

# ABDOMINAL WALL DEFECTS AMONG MEXICAN AMERICAN INFANTS: THE EFFECT OF MATERNAL NATIVITY

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**Background:** US-born Mexican American women have greater rates of preterm birth and consequent overall infant mortality than their Mexico-born peers. However, the relation of Mexican American women's nativity to rates of congenital anomalies is poorly understood. Hispanic ethnicity and young maternal age are well-known risk factors for gastroschisis.

**Objective:** To determine the extent to which nativity of Mexican American women is associated with abdominal wall defects.

**Methods:** Stratified and multivariable logistic regression analyses were performed on the 2003-2004 National Center for Health Statistics linked live birth-infant death cohort. Only Mexican American infants were studied. Maternal variables examined included nativity, age, education, marital status, parity, and prenatal care usage.

**Results:** Infants with US-born Mexican American mothers (n=451,272) had an abdominal wall defect rate of 3.9/10,000 compared with 2.0/10,000 for those with Mexico-born mothers (n=786,878), RR=1.9 (1.5-2.4). Though a greater percentage of US-born (compared with Mexico-born) Mexican American mothers were teens, the nativity disparity was actually widest among women in their 20s. The adjusted (controlling for maternal age, education, marital status, parity, and prenatal care) odds ratio of abdominal wall defects among infants of US-born (compared with Mexico-born) Mexican American mothers was 1.6 (1.2-2.0).

**Conclusions:** US-born Mexican American women have nearly a two-fold greater rate of delivering an infant with an abdominal wall defect than their Mexico-born counterparts. This phenomenon is

## INTRODUCTION

Mexican Americans are the second largest and fastest-growing underserved minority immigrant group in the United States.<sup>1</sup> Most striking, they have favorable birth outcomes with rates of low birth weight (< 2500 grams, LBW), preterm birth (< 37 weeks, PTB), and infant mortality that are actually lower than non-Hispanic White women.<sup>2-6</sup> However, this advantage is limited to Mexico-born mothers,<sup>7-9</sup> suggesting that lifelong minority status and/or acculturation to an American lifestyle are risk factors for adverse birth outcome.<sup>2,6,8,10-15</sup> Using national vital record data, a recent study found that the infant mortality rate of term births to US-born Mexican American mothers exceeded that of their Mexico-born counterparts.<sup>16</sup> Although congenital anomalies were the leading cause of first year mortal-

ity in both subgroups of term infants, maternal birth in the United States (compared with Mexico) was not associated with increased infant mortality rates due to congenital anomalies.<sup>1</sup> Interestingly, prior studies found a higher incidence of congenital anomalies among US-born (compared to foreign-born) Hispanics.<sup>17-19</sup> The extent to which maternal nativity is associated with non-lethal congenital anomalies among Mexican Americans is incompletely understood.

Abdominal wall defects (gastroschisis and omphalocele) are one of the most common congenital anomalies.<sup>20</sup> Gastroschisis is a full thickness abdominal wall defect lateral to the umbilical cord. For unclear reasons, the incidence of gastroschisis has increased 10- to 20-fold over the past two decades.<sup>18,21-23</sup> Although the mortality associated with gastroschisis is relatively low, the cost of treatment is among the highest

only partially explained by traditional risk factors and highlights a detrimental impact of lifelong residence in the United States, or something closely related to it, on the pregnancy outcome of Mexican American women. *Ethn Dis*; 2016;26(2):165-170; doi:10.18865/ed.26.2.165

**Keywords:** Abdominal Wall Defect; Gastroschisis; Omphalocele; Mexican American; Nativity; Disparity

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of non-cardiac birth defects.<sup>24</sup> Major maternal risk factors for gastroschisis include young age, low socioeconomic status, and Hispanic ethnicity.<sup>18,22,25-27</sup> Minor risk factors include cigarette smoking, non-steroidal anti-inflammatory and illicit drug use.<sup>22,26,28,29</sup>

Omphalocele is a herniation of abdominal contents into the base of the umbilical cord with a protective membrane enclosing the displaced abdominal contents. Omphalocele has an incidence rate approximately one-half that of gastroschisis and has been stable over time.<sup>22,28</sup> Omphalocele is associated with chromosomal disorders and consequently advancing maternal age.<sup>22</sup> Compared with gastroschisis, there is a greater mortality risk with more than half of affected infants possessing cardiac defects or other co-morbid anomalies.<sup>22</sup> In contrast to gastroschisis, maternal economic and behavioral characteristics are not associated with omphalocele.

