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Change in birth outcomes among infants born to Latina mothers after a major immigration raid

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Abstract

Background: Growing evidence indicates that immigration policy and enforcement adversely affect the well-being of Latino immigrants, but fewer studies examine 'spillover effects' on USA-born Latinos. Immigration enforcement is often diffuse, covert and difficult to measure. By contrast, the federal immigration raid in Postville, Iowa, in 2008 was, at the time, the largest single-site federal immigration raid in US history.

Methods: We employed a quasi-experimental design, examining ethnicity-specific patterns in birth outcomes before and after the Postville raid. We analysed Iowa birth-certificate data to compare risk of term and preterm low birthweight (LBW), by ethnicity and nativity, in the 37 weeks following the raid to the same 37-week period the previous year ($n = 52\,344$). We model risk of adverse birth outcomes using modified Poisson regression and model distribution of birthweight using quantile regression.

Results: Infants born to Latina mothers had a 24% greater risk of LBW after the raid when compared with the same period 1 year earlier [risk ratio (95% confidence interval) = 1.24 (0.98, 1.57)]. No such change was observed among infants born to non-Latina White mothers. Increased risk of LBW was observed for USA-born and immigrant Latina mothers. The association between raid timing and LBW was stronger among term than preterm births. Changes in birthweight after the raid primarily reflected decreased birthweight below the 5th percentile of the distribution, not a shift in mean birthweight.

Conclusions: Our findings highlight the implications of racialized stressors not only for the health of Latino immigrants, but also for USA-born co-ethnics.

Key words: immigration enforcement, birth outcomes, stress, Latinos/Hispanics, nativity

Key Messages

- We compare risk of adverse birth outcomes before and after a major federal immigration raid in Postville, Iowa.
- Whereas there was no change in risk of low birthweight for infants born to White mothers in Iowa, infants born to Latina mothers in Iowa had a 24% higher risk of low birthweight in the period following the Postville raid.
- Analyses including gestational age reveal an elevation in risk of moderate-preterm birth (PTB) after the raid among Latina mothers, rather than an increase in very-PTB.
- These findings are consistent with theories linking immigration enforcement to the health of Latino immigrants and their USA-born co-ethnics.

Introduction

Investigators theorize that unintended consequences of social policies affecting disadvantaged groups contribute to entrenched US health disparities.[1–5] A growing literature examines effects of US immigration policy on immigrants (particularly Latino immigrants),[5] documenting links between immigration policy and health care utilization,[6–9] Medicaid participation[10,11] or food insecurity.[12] A smaller, but growing number of studies examine links between immigration enforcement and psychosocial well-being,[13,14] self-rated health[15] and enforcement-related distress.[15–17]

Many existing studies of immigration policy/enforcement and health focus on immigrant (or specifically undocumented-immigrant) samples[18] or examine Latinos regardless of nativity.[6,7,15] Whereas some studies have documented effects of immigration policy and enforcement on USA-born children of immigrants,[9,11,19] far fewer examine implications specifically for co-ethnic USA-born adults.[8,12,16] Although USA-born Latinos are not subject to immigration deportation, many are embedded in communities targeted by immigration enforcement[20,21] and may experience discrimination, 'othering'[20] or chronic identity-related vigilance[22] in response to racialized exclusion.[5,23–26]

Measuring causal relationships between immigration policy/enforcement and health outcomes has proved challenging: policy changes usually occur after an extended deliberation period that makes exposure classification difficult, and enforcement practices are often diffuse and covert.[10,21] In contrast, the 2008 Immigration and Customs Enforcement (ICE) raid on a meat-processing plant in Postville, Iowa, was the largest single-site raid yet seen in the USA, and occurred without warning, allowing a clear before-and-after comparison.

