–2.495)
Marital status (ref: unmarried)						
Married	0.568	1.106	0.984	0.678	1.083	0.827
	(0.218–1.479)	(0.414–2.955)	(0.483–2.002)	(0.395–1.165)	(0.473–2.476)	(0.417–1.638)
Maternal education (ref: less than high school)						
High school	0.853	0.454**	1.716	1.106	1.917	1.189
	(0.332–2.191)	(0.219–0.943)	(0.658–4.473)	(0.671–1.825)	(0.858–4.281)	(0.661–2.139)
Some college	0.566	0.575	2.067	0.491	1.709	1.099
	(0.176–1.823)	(0.178–1.863)	(0.674–6.335)	(0.191–1.259)	(0.579–5.047)	(0.548–2.203)
College graduate	0.354	0.247**	1.330	0.623	0.767	0.760
	(0.072–1.741)	(0.078–0.779)	(0.293–6.027)	(0.253–1.530)	(0.233–2.525)	(0.362–1.594)
Poverty level						
<100 FPL (reference)						
100%–129% FPL	1.634	1.783	1.282	1.537	0.663	1.739
	(0.554–4.816)	(0.681–4.665)	(0.433–3.797)	(0.652–3.624)	(0.262–1.675)	(0.771–3.924)

(Continued)

Table 5. (Continued)

	Obese		Inadequate GWG[a]		Excessive GWG[b]	
	<18	18 and above	<18	18 and above	<18	18 and above
	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
	CI	CI	OR	OR	OR	OR
130%–185% FPL	1.446	0.946	1.099	1.620	0.736	1.366
	(0.447–4.679)	(0.227–3.944)	(0.430–2.808)	(0.755–3.476)	(0.270–2.002)	(0.633–2.944)
>185 FPL	1.039	0.955	1.548	1.045	0.835	1.141
	(0.280–3.860)	(0.349–2.617)	(0.544–4.405)	(0.440–2.478)	(0.341–2.043)	(0.550–2.367)
Number of household members	1.214	1.238	1.230	1.091	1.113	1.110
	(0.955–1.544)	(0.974–1.573)	(0.945–1.600)	(0.908–1.310)	(0.889–1.394)	(0.958–1.288)
Region						
West (reference)						
Northeast	0.243**	1.307	0.826	0.742	1.184	0.717
	(0.068–0.870)	(0.421–4.061)	(0.309–2.209)	(0.369–1.495)	(0.501–2.801)	(0.393–1.310)
Midwest	0.784	4.416***	0.345**	0.404***	0.426	0.693
	(0.229–2.688)	(1.610–12.113)	(0.128–0.930)	(0.219–0.747)	(0.161–1.129)	(0.373–1.289)
South	1.184	2.033	0.796	1.373	0.584	1.059
	(0.509–2.753)	(0.828–4.990)	(0.381–1.662)	(0.741–2.544)	(0.329–1.037)	(0.602–1.866)
Constant	0.025***	0.001***	0.541	1.001	1.229	0.532
	(0.002–0.315)	(0.000–0.052)	(0.039–7.577)	(0.121–8.295)	(0.132–11.424)	(0.074–3.827)

GWG: gestational weight gain; BMI: body mass index; NH: non-Hispanic; FPL: federal poverty line. Sample sizes rounded to 50 as instructed by Department of Education. GWG adequacy categorized using the "adequacy ratio" method that is based on the 2009 Institute of Medicine guidelines and adjusting for gestational age.

[a]Samples include mothers with adequate and inadequate GWG.

[b]Samples include mothers with adequate and excess GWG.

[c]NH White and NH Black racial groups collapsed due to small sub-sample sizes.

**$p < 0.05$, ***$p < 0.01$.

United States varied by maternal age at arrival. Among the sub-sample of women who arrived in the United States prior to age 18, there were no significant relationships between duration and pregnancy-related weight. However, among the sub-sample of women who arrived in the United States at age 18 or older, those who had lived in the United States for 10–15 years were more likely to be classified as obese prior to conception than those who lived in the United States for less than 5 years. These results were somewhat unexpected, given prior evidence that the associations between weight and duration of residence are stronger among women who migrate earlier in the life course.[12,13] Given the relatively small sample sizes available for these analyses (particularly the number of immigrants who migrated prior to age 18), further investigation and replication of these results in larger and more diverse samples are critical.

This study has several limitations. First, the measures of preconception weight and GWG were based on retrospective maternal self-reports, and thus may be subject to recall bias or misreporting. Weight at the time of delivery can also vary due to factors such as edema. However, self-reported preconception weight and weight status (i.e. obesity) are generally strongly associated with objective maternal weight measures.[34] Second, we lacked information about behaviors (e.g., diet and exercise) that are associated with pregnancy-related weight and may vary by maternal duration of residence or age at arrival.[13] However, we were able to include preconception smoking in the models, which may serve as a rough proxy for health-related attitudes. A related limitation is that we were unable to measure the quality of care (e.g. whether mothers received guideline-concordant information about GWG during prenatal visits) or insurance coverage, which impacts access to prenatal care. Third, because the study was cross-sectional, we were unable to address changing lifestyle factors (e.g. diet) that can influence weight-related trajectories, particularly between pregnancies. In addition, sample size limitations prevented us from examining whether the relationships between pregnancy-related weight, duration of US residence, and age at migration varied by race/ethnicity or region of origin, even though prior research suggests that such variation exists.[12,15] Future work should use more recent data as it becomes available to shed additional light on these differences. However, an important strength of this study is the use of

data from a racially diverse, nationally representative sample of new mothers, which allowed us to speak more broadly to the relationships between migration-related characteristics and pregnancy-related weight.

Conclusion

As clinicians and researchers focus on ways to support pregnant women in achieving recommended weight gain targets, our findings suggest that it is important to consider differences among immigrant subpopulations. Specifically, longer-residing immigrants are at greater risk of being classified as obese prior to pregnancy and experiencing excessive GWG compared to their counterparts that have spent less time in the United States. It is imperative for researchers to adopt a more upstream approach, and identify the policies, social factors, and environmental stressors that directly and indirectly impact pregnancy-related weight trajectories among immigrants, particularly as the duration of their US residence increases. While the immigrant health literature has typically focused on acculturation (i.e. the adoption of behaviors and practices like those of US-born individuals) and its relationship with dietary changes,[35–37] the role of discrimination-related stress in driving *immigrant* weight outcomes has been largely overlooked. Immigrants who have lived in the United States for longer periods of time report experiencing more frequent and intense discrimination than more recent arrivals.[38,39] Furthermore, a study of Asian immigrants found that BMI levels only increased with the duration of US residence among respondents who reported experiencing racial/ethnic discrimination.[33] Recent evidence has also identified the political climate as an important determinant of immigrant birth outcomes.[40] Thus, while addressing social policies that increase stress and discriminatory treatment among immigrant populations, individual-level clinical interventions should explore the effectiveness of equipping immigrant mothers with mental health strategies to mitigate the effects of these external stressors.

Author contributions

Tiffany L Green conceptualized the study and led the analyses and the writing of the manuscript. Muloongo Simuzingili conducted analyses and contributed to the writing of the manuscript. Mandar Bodas conducted analyses and contributed to the writing of the manuscript. Hong Xue contributed to the interpretation of analyses and the writeup of the results and discussion. All authors approved the final version of this manuscript.

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Data accessibility statement

The data used in the present study are restricted access, but can be obtained through an application to the National Center for Education Statistics.

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