The limited available published data are conflicting with regard to the impact of maternal nativity on the incidence of gastroschisis among Hispanics.<sup>18,19,30</sup> However, Hispanics are a heterogeneous group that includes Mexican Americans, Puerto Ricans, Cubans, and Central-South Americans. There is also heterogeneity within the Mexican American population with respect to region of immigration from Mexico, US migration patterns, and region of residence in the United States. Notwithstanding, no study has ascertained the relation of maternal nativity to abdominal wall defects among the US population of Mexican Americans.

We, therefore, performed a national population-based study to

determine: 1) the incidence of abdominal wall defects among Mexican American infants with US-born and Mexico-born mothers; and 2) the extent to which traditional maternal demographic, medical, and behavioral risk factors operate as effect modifiers by strengthening the association of maternal birth in the US and the rate of abdominal wall defects.

## METHODS

We used the birth certificate fields from 2003 and 2004 public use birth cohort linked live birth-infant death data files from the National Center for Health Statistics (NCHS).<sup>31,32</sup> We used the Mexican Hispanic origin variable to define women as Mexican American (n=1,337,314). The nativity variable was used to classify these women as US-born or Mexican-born.

Infants with abdominal wall defects were identified using the congenital abnormalities section of the birth certificate. Both term and preterm infants were included in analyses. Gastroschisis and omphalocele were identified by the same code on birth records and the two defects could not be separated. Maternal variables examined include age (<20, 20-24, 25-29, ≥30 years), level of educational attainment (<12 years, 12 years, >12 years), marital status (unmarried, married), and parity (0 previous births, 1-2 previous births, ≥3 previous births). The adequacy of prenatal care utilization (APNCU) index was determined based on trimester of prenatal care initiation and number of prenatal care visits (inadequate, intermediate, adequate, adequate+).<sup>32</sup> Records for 99,164 (7.5%) infants of

Mexican American mothers were excluded from this study due to missing values for the outcome or covariates of interest, leaving 1,238,150 infants in the final analytic sample. There were no differences in the distribution of maternal nativity or measured covariates between included and excluded births (data available on request). Data on maternal cigarette smoking was missing for 36.8% of our study sample because some states (including California, which represents a large proportion of Mexican Ameri-

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can mothers in the United States) did not collect this information. Due to the high number of missing values, we did not evaluate maternal smoking status in the initial analyses.

Rates of abdominal wall defects were calculated per 10,000 live births among Mexican American infants with US-born and Mexico-born mothers. Next, we determined the distribution of selected covariates among US-born and Mexico-born mothers. Stratified analyses were then performed to determine whether measured covariates were confounders or effect modifiers of the association between maternal nativity and rates of abdominal wall

defects. If heterogeneity of risk was identified for a given variable, the Breslow-Day test was used to assess the statistical significance of the interaction.

To assess the independent association between maternal nativity and abdominal wall defects, multi-variable logistic regression analyses were performed. The logistic models controlled for confounding and accounted for effect modification by using interaction terms. The adjusted odds ratio (OR) of abdominal wall defects was determined by taking the antilogarithm of the beta-coefficient and 95% CIs were estimated from the standard errors of those coefficients. Lastly, we performed a sensitivity analysis in which maternal smoking status (from the states that collected this variable) was added to the final model. All analyses were conducted using SAS version 9.2 (Cary, NC).

**RESULTS**

Mexican American infants with US-born mothers (n=451,272) had an abdominal wall defect rate of 3.9/10,000 live births compared with 2.0/10,000 live births for infants with Mexico-born mothers (n=786,878), crude RR=1.9 (1.5-2.4). US-born Mexican American mothers were significantly more likely than Mexico-born mothers to have a younger age distribution; they were also more likely to attend college (Table 1).

Table 2 shows maternal nativity-specific abdominal wall defect rates according to level of selected risk factors. Notwithstanding sample size considerations, the point estimates for abdominal wall defects for US-born

**Table 1. The distribution of selected characteristics among US-born and Mexico-born Mexican American mothers; 2003-2004 United States**

Maternal variables		US-Born, n= 451,272, %	Mexico-Born, n= 786,878, %
Age, years <sup>a</sup>	<20	21.5	11.8
	20-24	35.1	28.4
	25-29	23.8	28.9
	≥30	19.8	30.9
Education, years <sup>a</sup>	<12	32.2	65.9
	12	39.2	23.4
	>12	28.7	10.7
Marital status <sup>a</sup>	Unmarried	49.0	41.7
	Married	51.0	58.3
Parity <sup>a</sup>	0 previous births	38.9	32.1
	1-2 previous births	48.0	51.8
	≥3 previous births	13.0	16.1
Adequacy of prenatal care utilization <sup>a</sup>	Inadequate	13.7	18.8
	Intermediate	13.3	16.1
	Adequate	39.6	38.4
	Adequate+	33.5	26.7

a. Characteristic varies by maternal nativity, P<.01

(compared with Mexico-born) mothers tended to be greater than unity across each level of the measured risk factors. The nativity disparity was present among teens, widest among moth-

ers in their 20s, and abated among those in their 30s. College-educated US-born mothers had approximately a two-fold greater abdominal wall defect rate than their Mexico-born peers;