We compare risk of adverse birth outcomes among Latina and non-Latina White mothers in the state of Iowa before and after the Postville raid. Birth outcomes, and particularly low birthweight (LBW), are well suited as health outcomes in this study because birth-certificate data are publicly available and collected for all births regardless of the mother's immigration status, and birthweight has little measurement error. Previous studies have documented increased LBW risk after population-level stressors such as terrorist attacks or natural disasters[27–31] (although some studies report null or mixed findings).[32,33]

Economic and demographic commonalities across Latino population clusters in Iowa (many, like Postville, centre on meat processing) and social and affective ties between foreign-born and USA-born Latinos lead us to hypothesize effects for Latinos across the entire state. We hypothesize that, among Iowa births, the association between LBW and birth after the raid will be modified by mother's ethnicity, such that foreign-born and USA-born Latina mothers will have higher LBW rates after the raid, whereas non-Latina White mothers will have no change in LBW. We anticipate that this effect modification will be independent of potential socio-economic confounders and traditional risk factors for LBW.

Exposure: the Postville raid

The ICE raid on a meat-processing plant in Postville, Iowa, on 12 May 2008 was implemented without advance warning to local or state officials. ICE deployed 900 agents using military tactics, including armed officers and a UH-60 Black Hawk helicopter, to arrest 389 employees, 98% of whom were Latino.[34] Agents used presumed race/ethnicity to identify suspected undocumented immigrants, allegedly handcuffing all employees assumed to be Latino until their immigration status was verified.[35]

Male arrestees were detained at the National Cattle Congress in Waterloo, Iowa (80 miles from Postville), whereas women were detained in county jails. Mothers of small children were allowed to return to Postville with ankle monitors but, barred from working, survived on charitable aid.[34,36] Detainees were chained together and arraigned in groups of 10 for felony charges of aggravated identity theft (knowingly working under a false Social Security Number). A plea bargain led nearly all to plead

guilty, although few were technically guilty of the crime, and 297 arrestees were deported after serving a 5-month prison sentence.[34]

The raid separated hundreds of families, most often from their primary breadwinner. Fear of follow-up home raids kept many Postville families from staying in their own homes, choosing instead to sleep in church pews or leave town altogether.[36] News of the raid immediately spread throughout the state. *La Prensa*, a Spanish-language newspaper in western Iowa, published eyewitness testimony of arrestees detained at a cattle fairground, cuffed and chained together from the waist to the ankles.[37]

Methods

We obtained birth-certificate data for all births in Iowa from 2006 to 2010 ($n = 209\,389$). We classified infants as 'exposed' to the post-raid environment if they were born in the 37 weeks following the Postville raid (12 May 2008–26 January 2009) and 'unexposed' if they were born in same period one year earlier (12 May 2007–26 January 2008). We chose 37 weeks because it was the minimum length of a normal gestation.

The primary outcome variable, LBW, was defined as birthweight <2500 g. We used self-reported race and Hispanic ethnicity to categorize mothers as Latina or non-Latina White, creating a 'Latina' category by restricting to mothers in any Hispanic subgroup except Hispanic/Spaniard. Latina mothers were predominantly of Mexican descent (81%), although 11% were of Central American origin and 8% were of other Hispanic origin. We used self-reported birthplace to categorize mothers as USA- or foreign-born. Immigration status is not collected in birth-certificate data. We included data on maternal age (<20, 20–25, 26–30, 31–35, 36–40, 41+ years), education (<8th grade, 9th–11th grade, high-school diploma/equivalent, some college/Associate's degree, college diploma), marital status (married/unmarried at conception) and parity (first live birth/second or higher). We also divided maternal education into tertiles within strata of ethnicity/nativity. We included data on prenatal maternal smoking (no smoking, <10, 10–19, 20+ cigarettes/day) and prenatal care utilization (Kessner index for adequate, intermediate and inadequate prenatal care).[38]

We used a data-cleaning algorithm to create a gestational age (GA) variable, which we categorized into preterm birth (PTB) and categories of GA. We took this step to address previously reported data-quality issues for GA estimation in vulnerable populations, including immigrant, Latina or low-English-proficient mothers and mothers with late prenatal care initiation.[39–42] The algorithm used a LMP-based estimate of GA wherever possible, and the clinical estimate when a LMP-based estimate was unavailable or implausible for the infant's birthweight; for more information, see Basso and Wilcox.[43] PTB was defined as GA < 37 weeks. We further categorized GA as very-preterm (<32 weeks), moderate-preterm (32–36 weeks), early-term (37–38 weeks) and full-term (≥39 weeks).[44,45]

We used the cleaned GA variable to estimate the stage of gestation at the time of the raid (or the comparison date), classifying infants as not yet conceived, or in the first, second or third trimester on the date of interest.

