Maternal Birthplace and Major Congenital Malformations among New York Hispanics

Motao Zhu,[1]* Charlotte Druschel,[2] and Shao Lin[3]

[1]Department of Epidemiology and Biostatistics, School of Public Health, State University of New York at Albany, Albany, New York
[2]The Congenital Malformations Registry, New York State Department of Health, Albany, New York
[3]Bureau of Environmental and Occupational Epidemiology, New York State Department of Health, Albany, New York

Received 9 February 2006; Revised 28 March 2006; Accepted 10 April 2006

BACKGROUND: Little is known about the association between maternal nativity and congenital malformations among Hispanics living in the United States. **METHODS:** We conducted a cross-sectional study to investigate the association between maternal nativity and various congenital malformations among singleton live-births born to Hispanic women in New York from 1993 to 2001. Birth certificates, used to identify maternal birthplace, were linked with congenital malformation registry files to obtain birth defects outcome. We examined how the risk of birth defects varied by maternal birthplace by estimating the adjusted odds ratios (aORs) using logistic regression. **RESULTS:** A foreign maternal birth showed statistically negative associations with overall congenital malformations (aOR, 0.70; 95% CI, 0.68–0.73), cardiovascular defects (aOR, 0.85; 95% CI, 0.77–0.93), central nervous system defects (aOR, 0.76; 95% CI, 0.63–0.91), and multiple defects (aOR, 0.80; 95% CI, 0.74–0.86). Specifically, foreign-born Hispanic women were statistically at reduced risk to deliver live babies with cleft palate (aOR, 0.56; 95% CI, 0.40–0.80), atresia and stenosis of rectum or anus (aOR, 0.58; 95% CI, 0.35–0.97), and craniosynostosis (aOR, 0.71; 95% CI, 0.51–0.99). Hispanic mothers born in Puerto Rico had a similar risk of delivering children with birth defects compared to U.S.-born Hispanic mothers. In contrast, Hispanic mothers born in Mexico, or Cuba and Central and South America were at reduced risk of delivering infants with overall congenital malformations (aOR, 0.64; 95% CI, 0.60–0.67) and (aOR, 0.65; 95% CI, 0.63–0.68), respectively. **CONCLUSIONS:** Foreign-born Hispanic mothers had a slightly lower risk to deliver live-born singleton infants with major congenital malformations than did U.S. born Hispanic mothers. *Birth Defects Research (Part A) 76:467–473, 2006.* © 2006 Wiley-Liss, Inc.

Key words: Hispanics; birth defects; maternal nativity

INTRODUCTION

The foreign-born population from Latin America has increased rapidly in the United States. In 1960, 900,000 immigrants were from Latin America (U.S. Census Bureau, 2000). By 1997, the Latin America–born population numbered 13.1 million, about half of the total foreign-born population in the United States (U.S. Census Bureau, 2000). Furthermore, the foreign-born Hispanic population increased at a faster rate compared to the U.S.-born Hispanic population, which resulted in a substantial change in the nativity composition of Hispanics in the United States (U.S. Census Bureau, 2000). New York State has a large Hispanic population; 22% of all live births were born to Hispanic women in 2003.

Previous research has documented that foreign-born Hispanic mothers have more favorable pregnancy outcomes, including lower infant mortality, lower rates of low birth weight, and lower preterm birth rates, relative to U.S.-born Hispanic mothers (Ventura and Taffel, 1985; Guendelman et al., 1990; Becerra et al., 1991; Collins and Shay, 1994; Singh and Yu, 1996). Hispanic maternal birth in a foreign country is considered as an indicator for the persistence of a Hispanic cultural orientation (i.e., lifestyle, diet, beliefs, and values associated with the Hispanic culture) (Scribner, 1989).

Grant sponsor: Centers for Disease Control and Prevention (CDC); Grant numbers: U50CCU213244, UC50CCU223184.
*Correspondence to: Motao Zhu, State University of New York at Albany, School of Public Health, Department of Epidemiology and Biostatistics, One University Place, Room 131, Rensselaer, NY 12144-3456.
E-mail: mxz04@health.state.ny.us
Published online in Wiley InterScience (www.interscience.wiley.com).
DOI: 10.1002/bdra.20270

