Birth Defect Survival for Hispanic Subgroups

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Abstract

Background—Previous studies demonstrate that infant and childhood mortality differ among children with birth defects by maternal race/ethnicity, but limited mortality information is published for Hispanic ethnic subgroups.

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Methods—We performed a retrospective cohort study using data for children with birth defects born to Hispanic mothers during 1999–2007 from 12 population-based state birth defects surveillance programs. Deaths were ascertained through multiple sources. Survival probabilities were estimated by the Kaplan-Meier method. Cox proportional hazards regression was used to examine the effect of clinical and demographic factors on mortality risk.

Results—Among 28,497 Hispanic infants and children with major birth defects, 1-year survival was highest for infants born to Cuban mothers at 94.6% (95% confidence intervals [CI] 92.7–96.0) and the lowest for Mexicans at 90.2% (95% CI 89.7– 90.6; $p < .0001$). For children aged up to 8 years, survival remained highest for Cuban Americans at 94.1% (95% CI 91.8–95.7) and lowest for Mexican Americans at 89.2% (95% CI 88.7–89.7; $p = .0002$). In the multivariable analysis using non-Hispanic White as the reference group, only infants and children born to Mexican mothers were noted to have a higher risk of mortality for cardiovascular defects.

Conclusions—This analysis provides a better understanding of survival and mortality for Hispanic infants and children with selected birth defects. The differences found in survival, particularly the highest survival rates for Cuban American children and lowest for Mexican American children with birth defects, underscores the importance of assessing Hispanic ethnic subgroups, as differences among subgroups appear to exist.

1. Introduction

Birth defects affect approximately 1 in 33 newborns and are a leading cause of infant mortality in the United States (Centers for Disease Control and Prevention, 2008; Heron et al., 2009). Birth defects are also a major contributor to pediatric hospitalizations, chronic childhood illness, and developmental disabilities (Utah Department of Health, n.d.). Given the heterogeneity of the U.S. population, it is important to understand how birth defects are affecting different racial/ethnic communities. Health disparities in both prevalence and survival are well described in non-Hispanic (NH) Black as well as Hispanic children with birth defects compared with NH-White children (Broussard et al., 2012; Centers for Disease Control and Prevention, 2010; Nembhard, Pathak, & Schocken, 2008; Nembhard et al., 2011; Reddy et al., 2011; Yang et al., 2006). Previous analyses of survival differences using population-based data have largely been limited to large racial groups (e.g., Whites and Blacks) or combined minority groups and have rarely examined racial/ethnic survival differences across more than one type of birth defect. The few studies that have assessed multiple birth defects for maternal racial/ethnic groups, noted that researchers should conduct further studies of variations among Hispanic ethnic subgroups, as previous studies have suggested potential variations in outcomes among these subgroups (Kucik et al., 2014; Reichman & Kenney, 1998).

Hispanics are the fastest growing minority population in the United States, constituting 17% of the population (Brown, n.d.; State and County Quickfacts, n.d.), but are a very heterogeneous group with the largest proportions comprised of Mexicans, Puerto Ricans,

and Cubans (Motel & Patten, n.d.). Overall, pediatric studies stratified by these Hispanic ethnic subgroups are limited. One statewide study assessing low birth weight and preterm delivery in Hispanic subgroups demonstrated that the risk of preterm delivery and low birth weight differed among these groups (Reichman & Kenney, 1998). In one of the few studies assessing the prevalence of an array of major birth defects prevalence among broader Hispanic subgroups, the study noted that Hispanic mothers born in Mexico/Central America were more likely to deliver babies with spina bifida and anotia or microtia than their U.S.-born counterparts (Ramadhani et al., 2009). Prevalence (but not survival) of birth defects among Hispanic ethnic subgroups was noted in one study, demonstrating that Mexican American children had a higher prevalence of anotia and microtia and Puerto Rican children had a higher prevalence of anencephaly (Canfield et al., 2014).

Obtaining information about Hispanic ethnic subgroups has been problematic in studies investigating survival among infants and children with birth defects that have relied on hospital discharge data, single institution medical records, or population-based surveillance data from a single state registry. These data sources typically do not have adequate sample sizes or sufficient subgroup variation to adequately evaluate this information among Hispanics. Also, while smaller studies have assessed birth defect prevalence and survival for Hispanic ethnic subgroups (Cohen, Friedman, Mahan, Lederman, & Munoz, 1993; Reichman & Kenney, 1998), there is a need for a large population-based study to explore survival of infants with birth defects among Hispanic ethnic subgroups.