We restricted our analysis to singletons born in the 37 weeks following the raid or the same period one year earlier ($n = 57\,850$), although we include data from the same period 2 years earlier ($n = 26\,531$) for description. We excluded 4659 infants born to mothers who were not Latina or non-Latina White, and those missing data on birthweight ($n = 20$), GA ($n = 115$), maternal nativity (Latina mothers only, $n = 11$), age ($n = 2$), education ($n = 332$), marital status ($n = 6$), parity ($n = 256$) and prenatal smoking ($n = 105$). Excluded infants ($n = 847$) were more likely to be LBW, both among Latina and non-Latina White mothers. The final sample included 52 344 infants, 25 979 born in the 37 weeks following the Postville raid and 26 365 born during the same 37-week period 1 year earlier.

Statistical methods

We used modified Poisson regression[46] to estimate risk ratios (RRs) comparing risk of LBW among infants born after Postville to those in the comparison period, and used Knol and VanderWeele's recommended methods for presenting analyses of effect modification.[47] This involved presenting: (i) RRs for each stratum of maternal ethnicity and birth timing with a single reference category; (ii) RRs for being born after the raid, stratified on maternal ethnicity; and (iii) measures of effect modification on the additive scale (relative excess risk due to interaction: RERI) and multiplicative scale (ratio of RRs).[48,49] We estimated a second set of models with Latina mothers further stratified on nativity.

To confirm that findings were not confounded by changes in the population of mothers, we re-estimated all models, first with adjustments for maternal risk factors for LBW (age, education, marital status and parity). We further adjusted for measured health behaviours that could have mediated changes in LBW after Postville: maternal smoking and prenatal care utilization.

We conducted additional analyses to better understand observed changes in LBW. We stratified our initial models on PTB to evaluate whether shifts in LBW were operating primarily on term or preterm births. We used conditional

quantile regression[50,51] to analyse the distribution of birthweight among Latinas by exposure period. Quantile regression models the association of the exposure with the full range of the birthweight distribution, not merely above or below the set cut-off of 2500 g for LBW.[51,52] Quantiles were specified to evaluate changes in birthweights lower than the 2500-g cut-off as well as changes throughout the full distribution of birthweight: the 2nd, 5th, 10th, 25th, 50th, 75th, 90th, 95th and 98th percentiles were considered. We estimated the association of birth post-raid with the distribution of birthweight, bootstrapping results 1000 times to estimate standard errors and confidence intervals.

We also examined changes in categories of GA (very-preterm, moderate-preterm, early-term, full-term) before and after the raid, among Latina mothers, using multinomial logistic regression with robust standard errors.

To examine differences in LBW risk according to stage of pregnancy at the time of the raid, we repeated initial analyses with the sample further stratified by stage of gestation at the time of the raid.[30,53,54] We estimated RRs for LBW after the raid compared with before the raid, by ethnicity and gestational category. To determine whether changes in risk of LBW varied by social position within strata of ethnicity/nativity, we also estimated LBW models stratified on within-group tertiles of education. Analyses were conducted with STATA 13.

Results

Traditional risk factors for LBW and PTB varied by maternal ethnicity and nativity; however, within ethnicity/nativity groups, the distribution of maternal socio-demographic characteristics remained consistent before and after the raid, as did mean birthweight (Table 1). Prior to the raid, Latina and White mothers had similar prevalence of LBW (4.7% for both) and PTB (7.5% for both), which is consistent with other reports of ethnicity-specific birth outcomes in Iowa in this period.[55,56]

Figure 1 displays temporal trends in LBW, by ethnicity and nativity, including the two time periods in the study sample and also extending an additional year earlier (12 May 2006–26 January 2007). Among White mothers, rates of LBW declined slightly (as has been the trend nationwide since 2006).[57] Among Latina mothers, rates of LBW were stable in 2006–07, but rose among USA- and foreign-born Latina mothers after the raid.