Few studies have investigated Hispanic maternal nativity and congenital malformations. The only published study comparing foreign-born and U.S.-born Hispanic women was conducted in California from 1989 to 1997 (Carmichael et al., 2004). Their results suggested that U.S.-born and foreign-born Hispanic mothers had similar risk in delivering babies with various congenital malformations, except that neural tube defects were more common among babies born to foreign-born Hispanic women. Although Hispanics share many common culture characteristics, research has documented that the demographics, income, family characteristics, language spoken at home, and access to health care of the foreign-born Hispanics varied by their birth country (Ramirez et al., 1995; U.S. Census Bureau, 2000). According to the 2000 U.S. Census, Hispanics in California were primarily Mexican in origin. Hispanics in New York were primarily from Central America, South America, and Puerto Rico. Because there has been little research on maternal birthplace and congenital malformations, in particular on specific defects and specific maternal birth countries; we examined: 1) whether the risk of congenital malformations differed among the offspring of U.S.-born and foreign-born Hispanic mothers in New York State; and 2) whether risk of selected congenital malformations among the offspring of foreign-born Hispanic mothers varied by country of birth.

MATERIALS AND METHODS

We conducted a cross-sectional study to investigate the association between maternal nativity and various congenital malformations among singleton live births born to Hispanic women in New York State. Birth certificates (BCs) were used to identify all live-born singleton births to Hispanic women in New York State, from 1993 to 2001, who were residents of the state. Hispanic women were identified based on the self-reported Hispanic ethnicity. BCs collect ethnicity (category: Hispanics or not) and race separately. No multiple coding of race or ethicity was implemented during the study period. Maternal nativity was defined as U.S.-born if the mother was born within the 50 states and the District of Columbia. Otherwise, she was defined as foreign-born and further categorized as born in Puerto Rico, Mexico, Cuba, or Central and South America. Variables derived from BCs and controlled in the analysis included maternal race (white, other), maternal age at delivery ($<$35 years, $\geq$35 years), maternal education ($\leq$12 years, $>$12 years), participation in Medicaid (yes, no), participation in a special financial assistance program (yes, no), nulliparous (yes, no), previous spontaneous abortion (yes, no), prenatal care (yes, no), cigarette smoking (yes, no), alcohol consumption (yes, no), illicit drug use (yes, no), and sex of the child (male, female).

Birth defects were ascertained by linking the BC file with the Congenital Malformations Registry (CMR) file, which contains data on live-born children with major congenital malformations who are diagnosed before they were 2 years of age in New York State. A birth defect is defined as any structural, functional, or biochemical abnormality determined genetically or induced during gestation and not due to birthing events. The CMR is a population-based passive surveillance system; hospitals and physicians are mandated to report cases to the CMR (Sekhobo and Druschel, 2001). In addition, the CMR routinely identifies birth defect cases from the Department of Health's Statewide Planning and Research Cooperative System (SPARCS), a hospital discharge database, to supplement its reports (Wang et al., 2005). Birth defects were chosen according to the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes, ranging primarily from 740 to 759. They were grouped into major organ systems (cardiovascular defects, central nervous system defects, chromosomal defects, clefts, digestive defects, ear defects, eye defects, genitourinary defects, integument defects, musculoskeletal defects, respiratory defects, and multiple defects) based on 3-digit ICD-9-CM codes. Cases with multiple birth defects were placed into 1 group because they are likely to have different etiologic causes compared to cases with single birth defects. For example, if a child had spina bifida and cleft palate, the child would be grouped in the category of multiple defects only, not in central nervous system defects or clefts. The 12 specific birth defects chosen a priori based on frequency, likely similar ascertainment, and public health significance included spina bifida, transposition of great vessels, tetralogy of Fallot, hypoplastic left heart syndrome, coarctation of aorta, cleft palate, cleft lip with or without cleft palate, tracheoesophageal fistula, atresia and stenosis of small intestine, atresia and stenosis of rectum or anus, reduction deformities of limb, and craniosynostosis. The specific defects included isolated malformations only.

We applied logistic regression to compare foreign-born Hispanic mothers with U.S.-born Hispanic mothers and estimated the adjusted odds ratios (aORs) and 95% confidence interval (CI) for overall birth defects, birth defects groups, and specific birth defects. All statistical analyses were conducted using SAS 9.1 (SAS Institute, Cary, NC).

RESULTS

In New York State from 1993 to 2001, a total of 19,351 singleton live births with major congenital malformations were delivered to Hispanic women. The prevalence of congenital malformation was 3.8 per 100 live births for foreign-born Hispanic women and 4.9 per 100 live births for U.S.-born Hispanic women. Approximately 82.2% of cases had only 1 major birth defect.