The objectives of this study were to (a) evaluate survival of infants and children of Hispanic ethnic subgroups with selected major birth defects, and (b) identify potential demographic and clinical factors associated with survival.

2. Methods

2.1. Population studied

A retrospective, population-based cohort study was conducted on all live births (singletons and multiples) between 1999 and 2007 with selected major birth defects from 12 population-based state birth defects surveillance programs that were pooled for larger collaborative studies of survival among all children with birth defects (Meyer et al., 2016; Wang et al., 2015). The population-based systems used either active (four state birth defects surveillance programs) or passive (eight state birth defects surveillance programs) case finding methodologies to identify all potential cases within a defined catchment area. For active case finding methodology, birth defects cases are actively identified by individuals reviewing birth defects data; for passive case finding methodology, cases are reported by providers/facilities or administrative/other data sets. Data for birth cohorts were included from 12 states (Appendix A). Our data include 1-year survival from all years for all states. In the current analysis, we included infants born to Hispanic mothers, who were subcategorized into Mexican, Puerto Rican, Cuban, and Other (Central and South American and other and unknown Hispanic), and infants born to NH-White mothers. For the purposes of this article, infants and children born to Mexican, Puerto Rican, and Cuban mothers will be referred to as Mexican, Puerto Rican, and Cuban, including Hispanic Blacks, if any. The study protocol was approved by each state's Institutional Review Board.

2.2. Determining birth defects

The International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) and British Paediatric Association (BPA) codes (Appendix B) were used to classify birth defects by each state program in our study. We selected birth defect categories based on the likelihood that these defects were consistently diagnosed during early infancy and ascertained by state surveillance programs, given that these programs were either actively surveilled or cases were reported by providers/facilities or administrative/other data sets (Canfield et al., 2014). If a child had any of these selected birth defects, information on any additional birth defects of the child were also included in the data set.

2.3. Vital statistics

Each state surveillance program linked their birth defect case information to state death certificate data files (follow-up ranging from 1 to 8 years) to obtain the vital status of the study cohort. For deceased children, programs provided the date of death, duration of life in days, and underlying cause of death. Eight states only used state death certificates to determine child and infant death. Other states used additional data sources to obtain vital status information included hospital discharge files, medical records, and the National Death Index. Two state programs also collected information on deaths among their residents from neighboring states' vital records.

2.4. Demographic data

Surveillance programs matched cases to state birth certificate records to obtain demographic and clinical characteristics. These included infant sex (male, female), birth weight (<2,500 and 2,500 g), gestational age (<37 and 37 weeks), plurality (singleton, multiple births), method of delivery (vaginal, caesarean), maternal age (<34 and 35 years), maternal education (high school, > high school), maternal nativity (U.S.-born, foreign-born), marital status (married, single), prenatal care (yes, no), maternal prenatal cigarette smoking (yes, no), maternal diabetes of any type (yes, no), maternal residence at delivery (metropolitan, non-metropolitan [based on county of maternal residence], and state of residence), and maternal race/ethnicity (NH White, Hispanic [Mexican, Cuban, Puerto Rican, and Hispanic other]). The maternal race/ethnicity were obtained from birth certificates of the infants/children through matching of the birth defect cases of the participating state birth defect surveillance programs to state vital records (birth certificates). The maternal race/ethnicity information in the birth certificate records are self-reported by mothers/fathers. All 12 programs had complete data on Hispanic subgroups for all years of the study and all ethnic subgroups listed above.

2.5. Statistical analysis

Using the Kaplan-Meier Product Limit method, survival probabilities for infant (< 1 year of age) and early childhood (1–8 years of age) were calculated for individual defects by maternal race/ethnicity. Greenwood's method was used to calculate 95% confidence intervals (CI) for estimates of survival probabilities. Data from all 12 birth defect programs were used to calculate infant survival estimates. For the analyses of survival beyond infancy, 10 programs' data were analyzed using data for those born during 1999–2005; Illinois and

Nebraska data were excluded because of unavailability of vital status beyond infancy. Additionally, the birth cohort for New Jersey was only through 2005, making this the last birth year to be included for all 10 programs in the analysis. Thus, the longest period of follow-up was 8 years.