As displayed in Table 2, the RRs [95% confidence intervals (CIs)] comparing risk of LBW after the raid to before the raid were 1.24 (0.98–1.57) among Latina mothers and 0.95 (0.87–1.03) among White mothers. The measure of effect modification on the additive scale, the RERI, was 0.30 (95% CI 0.03–0.57) and the measure of effect modification on the multiplicative scale, the ratio of RRs, was 1.31 (1.02–1.68). RRs and effect modification measures were robust to adjustment for potential confounders and mediators (Supplementary Tables 1 and 2, available as Supplementary data at *IJE* online).

Table 3 displays the same models with Latina mothers further stratified by nativity. Although confidence intervals widen because of the smaller sample in each group, the RRs (95% CIs) for LBW after the raid among foreign-born (1.25, 0.93–1.67) and USA-born Latina mothers (1.22, 0.83–1.81) were similar in magnitude to the RR from the pooled model, as were the effect modification measures. Adjustment for potential confounders or mediators did not affect these findings (Supplementary Tables 3 and 4, available as Supplementary data at *IJE* online).

In models stratified by term/preterm births, LBW was more strongly associated with birth post-raid among term infants born to Latina mothers (RR, 95% CI = 1.49, 0.95–2.33) than among preterm infants (1.08, 0.88–1.33) (results not shown).

Multinomial logistic regression comparing categories of GA, by ethnicity, before and after Postville, reveals an elevation in risk of moderate-PTB after the raid among Latina mothers (relative risk ratio, 95% CI = 1.11, 0.89–1.38), but no change in risk of very-PTB (0.81, 0.46–1.41) (Table 4).

Quantile regression on the distribution of birthweight indicated that, among Latina mothers, birth post-raid was associated with reduced birthweight only at the left tail of the birthweight distribution, where infants below the 5th percentile of birthweight (corresponding to 2518 g before the raid) were 88 g lighter after the raid (95% CI –168g to –8g). Birth post-raid was not associated with differences in birthweight among infants below the 2nd percentile of birthweight, which corresponded to 2084 g before the raid (6 g heavier, 95% CI –224g to –236g) or at any other point in the birthweight distribution.

In models examining risk of LBW among Latina mothers stratified by stage of gestation at the time of the raid, we found the strongest association between LBW and birth post-raid among mothers in the first trimester at the time of the raid (RR, 95% CI = 1.39, 0.97–1.98) (Table 5). In LBW models stratified by within-group tertiles of education, we observed the strongest association between LBW and birth post-raid in the lower two tertiles of education for both immigrant and USA-born Latina mothers (Table 6).

Discussion

We used the Postville raid, a large-scale immigration raid implemented without warning, as a natural experiment to

Table 1. Descriptive statistics by mother's ethnicity/nativity, during the 37 weeks following the Postville raid (12 May 2008–26 January 2009) and during the same time period 1 year earlier (12 May 2007–26 January 2008) ($n = 52\,344$)