Socioeconomic and health-related characteristics varied by the nativity of the Hispanic mothers (Table 1). Substantial differences were seen in socioeconomic factors. Compared to U.S.-born Hispanic mothers, foreign-born Hispanic mothers were 1.7 times more likely to deliver an infant after age 35, 33% less likely to obtain some college education, 1.4 times more likely to be non-white, 1.3 times more likely to receive Medicaid, and 1.3 times more likely to participate in a special financial assistance program. A U.S.-born mother was more likely to be nulliparous and to have experienced a previous spontaneous abortion. A majority of foreign-born and U.S.-born Hispanic mothers utilized prenatal care; the percentage of prenatal care use was 97.8% among foreign-born Hispanic mothers and 97.5% among U.S.-born Hispanic mothers. Relative to U.S.-born Hispanic mothers, foreign-born Hispanic mothers were 76% less likely to smoke cigarettes, 63% less likely to drink alcohol, and 51% less likely to use illicit drugs.

Table 1
Socioeconomic and Health-Related Characteristics by Hispanic Mothers' Nativity, New York, 1993–2001

	Foreign-born		U.S.-born[a]		
Maternal characteristics	*n*	%	*n*	%	RR (95% CI)
Socioeconomic					
Age ≥35 years	39,616	12.7	11,001	7.3	1.74 (1.71–1.78)
Education >12 years	65,957	21.8	48,374	32.6	0.67 (0.66–0.67)
Non-white race	34,150	11.1	11,745	7.9	1.41 (1.38–1.44)
Medicaid	233,027	75.8	87,757	59.0	1.29 (1.28–1.29)
Special financial program	200,865	65.0	75,682	50.9	1.28 (1.27–1.29)
Health related					
Nulliparous	119,725	40.9	66,999	47.2	0.87 (0.86–0.87)
No prenatal care	6,168	2.2	3,232	2.5	0.91 (0.88–0.95)
Previous spontaneous abortion	43,875	15.0	29,462	20.6	0.73 (0.72–0.73)
Smoked cigarettes	6,482	2.1	13,214	8.9	0.24 (0.23–0.24)
Drank alcohol	633	0.2	830	0.6	0.37 (0.33–0.41)
Used illicit drugs	12,672	4.1	11,805	8.4	0.49 (0.48–0.51)
Total births	311,811		130,757		

[a]Reference group.

Comparisons of the crude odds ratios (cORs) and aORs for overall birth defects and birth defects groups between foreign-born and U.S.-born Hispanic mothers are shown in Table 2. The cORs and aORs were similar. A foreign maternal birth showed statistically significant negative associations with overall congenital malformations (aOR, 0.70; 95% CI, 0.68–0.73), cardiovascular defects (aOR, 0.85; 95% CI, 0.77–0.93), central nervous system defects (aOR, 0.76; 95% CI, 0.63–0.91), digestive defects (aOR, 0.86; 95% CI, 0.75–0.98), musculoskeletal defects (aOR, 0.91; 95% CI, 0.84–0.99), and multiple defects (aOR, 0.80; 0.74–0.86). Two groups had aORs >1.25 but were not statistically significant; they include chromosomal defects (aOR, 1.32; 95% CI, 0.94–1.86) and ear defects (aOR, 1.43; 95% CI, 0.95–2.17). The aORs for other systems, including clefts, eye defects, genitourinary defects, integument defects, and respiratory defects, were close to 1.0 and were not statically significant.

The cORs and aORs for the 12 selected specific malformations are shown in Table 3. Foreign-born Hispanic women were at a reduced risk to deliver live babies with cleft palate (aOR, 0.56; 95% CI, 0.40–0.80), atresia and stenosis of rectum or anus (aOR, 0.58; 95% CI, 0.35–0.97), and craniosynostosis (aOR, 0.71; 95% CI, 0.51–0.99). These results were statistically significant. Two defects (tetralogy of Fallot and tracheoesophageal fistula) had negative associations with aORs ≤0.8, but these were not statistically significant. Foreign-born mothers showed a higher risk for a baby with spina bifida (aOR, 1.26; 95% CI, 0.83–1.91); however, this was not statistically significant.