**Table 2. Abdominal wall defect rates (per 10,000 live births) among infants of US-born and Mexico-born Mexican American mothers by selected maternal characteristics; 2003-2004 United States**

		US-Born, n= 451,272	Mexico-Born, n= 786,878	US-Born vs Mexico-Born, RR (95% CI)	Breslow-Day test
Maternal age, years	<20	6.9	5.3	1.3 (.9-1.9)	.17
	20-24	4.7	2.7	1.8 (1.3-2.5)	
	25-29	2.2	1.1	2.0 (1.2-3.6)	
	≥30	.7	.9	.7 (.3-1.8)	
Maternal education, years	<12	5.3	2.2	2.4 (1.8-3.3)	.58
	12	3.3	1.8	1.9 (1.2-2.9)	
	>12	2.8	1.3	2.1 (1.1-4.2)	
Marital status	Unmarried	5.6	2.1	2.6 (2.0-3.5)	<.01
	Married	2.1	1.9	1.1 (.8-1.6)	
Parity	0 previous births	5.8	3.8	1.6 (1.2-2.0)	.31
	1-2 previous births	2.6	1.2	2.1 (1.5-3.1)	
	≥3 previous births	2.1	.9	2.3 (1.0-5.3)	
Adequacy of prenatal care utilization	Inadequate	4.4	2.2	2.0 (1.2-3.3)	.51
	Intermediate	3.3	1.5	2.2 (1.2-3.3)	
	Adequate	1.7	1.3	1.4 (.8-2.2)	
	Adequate+	6.2	3.1	2.0 (1.5-2.7)	

RR (95% CI), relative risk (95% confidence interval)

crude RR=2.1(1.1-4.2). The crude RR of abdominal wall defects among unmarried and married US-born (compared with Mexico-born) mothers was RR=2.6 (2.0-3.5) and 1.1 (0.8-1.6), respectively. Marital status was the only variable that modified the relationship between maternal nativity and abdominal wall defects ( $P<.01$ ).

In a multivariable logistic regression model, the adjusted (controlling for maternal age, education, marital status, parity, and prenatal care usage) OR of abdominal wall defects for maternal birth in the US (compared with Mexico) was 1.6 (1.2-2.0). However, the adjusted (controlling for maternal age, education, parity, and prenatal care usage) ORs of abdominal wall defects among unmarried and married US-born (compared with Mexico-born) mothers were OR=2.1 (1.6-2.9) and 1.0 (0.7-1.4), respectively. When the multivariable analyses were restricted to births in states that collected cigarette smoking data (n=776,327), the adjusted (controlling for maternal age, education, marital status, parity, prenatal care usage, and smoking status) stratum-specific OR of abdominal wall defects among infants of US-born (compared with Mexico-born) Mexican American mothers was 1.5 (1.2-2.0).

## DISCUSSION

This population-based investigation provides new information on the relationship between maternal nativity and the incidence of abdominal wall defects among Mexican Americans. We found that infants with US-born Mexican American moth-

ers have a nearly two-fold greater abdominal wall defect rate than those with Mexico-born mothers. Furthermore, traditional demographic, medical, and behavioral risk factors explain only a small proportion of this disparity. These intriguing findings provide additional evidence that maternal lifelong residence in the US, or something closely related to it, is disadvantageous to the pregnancy outcome of Mexican American women.

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The incidence of gastroschisis is rising and significantly exceeds that of omphalocele.<sup>20,21</sup> Hispanic ethnicity and young maternal age are the major risk factors for gastroschisis.<sup>18,34</sup> Most pertinent, a handful of prior studies show that US-born (compared with foreign-born) Hispanic mothers have a greater risk of delivering an infant with gastroschisis.<sup>19,30</sup> Notwithstanding the grouping of gastroschisis and omphalocele into a single category, our data highlight this phenomenon among Mexican American mothers. At first glance, teenage pregnancy is a plausible explanation. However, we found that while US-born Mexican American mothers have a greater pro-

portion of teen births than Mexico-born mothers, the nativity disparity in abdominal wall defects is widest among Mexican American mothers in their 20s. Further research into other Hispanics (ie, women of Puerto Rican, Cuban, and Central-South American descent) is warranted.