Time period	White		Foreign-born Latina		USA-born Latina	
	Before raid ($n = 23\,878$) Mean %	After raid ($n = 23\,379$) Mean %	Before raid ($n = 1689$) Mean %	After raid ($n = 1746$) Mean %	Before raid ($n = 798$) Mean %	After raid ($n = 854$) Mean %
Infant sex						
Male	51.3	51.5	50.4	50.2	50.4	48.7
Female	48.7	48.5	49.6	49.7	49.6	51.3
Mother's age (years)						
<20	7.7	7.8	9.9	9.3	27.3	27.3
20–25	32.5	31.1	33.3	33.1	38.5	39.0
26–30	33.2	34.1	27.5	27.7	22.1	20.3
31–35	18.6	18.9	19.7	21.0	8.9	9.4
36–40	6.9	6.9	8.1	7.9	2.9	3.2
41+	1.1	1.1	1.5	1.0	0.4	0.9
Education						
8th grade or less	1.3	1.2	34.2	33.7	2.6	2.9
Some high-school education	8.2	8.2	35.5	36.2	33.6	32.4
High-school diploma/equivalent	21.4	20.4	18.1	18.4	31.1	30.8
Some college	38.5	38.8	8.2	7.8	26.2	26.2
College degree+	30.7	31.4	4.1	3.9	6.5	7.6
Maternal marital status						
Mother unmarried	31.3	31.7	44.9	47.0	64.5	56.8
Mother married	68.7	68.3	55.1	53.0	35.5	43.2
Parity						
0 previous	40.0	39.8	28.4	27.8	41.1	40.4
1 or more previous	60.0	60.2	71.5	72.2	59.9	59.6
Prenatal care (Kessner Index)						
Inadequate	2.2	2.2	5.0	4.9	4.8	3.9
Intermediate	7.7	7.7	19.2	17.5	13.4	15.2
Adequate	90.1	90.1	75.7	77.6	81.8	80.9
Smoking in pregnancy						
No smoking	80.0	80.7	98.7	99.1	82.0	87.2
<10 cigarettes/day	10.3	10.2	1.1	0.9	12.7	9.1
10–19 cigarettes/day	7.4	6.9	0.2	0.1	3.6	3.0
20+ cigarettes/day	2.4	2.2	0.1	—	1.8	0.6
Low birthweight	4.7	4.4	4.5	5.6	5.3	6.4
Mean birthweight (g)	3401	3407	3349	3339	3336	3315
Preterm birth	7.5	7.5	7.8	8.0	7.5	8.9

investigate the effects of immigration enforcement on birth outcomes among Latina mothers in a Mid-western state. We found that rates of LBW were steady among White and Latina mothers in the 2 years preceding the raid, but that rates of LBW rose only among Latina mothers after the raid. The association between birth post-raid and LBW was modified by maternal ethnicity on both the additive (RERI > 0) and multiplicative scales (ratio of RRs > 1). This association was evident among both foreign-born and USA-born Latina mothers and persisted after adjustment for maternal risk factors, maternal smoking and prenatal care utilization.

We found that the increases in LBW were greatest among term births, but that there was also a higher prevalence of moderate-preterm (not very-preterm) infants after the raid. Previous studies of psychosocial stressors and birth outcomes have found that LBW increased both through increased PTB[30,53] and through intrauterine growth restriction[58,59]; it appears that both mechanisms operated in Iowa, which is plausible given the diversity of economic and psychosocial pathways by which the raid may have affected Latina mothers.

Comparing births after Postville to births in the same period 1 year earlier accounted for seasonality in birth outcomes and avoided the 'mechanical correlation' between pregnancy duration and risk of exposure to stressful events—a methodological pitfall in studies using the time

period immediately preceding an event as the comparison period.[33]

Our examination of births in the entire state of Iowa makes this a conservative analysis as one might hypothesize stronger effects in or near Postville compared with Latino communities farther away. Previous studies have examined dose–response relationships based on geographic distance from a natural disaster or attack[28,33] but, for privacy reasons, the Iowa Department of Public Health does not release microdata with date of birth and geographic information. However, we do not have reason to believe that stressors resulting from Postville raid would emanate by geographic distance in as dramatic a way as a geographically confined natural disaster or attack. Many Latino communities in Iowa are economically similar to Postville, and communication networks between communities make it plausible that Latinos across the state would feel connected to an enforcement event targeted at a single workplace. Lauderdale's finding of increased LBW among Arabic-named mothers in California after the attacks of 11 September 2001 that occurred across the country in New York City lends plausibility to the view that social identity threats can affect co-ethnics at remote distances.