Table 2
Crude Odds Ratios (cORs) and Adjusted Odds Ratios (aORs) for Total Birth Defects and Grouped Defects by Maternal Place of Birth, Hispanic Mothers, New York, 1993–2001

		Crude OR[a]		Adjusted OR[a,c]	
Congenital malformation	*n* (Case)	cOR	95% CI	aOR	95% CI
Total birth defects	19,351	0.77	0.74–0.79[b]	0.70	0.68–0.73[b]
Foreign-born	11,920				
U.S.-born	7,431	1.00		1.00	
Major system defects					
Cardiovascular defects	2,429	0.83	0.77–0.90[b]	0.85	0.77–0.93[b]
Central nervous system defects	604	0.85	0.72–1.01	0.76	0.63–0.91[b]
Chromosomal defects	234	1.76	1.29–2.40	1.32	0.94–1.86
Clefts	337	0.85	0.68–1.07	0.83	0.85–1.07
Digestive defects	1,174	0.83	0.73–0.93[b]	0.86	0.75–0.98[b]
Ear defects	148	1.60	1.09–2.35	1.43	0.95–2.17
Eye defects	119	1.06	0.72–1.56	1.03	0.67–1.61
Genitourinary defects	3,062	0.96	0.89–1.03	0.98	0.90–1.07
Integument defects	81	0.86	0.54–1.35	0.84	0.51–1.39
Musculoskeletal defects	3,118	0.92	0.85–0.99[b]	0.91	0.84–0.99[b]
Respiratory defects	295	0.88	0.69–1.11	0.84	0.64–1.09
Multiple defects	3,479	0.87	0.81–0.94[b]	0.80	0.74–0.86[b]

[a]The reference group is U.S.-born Hispanic mothers.
[b]Statistical significance at $\alpha = 0.05$ for 2-sided test.
[c]The aORs from the logistic regression model were adjusted for maternal race, maternal age, maternal education, child sex, previous live births, previous spontaneous abortion, Medicaid, and participation in special financial assistance program.

Table 3
Crude Odds Ratios (cORs) and Adjusted Odds Ratios (aORs) for Selected Specific Birth Defects by Maternal Place of Birth, Hispanic Mothers, New York, 1993–2001

Specific birth defects	*n* (cases)	Crude OR[a]		Adjusted OR[a,b]	
		cOR	95% CI	aOR	95% CI
Spina bifida	134	1.30	0.89–1.91	1.26	0.83–1.91
Transposition of great vessels	71	1.22	0.73–2.04	1.05	0.58–1.89
Tetralogy of Fallot	124	0.84	0.58–1.21	0.72	0.48–1.08
Hypoplastic left heart syndrome	43	1.10	0.58–2.11	0.87	0.43–1.75
Coarctation of aorta	52	0.83	0.47–1.46	0.85	0.46–160
Cleft palate	166	0.64	0.47–0.87[b]	0.56	0.40–0.80[b]
Cleft lip with or without cleft palate	225	1.06	0.80–1.40	1.19	0.86–1.64
Tracheoesophageal fistula	63	0.64	0.39–1.05	0.60	0.34–1.05
Atresia and stenosis of small intestine	58	0.78	0.46–1.33	0.91	0.50–1.67
Atresia and stenosis of rectum or anus	78	0.65	0.42–1.02	0.58	0.35–0.97[c]
Reduction deformities of limb	114	0.85	0.58–1.25	0.83	0.55–1.27
Craniosynostosis	185	0.75	0.56–1.01	0.71	0.51–0.99[c]

[a]The reference group is U.S.-born Hispanic mothers.
[b]The aORs from logistic regression model were adjusted for maternal race, maternal age, maternal education, child sex, previous live births, previous spontaneous abortion, Medicaid, and participation in special financial assistance program.
[c]Indicates statistical significance at $\alpha = 0.05$ for 2-sided test.

The aORs for the remaining birth defect groups were close to 1.0.

We further analyzed the relationship between specific birthplace and birth defects. Of the foreign-born Hispanic mothers, 13.2% were born in Puerto Rico, 19.0% in Mexico, and 67.8% in Cuba or Central and South America. The logistic regression results for overall birth defects and major birth defects groups for specific maternal birthplace using U.S.-born as the reference exposure group is displayed in Table 4. For overall birth defects, a maternal birth in Mexico was protective (aOR, 0.64; 95% CI, 0.60–0.67), as was a maternal birth in Cuba or Central and South America (aOR, 0.65; 95% CI, 0.63–0.68). These results were statistically significant. In contrast, Hispanic mothers born in Puerto Rico had a risk of delivering children with birth defects that was similar to the risk in U.S.-born Hispanic mothers (aOR, 1.03; 95% CI, 0.98–1.09). For major defect groups, the aORs for mothers born in Puerto Rico were close to 1.0 or nonsignificant. Hispanic women born in Mexico were statistically less likely to deliver a child with cardiovascular defects (aOR, 0.86; 95% CI, 0.74–0.99), central nervous system defects (aOR, 0.63; 95% CI, 0.47–0.85), musculoskeletal defects (aOR, 0.86; 95% CI, 0.75–0.98), or multiple defects (aOR, 0.81; 95% CI, 0.71–0.91), but were at statistically higher risk of ear defects (aOR, 2.90; 95% CI, 1.76–4.79). The other aORs were not statistically significant. Hispanic women born in Cuba or Central and South America were statistically less likely to deliver a child with cardiovascular defects (aOR, 0.79; 95% CI, 0.71–0.87), central nervous system defects