An initial bivariate analysis of all the selected variables was performed to determine possible explanatory variables for inclusion in multivariable models. Multivariable analysis using Cox proportional hazards regression models was conducted to explore associations between the explanatory variables and survival, controlling for infant sex, gestational age, birth weight, maternal age, maternal metropolitan or nonmetropolitan county of residence at delivery, maternal nativity, maternal race/ethnicity, surveillance methodology (active or passive case ascertainment), maternal diabetes, plurality, prenatal care, method of delivery, and birth year. The proportionality assumption was examined in the Cox model. Children with more than one defect are represented in more than one defect category.

SAS Version 9.2 (SAS Institute, Cary, NC) was used for all statistical analyses.

3. Results

During the study period, the 12 programs ascertained cases among approximately 14 million live births (about 39% of all live births in the United States), with 98,833 infants identified as having at least one of the 21 selected birth defects. Of these, we identified 28,497 Hispanic births (28.8% of all births with birth defects), with all cases having vital status data for the infancy period, thus all being included in the first year survival analysis. A total of 18,342 cases who survived beyond infancy (1 year of age) were followed up to 8 years. Of all infants, we had 69.8% Mexican (n = 19,881), 7.1% Puerto Rican (n = 2,024), 2.7% Cuban (n = 773), and 20.4% Hispanic other (n = 5,819) (e.g., mothers from Central and South American countries) (Table 1). NH Whites were the referent group. A total of 2,688 Hispanic infants (9.4%) died in infancy with a survival probability of 90.6% (95% CI: 90.2–90.9); 4,165 (7.6%) of NH-White infants died in infancy, with a survival probability of 92.4% (95% CI: 92.1–92.6). There were 202 Hispanic children (1.1%) who died during childhood with the survival probability of 98.9% (95% CI: 98.799.0); 327 NH-White children (0.9%) died during childhood, with the survival probability of 99.1% (95% CI: 99.0–99.2). The highest infant survival probability was in Cubans at 94.6% (95% CI 92.7–96.0), followed by NH Whites at 92.4% (95% CI 92.1–92.6). The lowest infant survival probability was in Mexicans at 90.2% (95% CI 89.7–90.6). Analysis outcome were not statistically different from combined surveillance systems when assessed individually by type of registry (active vs. passive).

As shown in Table 1, survival probability was higher for infants who were male, of gestational age >37 weeks, an only child, born to a nondiabetic mother, lived in a metropolitan area, were delivered vaginally, had prenatal care, and were born after 2002. For Hispanic children who survived beyond infancy, childhood (1–8 years old) survival probability was higher for children who were of gestational age >37 weeks, had a vaginal delivery, and were born after 2002.

Figure 1 shows Kaplan-Meier survival curves for infants born between 1999 and 2005 from 10 surveillance programs stratified by Hispanic ethnic groups and NH Whites. When compared to NH Whites, the 8-year survival probability was the highest for Cubans (94.1% [95% CI 91.8–95.7]), similar for NH Whites and Puerto Ricans, and significantly lower for Mexicans (89.2% [95% CI 88.7–89.7; $p = .0002$]).

Results from survival analysis of Hispanic children by birth defect category and Hispanic subgroup are shown in Table 2. For comparison, data for NH Whites were added. The lowest overall survival probability occurred for Mexican and Puerto Rican children (0–8 years old) with hypoplastic left heart syndrome (HLHS), 44.9% (95% CI 39.4–50.3) and 45.9% (95% CI 29.6–60.9), respectively. Mexican and Puerto Rican infants with HLHS also had the lowest survival probability. In addition, less than 70% survival was found among Mexican infants with encephalocele, atrioventricular septal defect, and omphalocele; Puerto Rican infants with an atrio-ventricular septal defect; and Cuban infants with an encephalocele and an atrioventricular septal defect.

In the multivariable analysis using NH White as the reference group (Table 3), only Mexican infants and children were noted to have a higher risk of mortality for cardiovascular defects: the hazard ratio (HR) of infant death was 1.8 for common truncus, 1.3 for transposition of great arteries, 1.6 for tetralogy of Fallot and aortic valve stenosis, and 1.4 for atrioventricular septal defect; the HR of childhood mortality (1–8 years old) was 2.2 for hypoplastic left heart syndrome. Cuban infants had a statistically significant higher risk of mortality for cleft palate without cleft lip (HR: 2.7). Puerto Rican infants and children have no significantly different HR in the listed defects except for gastroschisis with a HR of 9.5 and a very broad range of 95% CI, which is possibly due to small numbers.