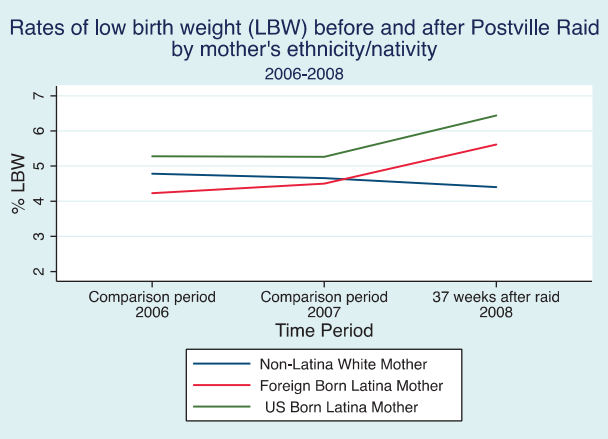

Figure 1. Descriptive graph: rates of low birthweight (LBW) in the 37 weeks following the Postville raid compared with the same time period 1 and 2 years earlier.

LBW risk increased most among Latina mothers with lower educational attainment (less than high school for the foreign-born and less than college for the USA-born). This could be because low-educated mothers were more vulnerable to the economic and psychosocial fallout of the raid or had fewer coping resources. Reports from throughout Iowa after the Postville raid include evidence of individuals and families preparing for the possibility of further immigration enforcement,[37,60–62] avoiding public space,[60,63] restricting spending,[63,64] losing income or economic security

Table 2. Modified Poisson regression results for risk of LBW by time period of birth (before/after Postville raid) and mother's ethnicity (White/Latina) ($n = 52\,344$)

	Before raid		After raid		RR (95% CI); *P* for after raid vs before within strata of ethnicity
	N LBW/non	RR (95% CI); *P*	*N* LBW/non	RR (95% CI); *P*	
White mother	1112/22 766	1.0 (Reference)	1029/22 350	0.95 (0.87, 1.03); $P = 0.18$	0.95 (0.87, 1.03); $P = 0.18$
Latina mother	118/2369	1.02 (0.84, 1.23); $P = 0.84$	153/2447	1.31 (1.02, 1.68); $P = 0.03$	1.24 (0.98, 1.57); $P = 0.07$

Measure of effect modification on additive scale: RERI (95% CI) = 0.30 (0.03, 0.57); $P = 0.03$.
Measure of effect modification on multiplicative scale: ratio of RRs (95% CI): 1.31 (1.02, 1.68); $P = 0.03$. RRs and measures of effect modification are unadjusted.

Table 3. Modified Poisson regression results for risk of LBW by time period of birth (before/after Postville raid) and mother's ethnicity/nativity (White/foreign-born Latina/USA-born Latina) ($n = 52\,344$)

	Before raid		After raid		RR (95% CI); *P* for after raid vs before within strata of ethnicity
	N BW/non	RR (95% CI); *P*	*N* LBW/non	RR (95% CI); *P*	
White mother	1112/22 766	1.0 (Reference)	1029/22 350	0.95 (0.87, 1.03); $P = 0.18$	0.95 (0.87, 1.03); $P = 0.18$
Foreign-born Latina mother	76/1613	0.97 (0.77, 1.21); $P = 0.77$	98/1648	1.32 (0.97, 1.79); $P = 0.07$	1.25 (0.93, 1.67); $P = 0.14$
USA-born Latina mother	42/756	1.13 (0.84, 1.53); $P = 0.42$	55/799	1.29 (0.87, 1.93); $P = 0.20$	1.22 (0.83, 1.81); $P = 0.31$

Measure of effect modification on additive scale: RERI (95% CI) = 0.29 (–0.03, 0.62); $P = 0.07$ (for Foreign-born Latinas), 0.31 (–0.18, 0.80); $P = 0.22$ (for USA-born Latinas).
Measure of effect modification on multiplicative scale: ratio of RRs (95% CI) = 1.32 (0.97, 1.79); $P = 0.07$ (for Foreign-born Latinas), 1.29 (0.87, 1.93); $P = 0.20$ (for USA-born Latinas). RRs and measures of effect modification are unadjusted.