Table 4
Adjusted Odds Ratios (aORs) for Total Birth Defects and Grouped Birth Defects by Native Country or Region, Foreign-born Hispanic Mothers, New York, 1993–2001

Congenital malformation	Puerto Rico		Mexico		Cuba and Central and South America	
	aOR[a]	95% CI	aOR[a]	95% CI	aOR[a]	95% CI
Overall major congenital malformation	1.03	0.98–1.09	0.64	0.60–0.67[b]	0.65	0.63–0.68[b]
Major system defects						
Cardiovascular defects	1.10	0.95–1.28	0.86	0.74–0.99[b]	0.79	0.71–0.87[b]
Central nervous system defects	1.02	0.76–1.37	0.63	0.47–0.85[b]	0.74	0.60–0.90[b]
Chromosomal defects	1.27	0.75–2.14	1.56	0.97–2.53	1.28	0.89–1.83
Clefts	0.65	0.40–1.05	0.96	0.66–1.39	0.84	0.64–1.10
Digestive defects	0.92	0.73–1.15	1.11	0.92–1.34	0.77	0.67–0.89[b]
Ear defects	1.37	0.72–2.63	2.90	1.76–4.79[b]	1.05	0.66–1.67
Eye defects	0.60	0.23–1.53	1.49	0.83–2.65	0.99	0.61–1.60
Genitourinary defects	1.09	0.95–1.25	0.99	0.87–1.13	0.95	0.87–1.04
Integument defects	1.06	0.48–2.36	0.72	0.31–1.63	0.83	0.48–1.42
Musculoskeletal defects	1.01	0.88–1.16	0.86	0.75–0.98[b]	0.91	0.83–0.99[b]
Respiratory defects	0.93	0.60–1.45	0.87	0.58–1.32	0.81	0.61–1.08
Multiple defects	1.03	0.91–1.17	0.81	0.71–0.91[b]	0.74	0.68–0.81[b]

[a]The reference group is US-born Hispanic mothers. The aORs from logistic regression model were adjusted for maternal race, maternal age, maternal education, child sex, previous live births, previous spontaneous abortion, Medicaid, and participation in special financial assistance program.
[b]Statistical significance at $\alpha = 0.05$ for 2-sided test.

Table 5
Adjusted Odds Ratios (aORs) for Specific Birth Defects by Native Country or Region, Foreign-born Hispanic Mothers, New York, 1993–2001

	Puerto Rico		Mexico		Cuba, Central and South America	
Congenital malformation	aORa	95% CI	aOR[a]	95% CI	aOR[a]	95% CI
Spina bifida	1.41	0.74–2.69	1.24	0.69–2.24	1.22	0.78–1.92
Transposition of great vessels	1.10	0.43–2.82	0.46	0.15–1.40	1.20	0.66–2.21
Tetralogy of Fallot	1.06	0.56–1.98	0.35	0.15–0.79[b]	0.76	0.49–1.17
Hypoplastic left heart syndrome	0.95	0.31–2.94	0.50	0.14–1.83	0.96	0.46–2.00
Coarctation of aorta	1.28	0.50–3.27	0.42	0.12–1.47	0.89	0.45–1.75
Cleft palate	0.55	0.28–1.07	0.49	0.27–0.90[b]	0.58	0.40–0.85[b]
Cleft lip with or without cleft palate	0.74	0.40–1.38	1.69	1.10–2.62[b]	1.17	0.82–1.65
Tracheoesophageal fistula	0.45	0.14–1.51	0.77	0.33–1.80	0.58	0.31–1.08
Atresia and stenosis of small intestine	1.21	0.48–3.05	0.98	0.39–2.44	0.82	0.41–1.60
Atresia and stenosis of rectum or anus	0.81	0.35–1.87	0.33	0.13–0.88[b]	0.62	0.36–1.07
Reduction deformities of limb	0.40	0.14–1.12	1.09	0.59–2.01	0.86	0.55–1.35
Craniosynostosis	1.00	0.59–1.70	0.52	0.29–0.93[b]	0.70	0.49–1.00

[a]The reference group is U.S.-born Hispanic mothers. The aORs from logistic regression model were adjusted for maternal race, maternal age, maternal education, child sex, previous live births, previous spontaneous abortion, Medicaid, and participation in special financial assistance program.
[b]Statistical significance at $\alpha = 0.05$ for 2-sided test.