Our data show that unmarried status is associated with an increased risk of abdominal wall defects among births to US-born, but not Mexico-born, Mexican American mothers. This finding suggests a possible interplay between behavioral factors associated with marital status and abdominal wall defect rates. Interestingly, an earlier investigation found that unmarried women's acculturation to an American lifestyle was associated with an increased incidence of cigarette smoking, which is known to be a minor risk factor for gastroschisis.<sup>35</sup> However, restricting the analysis to the states that included smoking status data on birth certificates failed to attenuate the association between maternal nativity and infant abdominal wall defects. It is possible that other behavioral risk factors that were not measured in the present study may underlie the observed association between marital status, maternal nativity, and abdominal wall defects.

An extensive published literature shows that infants of US-born Mexican American mothers have greater rates of LBW, PTB, and first year mortality.<sup>2-6</sup> Acculturation to an American lifestyle is the leading explanation for these phenomena.<sup>2,6,8,10-15</sup> Using national data, Khodr et al reported an increased rate of gastroschisis among infants of more acculturated, non-teen Hispanic mothers.<sup>19</sup> In contrast, Ramadhani et

al found a decreased rate of gastroschisis among infants whose foreign-born Hispanic mothers resided in the US for >5 years.<sup>30</sup> However, neither study accounted for the heterogeneity of Hispanics. We speculate that Mexican American women's acculturation to an American lifestyle is a risk factor for gastroschisis in the developing fetus. Unhealthy pregnancy-related behaviors strongly associated with acculturation to an American lifestyle include alcohol usage, over-the-counter medications, and unhealthy diet.<sup>8,13,15,36</sup> Each of these factors can potentially impact first trimester fetal development. More detailed research is needed to identify the mechanisms underlying the association between maternal nativity and abdominal wall defects among Mexican American infants.

Given the strong association of young maternal age and abdominal wall defects in our study population and the known greater incidence of gastroschisis (compared with omphalocele), we strongly suspect that the observed greater risk of abdominal defects among US-born (compared with Mexico-born) Mexican American mothers reflects their increased risk of gastroschisis, not omphalocele. More detailed studies that separate the two entities are warranted.

Our study has a number of limitations. First, documentation of birth defects on birth certificates can be inconsistent, with variable sensitivities reported in existing literature.<sup>37,38</sup> However, the abdominal wall defect rate in this study is comparable to recent national estimates,<sup>18,20,34</sup> suggesting our data provide a reasonable representation of abdominal wall defect rates. Second, the vast majority

of states used the 1989 version of the birth certificate in which omphalocele and gastroschisis were identified by the same code, making separation of the two conditions impossible. While the 2003 revision of the birth certificate provides states the option of reporting gastroschisis and omphalocele separately, none of the handful of states using the revised version in 2003-2004 chose to do so, again precluding separation of the two abdominal wall defects.<sup>31,32</sup> Since 2005, more states have adopted the 2003 revision of the birth certificate and have captured the two birth defects separately; however, maternal nativity has been restricted from the latest public use datasets. Third, smoking can be underreported on birth certificates and thus, the results of the sensitivity analysis may not have fully captured the extent to which maternal smoking underlies the relationship between maternal nativity and abdominal wall defects.<sup>39</sup> Fourth, we did not examine maternal alcohol usage because the correlation between birth certificate data and actual maternal alcohol use is very weak.<sup>40</sup> Fifth, there is heterogeneity within Mexican Americans with respect to region of origin in Mexico, US migration patterns, and region of residence in the United States. This may limit the generalizability of our findings to select Mexican American subgroups. Lastly, birth certificates contain no information on duration of US residence, which may be relevant for Mexico-born mothers.

## CONCLUSIONS

We conclude that US-born Mexican American women have nearly a

two-fold greater rate of delivering an infant with an abdominal wall defect than their Mexico-born counterparts. This intriguing finding is only partially explained by traditional risk factors and highlights an additional detrimental impact of lifelong residence in the United States, or something closely related to it, on the pregnancy outcome of Mexican American women.

## CONFLICT OF INTEREST

No conflicts of interest to report.

## AUTHOR CONTRIBUTIONS

Research concept and design: Hibbs, Bennett, Castro, Collins; Acquisition of data: Hibbs, Bennett, Castro, Rankin, Collins; Data analysis and interpretation: Hibbs, Bennett, Castro, Rankin, Collins; Manuscript draft: Hibbs, Rankin, Collins; Statistical expertise: Bennett, Rankin; Obtained funding: Castro, Collins; Administrative: Hibbs, Castro; Supervision: Rankin, Collins.

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