Table 4. Multinomial logistic regression results, categories of gestational age at birth in 37 weeks following the Postville raid compared with same period 1 year earlier, by maternal ethnicity ($n = 52\,344$)

Gestational age at birth	White ($n = 47\,907$) RR (95% CI); P	Latina ($n = 5149$) RR (95% CI); P
Full-term (reference) (39+ weeks)	1.00	1.00
Early-term (37–38 weeks)	0.91 (0.87, 0.95); $P < 0.01$	0.92 (0.81, 1.04); $P = 0.20$
Moderate-preterm (32–36 weeks)	0.97 (0.90, 1.04); $P = 0.39$	1.11 (0.89, 1.38); $P = 0.34$
Very-preterm (<32 weeks)	0.96 (0.79, 1.17); $P = 0.70$	0.81 (0.46, 1.41); $P = 0.45$

Table 5. Modified Poisson regression results for risk of LBW by time period of birth (before/after Postville raid) and mother's ethnicity (White/Latina), stratified by stage of gestation at time of Postville raid ($n = 52\,344$)

	White mothers	Latina mothers	Measures of effect modification	
Stage of gestation at time of Postville raid	RR (95% CI); P	RR (95% CI); P	Ratio of RRs (95% CI); P	RERI (95% CI); P
Not yet conceived ($n = 359$)	1.12 (0.93, 1.35); $P = 0.24$	1.03 (0.65, 1.63); $P = 0.89$	0.92 (0.56, 1.52); $P = 0.75$	–0.08 (–0.70, 0.54); $P = 0.81$
First trimester ($n = 14\,302$)	0.89 (0.78, 1.02); $P = 0.10$	1.39 (0.97, 1.98); $P = 0.07$	1.55 (1.06, 2.27); $P = 0.02$	0.49 (0.07, 0.92); $P = 0.02$
Second trimester ($n = 23\,355$)	0.98 (0.87, 1.11); $P = 0.75$	1.12 (0.79, 1.59); $P = 0.54$	1.14 (0.79, 1.65); $P = 0.49$	0.14 (–0.26, 0.55); $P = 0.49$
Third trimester ($n = 14\,687$)	1.00 (0.81, 1.23); $P = 0.98$	1.12 (0.58, 2.13); $P = 0.74$	1.12 (0.58, 2.16); $P = 0.74$	0.12 (–0.58, 0.81); $P = 0.74$

Table 6. Modified Poisson regression results for risk of LBW by time period of birth (before/after Postville raid) and mother's ethnicity and nativity, stratified by approximate within-group tertiles of education ($n = 52\,344$)

Non-Latina White mothers		Foreign-born Latina mothers		USA-born Latina mothers	
($n = 47\,257$)		($n = 3435$)		($n = 1652$)	
Within-group tertiles of education (n)	RR for birth after Postville raid	Within-group tertiles of education (n)	RR for birth after Postville raid	Within-group tertiles of education (n)	RR for birth after Postville raid
High-school diploma ($n = 14\,334$)	0.95 (0.83, 1.08)	Less than 8th grade ($n = 1165$)	1.42 (0.90, 2.25)	Less than high school ($n = 591$)	1.18 (0.68, 2.06)
Associate's degree or some college ($n = 18\,261$)	0.98 (0.86, 1.12)	Some high school ($n = 1232$)	1.40 (0.84, 2.35)	High-school diploma ($n = 511$)	1.48 (0.78, 2.83)
College diploma or higher ($n = 14\,662$)	0.91 (0.76, 1.09)	High school or greater ($n = 1038$)	0.89 (0.51, 1.57)	Some college or greater ($n = 550$)	0.90 (0.32, 2.54)

due to changing employment practices[62,65–68] and experiencing increased discrimination, stereotype threat or racialized exclusion as public discourse frequently conflated Latino/Hispanic phenotype with undocumented status.[35,65] These reports align with findings from a recent quasi-experimental study in Michigan: after a local immigration raid led to several arrests and deportations, Latinos were more likely to report that they feared the consequences of deportation, and that their immigration status impeded social relationships.[15] In the wake of the Postville raid, similar restrictions in social support and increases in day-to-day fear may have coalesced to increase psychosocial stress and reduce coping resources among Latino immigrants and USA-born co-ethnics. Following the raid, Latino Iowans likened the experience to a flood or earthquake, reflecting the profound impact of this stressor on their lives and on their health.[69,70]