(aOR, 0.74; 95% CI, 0.60–0.90), digestive defects (aOR, 0.77; 95% CI, 0.67–0.89), musculoskeletal defects (aOR, 0.91; 95% CI, 0.83–0.99), and multiple defects (aOR, 0.74; 95% CI, 0.68–0.81).

The results for logistic regression analyses of the selected defects for specific maternal birthplace using U.S.-born Hispanic mothers as the referent group is shown in Table 5. All aORs for mothers born in Puerto Rico were not statistically significant. Mexico-born mothers had statistically significant decreased risk of having a child with tetralogy of Fallot (aOR, 0.35; 95% CI, 0.15–0.79), cleft palate (aOR, 0.49; 95% CI, 0.27–0.90), atresia and stenosis of rectum or anus (aOR, 0.33; 95% CI, 0.13–0.88), and craniosynostosis (aOR, 0.52; 95% CI, 0.29–0.93). Mexico-born women showed an increased risk for cleft lip with or without cleft palate (aOR, 1.69; 95% CI, 1.10–2.62). Hispanic women born in Cuba or Central and South America had reduced risk of having a child with cleft palate (aOR, 0.58; 95% CI, 0.40–0.85). All other aORs were not statistically significant.

In addition, we obtained information on paternal birthplace (U.S.-born, foreign-born) from the BC. Maternal and paternal birthplace were combined into categories and their associations for congenital malformations were examined. The 4 categories created were as follows: 1) maternal birthplace: U.S., paternal birthplace: U.S.; 2) maternal birthplace: U.S., paternal birthplace: foreign; 3) maternal birthplace: foreign, paternal birthplace: U.S.; and 4) maternal birthplace: foreign, paternal birthplace: foreign. Results did not suggest that paternal birthplace modified the effect of maternal birthplace on birth defects (data not shown).

DISCUSSION

The overall congenital malformation prevalence in New York from 1993 to 2001 was 4.9 per 100 singleton live births and 3.8 per 100 live births for U.S.-born Hispanic mothers and foreign-born Hispanic mothers, respectively. Foreign-born Hispanic mothers experienced a 30% lower risk of delivering live-born singleton infants with overall major congenital malformations, despite their lower socioeconomic status. The only published study for comparison, by Carmichael et al. (2004), reported that U.S.-born and foreign-born Hispanic mothers had similar a prevalence of delivering babies with overall structural congenital malformation—2.0 per 100 live births and stillbirths in California from 1989 to 1997. Our study supports their findings that foreign-born Hispanic mothers were at reduced risk for offspring with cardiovascular defects, digestive defects, tetralogy of Fallot, cleft palate, atresia and stenosis of rectum or anus, and craniosynostosis, although they documented a milder reduced effect. Particularly, we found a 26% increased risk for spina bifida with or without hydrocephalus among babies born to foreign-born Hispanic mothers, which is consistent with other studies (Strassburg, 1983; Shaw, 1997; Carmichael et al., 2004). Based on Carmichael et al.'s (2004) study of California births from 1989 through 1997, foreign-born Hispanics were had ~1.2 times the risk of giving birth to spina bifida as compared with U.S.-born Hispanics. Shaw et al.'s (1997) study of California births from 1989 through 1991 reported that Mexico-born Mexicans had ~2.1 times the risk to give birth to neural tube defects as compared with U.S.-born Mexicans. Strassburg et al. (1983) reported a 10% increased risk for spina bifida with anencephalus and 50% increased risk for spina bifida without anencephalus among babies born to Mexico-born Hispanic mothers as compared to U.S.-born Hispanics in Los Angeles County from 1973 to 1977. In our study, despite an increased risk to give birth to babies with spina bifida, foreign-born Hispanic mothers were at reduced risk for the overall central nervous system defects (aOR, 0.76; 95% CI, 0.63–0.91). This overall decrease results from lower risk for the foreign-born Hispanic mothers of giving birth to babies with other central nervous system anomalies, particularly isolated hydrocephalus (aOR, 0.63; 95% CI, 0.46–0.86) and microcephalus (aOR, 0.59; 95% CI, 0.41–0.86). Carmichael et al.'s (2004) study of live-births and stillbirths in California from 1989 to 1997 reported that U.S.-born and foreign-born Hispanic mothers had a similar prevalence of delivering babies with hydrocephalus including both isolated hydrocephalus and spina bifida with hydrocephalus.

Hispanic maternal birth in a foreign country is an indicator for the perseverance of a Hispanic cultural orientation, such as lifestyle, diet, beliefs, and values associated with Hispanic culture (Scribner and Dwyer, 1989). The possible Hispanic cultural components include a balanced diet with less fat and sodium, planned pregnancy, marital stability, familial support, religiosity, and lower rates of smoking, drug abuse, premarital birth, and adolescent pregnancies (Collins and Shay, 1994; Singh and Yu, 1996; English et al., 1997). Human studies have documented that good nutrition status reduces the risk of birth defects and the American Dietetic Association recommends that women consume balanced foods during pregnancy (Kaiser and Allen, 2002). Our study found that foreign-born Hispanic mother were 76% less likely to smoke cigarettes, 63% less likely to drink alcohol, and 51% less likely to use illicit drugs, relative to U.S.-born Hispanic mothers. Our findings are consistent with Coonrod et al.'s (2004) study, which reported that low-acculturation Hispanic mothers were less likely to smoke cigarettes, drink alcohol, and abuse drugs, relative to high-acculturation Hispanic mothers. According to the 1988 National Maternal and Infant Health Survey, foreign-born mothers were less likely to use alcohol and marijuana/cocaine during pregnancy than U.S.-born mothers.

The aORs for foreign-born Hispanics range from ~0.6 to 1.5. This might suggest that maternal nativity, a surrogate of cultural orientation including lifestyle, nutrition, and familial support, does not have strong effects on birth defects. It has been documented that the protective effects of foreign maternal nativity on other pregnancy outcomes are also mild (Ventura and Taffel, 1985; Guendelman et al., 1990; Becerra et al., 1991; Collins and Shay, 1994; Singh and Yu, 1996). Singh and Yu (1996) analyzed national linked birth and infant death records from 1985 to 1987 and found estimated aORs ranging from 0.80 to 1.63 for pregnancy outcomes, including infant mortality, low birth weight, and preterm birth, after adjustment for maternal race, maternal age, marital status, maternal education, metropolitan residence, plurality, birth order, and trimester of prenatal care initiation.

In our study, compared to U.S.-born Hispanic mothers, Hispanic mothers born in Puerto Rico had a similar risk of delivering infants with congenital malformations, and those born in Mexico, Cuba, or Central and South America were at reduced risk. Our results confirm that foreign-born Hispanic women are not homogenous and there are some subgroup differences by specific maternal birth county. We suspect that mothers born in Puerto Rico might have a similar cultural orientation to U.S.-born Hispanics because Puerto Rico is a U.S. territory. Mothers born in Mexico, Cuba, and Central and South America preserve their lifestyle, beliefs, and values more during the acculturation process.

This study had several limitations. First, because the New York State CMR relies on passive case ascertainment, completeness and accuracy may be a concern. Based on a capture-recapture estimate, Honein and Paulozzi (1999) reported that the completeness of the CMR was 86.4%, which was similar to that of Metropolitan Atlanta Congenital Defects Program (MACDP), an active surveillance regarded as the ''gold standard.'' First, additional internal studies have shown an 85% accuracy to cardiac defect reports when compared to medical records, and onsite audits of hospitals have documented that reports to the CMR are >90% correct when compared to the medical record. Second, maternal birthplace is a rough measurement of cultural orientation and acculturation. Information was not available on length of maternal residence in the United States, generation status, mother's language spoken at home and outside of the home, behavioral and lifestyle habits, and nutrition status. Third, prevalence bias might exist because we could not include terminated cases and therefore could not calculate incidence; this is a limitation for most birth defects studies. The influence and magnitude of this prevalence bias would depend on the access and utilization of prenatal diagnosis and elective abortion for birth defects. If U.S.-born Hispanic mothers tended to choose termination more often than foreign-born Hispanic mothers, the ORs would be influenced toward the null, especially for those birth defects such as neural tube defects, for which pregnancies more commonly terminated (Roberts et al., 1995). This is supported by Velie and Shaw's (1996) study of California's births from 1989 through 1991 on neural tube defects. These authors documented that inclusion of elective terminations for neural tube defects would reduce the OR from 2.5 to 1.8 when comparing foreign-born with U.S.-born Hispanic mothers. The prevalence bias for birth defects that are less likely to cause a pregnancy to be terminated, such as clefts, would be weaker. Additionally, we cannot rule out that some statistically significant results were due to multiple tests.