Quantile regression indicated that the higher risk of LBW among Latina mothers after Postville resulted from decreased birthweight at the left tail of the distribution,

not a shift in mean birthweight. This is similar to Lauderdale's findings for ethnicity-specific change in birthweight after 9/11.[71] Lower birthweights at the left tail of the birthweight distribution are more likely to be associated with infant mortality than a leftward shift of the entire distribution.[71,72]

Post-raid increases in LBW risk were greatest for Latina mothers in the first trimester of gestation at the time of the raid. Several other studies have also found stronger effects among first-trimester exposures,[27,29,30,73] but others have not.[31,33,53,54] Our finding in Iowa could suggest that early-gestation infants were more vulnerable, or it may be that those infants were simply exposed to the post-raid environment for a larger proportion of gestation.

Several complex immune, inflammatory and endocrine pathways are proposed to link psychosocial stressors and birthweight. One hypothesis is that maternal psychosocial stress disrupts the balance between maternal glucocorticoid levels and 11 beta-hydroxysteroid dehydrogenase type 2 (HSD2), an enzyme that metabolizes cortisol into inactive cortisone.[74,75] Placental HSD2 typically up-regulates in tandem with serum glucocorticoid levels during gestation, protecting the fetus from 80–90% of circulating maternal glucocorticoids.[76] However, psychosocial stress and disruption of maternal emotional support have been linked to both higher prenatal glucocorticoid concentrations and lower placental HSD2,[75,77–79] both of which are linked to LBW.[76,80–84] The psychosocial, economic, communal and identity-based stressors activated by the Postville raid may have interfered with Latina mothers' neuroendocrine balance and coping resources, leaving infants vulnerable to a dysregulated endocrine environment.

Limitations

If healthy pregnant Latinas left Iowa after Postville, increased LBW among Latinas might reflect selection effects. However, analysing Census data,[85] we found no evidence that the raid was associated with a change in the size of Iowa's Latino population, overall or among women of reproductive age. And, as noted, we found no difference in demographic characteristics among Latina mothers before or after the raid.

There is random year-to-year variation in LBW prevalence, especially in small populations, which raises concerns that the observed increase in LBW among Latina mothers was a chance finding. We do not have access to birth microdata pre-2006, but we used publicly available data[56] to calculate crude LBW prevalences among singleton births to non-Hispanic White and Hispanic mothers during May–January for the 5 years preceding and following the raid. LBW prevalence among infants born to Hispanic mothers is higher from May 2008 to January 2009 than in any other May–January period from 2003 to 2013 (Supplementary Figure 1, available as Supplementary data at *IJE* online).

Birth-certificate data for birthweight, maternal ethnicity and maternal birthplace have high validity relative to medical records.[86–89] However, data on GA are of lower quality,[86] particularly for Latina and non-English-proficient mothers,[39,41] which affects our classification of PTB and stage of gestation at the time of the raid. We used a data-cleaning algorithm to mitigate data-quality issues, but this entails several assumptions[90] and, whereas it is unlikely that remaining misclassification of GA differs by raid timing, even non-differential misclassification may have biased findings for PTB and stage of gestation towards the null. Birth-certificate data for our hypothesized mediators, prenatal smoking and prenatal care are also of lower quality,[86–88] which reduces our ability to observe mediation by changed health behaviours.

Conclusions

Our findings are consistent with studies observing changes in adverse birth outcomes after a major population-level stressor[28,30,53,71] and contribute to literature on racialized stressors and ethnicity-specific birth outcomes.[32,71] We extend the literature on immigration policy/enforcement and health by specifically examining a physical outcome and by examining both immigrant and USA-born Latinos.

The Postville raid was an extreme example of diffuse and pervasive racialized economic and psychosocial stressors that Latinos face throughout the USA. The scale and temporality of this event created conditions that lend insight into the pervasive effects of these stressors, which are often difficult to measure. Exclusive immigration policies and their militarized enforcement exacerbate the racialized exclusion of Latinos in the USA, which may contribute to a cumulative health burden for immigrant and USA-born Latinos alike.

Supplementary Data

Supplementary data are available at *IJE* online.

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