Despite the limitations noted, this study is one of the first studies to document that foreign-born Hispanic mothers deliver fewer infants with congenital malformations than U.S.-born Hispanic mothers, using birth defects accumulated during 9 years from one of the nation's largest population-based birth defects registries and adjusting for several potential confounders. We examined not only birth defects overall or specifically only neural tube defects, but also birth defects by major organ systems and 12 specific birth defects with public health implications. Our research is one of the first attempts not only to extend the well-documented epidemiologic paradox from other pregnancy outcomes to congenital malformation but also to recognize that the reduced birth defects risk varied by maternal birth country. Further studies are needed to investigate factors influencing and preserving favorable lifestyle during the Hispanic acculturation process.

ACKNOWLEDGMENTS

We thank Dr. Erin Bell and Ms. April Austin for their assistance in reviewing this manuscript.

REFERENCES

Becerra J, Hogue CJ, Atrash HK, Perez N. 1991. Infant mortality among Hispanics: a portrait of heterogeneity. JAMA 265:217–221.

Carmichael SL, Shaw GM, Kaidarova Z. 2004. Congenital malformations in offspring of Hispanic and African-American women in California, 1989–1997. Birth Defects Res A Clin Mol Teratol 70:382–388.

Collins JW, Shay DK. 1994. Prevalence of low birth weight among Hispanic infants with United States-born and foreign-born mothers: the effect of urban poverty. Am J Epidemiol 139:184–192.

Coonrod DV, Bay RC, Balcazar H. 2004. Ethnicity, acculturation and obstetric outcomes, different risk factor profile in low- and high-acculturation Hispanics and in White Non-Hispanics. J Reprod Med 49:17–22.

English PB, Kharrazi M, Guendelman S. 1997. Pregnancy outcomes and risk factors in Mexican Americans: the effects of language use and mother's birthplace. Ethn Dis 7:229–240.

Guendelman S, Gould JB, Hudes M, Eskenazi B. 1990. Generational differences in perinatal health among the Mexican American population: findings from the HHANES 1982–1984. Am J Public Health 80(Suppl): 61–65.

Honein M, Paulozzi LJ. 1999. Birth defects surveillance: assessing the ''gold standard.'' Am J Public Health 89:1238–1240.

Kaiser LL, Allen L,American Dietetic Association. 2002. Position of the American Dietetic Association: nutrition and lifestyle for a healthy pregnancy outcome. J Am Diet Assoc 102:1479–1490.

Ramirez AG, Villarreal R, Suarez L, Flores ET. 1995. The emerging Hispanic population: a foundation for cancer prevention and control. Monogr Natl Cancer Inst 18:1–9.

Roberts HE, Moore CA, Cragan JD, et al. 1995. Impact of prenatal diagnosis on the birth prevalence of neural tube defects, Atlanta, 1990–1991. Pediatrics 96:880–883.

Scribner R, Dwyer JH. 1989. Acculturation and low birthweight among Latinos in the Hispanic HANES. Am J Public Health 79:1263–1267.

Sekhobo JP, Druschel CM. 2001. An evaluation of congenital malformations surveillance in New York State: an application of Centers for Disease Control and Prevention (CDC) guidelines for evaluating surveillance systems. Public Health Rep 116:296–305.

Shaw GM, Velie EM, Wasserman CR. 1997. Risk for neural tube defect–affected pregnancies among women of Mexican descent and White women in California. Am J Public Health 87:1467–1471.

Singh GK, Yu SM. 1996. Adverse pregnancy outcomes: differences between US- and foreign-born women in major US racial and ethnic groups. Am J Public Health 86:837–843.

Strassburg MA, Greenland S, Portigal LD, Sever LE. 1983. A population-based case-control study of anencephalus and spina bifida in a low-risk area. Dev Med Child Neurol 25:632–641.

U.S. Census Bureau. 2000. Census 2000 brief: coming from the Americas: a profile of the nation's Latin American foreign born. Washington, DC: U.S. Census Bureau.4 p. Available at: http://www.census.gov/prod/2000pubs/cenbr003.pdf. Accessed: May 4, 2006.

Velie EM, Shaw GM. 1996. Impact of prenatal diagnosis and elective termination on prevalence and risk estimates of neural tube defects in California, 1989–1991. Am J Epidemiol 144:473–479.

Ventura SJ, Taffel SM. 1985. Childbearing characteristics of US-born and foreign-born Hispanic mothers. Public Health Rep 100:647–652.

Wang Y, Sharpe-Stimac M, Cross PK, et al. 2005. Improving case ascertainment of a population-based birth defects registry in New York State using hospital discharge data. Birth Defects Res A Clin Mol Teratol 73:663–668.