4. Discussion

Our study used multistate pooled data for 21 selected major birth defects to determine associated survival estimates and mortality risk for infants and children born to mothers of three major Hispanic ethnic groups. We identified 28,497 Hispanics (28.8%) with birth defects, providing a sufficiently large sample size to identify factors associated with Hispanic infant and child survival for a broad range of major birth defects. We found that demographic and clinical factors associated with survival for Hispanic infants included infant sex, gestational age/birth weight, plurality, maternal age, maternal diabetes, geographic area, method of delivery, prenatal care, and birth period.

The majority of studies use broad racial/ethnic groups (e.g., Blacks and Hispanics) when assessing survival outcomes. Using an analytic category of "Hispanic" makes it impossible to detect any disparities across the heterogeneous Hispanic community. We investigated infant and child survival within Hispanic ethnicities after adjustment for regional variations and other covariates. We observed differences in mortality and survival risk analysis between Hispanic ethnic groups and NH Whites for selected congenital heart defects, gastrointestinal defects, oral clefts, and central nervous system defects. A recent study using similar data from the 12 state birth defects programs used in our study demonstrated elevated prevalence in birth defects not found to be of higher mortality in our study (Canfield et al., 2014). This

includes a 50% or higher prevalence of anotia or microtia for Mexicans and a higher prevalence of anencephaly for Puerto Ricans. Cubans had a lower or similar prevalence for all birth defects studied (Canfield et al., 2014). Another study examining congenital heart disease in the United States noted that no racial/ethnic difference was observed in the overall congenital heart disease prevalence in Hispanics except for atrial septal defects (not assessed in our study) (Egbe et al., 2014). Our study demonstrated specific increases in mortality risk for Mexican infants and children with common truncus, atrioventricular septal defects, and aortic valve stenosis, a finding not seen in Puerto Ricans or Cubans. Other studies have conflicting findings regarding increased gastroschisis prevalence in Hispanics (Kim, Wang, Kirby, & Druschel, 2013; Kirby et al., 2013). We found that rectal and large intestinal atresia/stenosis were associated with a higher risk of infant mortality for the three Hispanic ethnic groups, which has not been described in the literature previously. In general, it is difficult to compare our findings to those previously studies, given the lack of information available on the mortality or survival for Hispanic ethnic groups.

Perhaps most interesting is our finding of overall survival for children with birth defects from infancy through childhood. While literature reporting overall survival for several birth defects often demonstrates lower rates for Hispanics compared with NH Whites (Canfield et al., 2006; Yang et al., 2006), when separated into Hispanic ethnic groups, Cubans had a statistically significant higher survival than all groups, including NH Whites. Further, Puerto Ricans and NH Whites had similar survival rates. Thus, given that the Mexican ethnic group had the lowest rate of survival, it is possible that previous studies demonstrating lower survival in Hispanics were reflecting this specific community, and caution must be taken when generalizing survival rates to "Hispanics" (not accounting for ethnic differences).

This study has several important strengths. First, the large sample size supports relatively stable survival estimates for most phenotypes and risk factors examined. Also, the data were collected from population-based birth defect programs linked to vital records, which enhances the reliability and representativeness of the study population. Our study extends the findings of a previous study (Kucik et al., 2014) using a larger population to provide more detailed survival estimates and to compare the survival and mortality experience of infants across an array of phenotypes and risk factors, throughout infancy and early childhood for Hispanic ethnic subgroups.

Limitations of our study include incomplete ascertainment of deaths. While the majority of deaths were identified by matching the state birth to death certificate records, some deaths were ascertained from medical records at birth hospitals. Any child for whom there was no record of death was assumed to be alive. Although some children might have moved and died in another state, many states have agreements in place with neighboring states to report deaths back to the state of birth. Additionally, three of 12 programs utilized the National Death Index, thus deaths that occurred outside the state of maternal residence at delivery could be potentially captured. Missed deaths could result in an overestimation of the survival probabilities. Finally, there is some degree of uncertainty given the wide CI in risk of death for the Cuban population due to their smaller sample size, thus findings should be carefully interpreted.

Also, of seven surveillance programs using passive case ascertainment methodologies, only three validate the accuracy of their birth defect case identification. The misclassification could introduce a bias in estimating the survival probabilities by assigning noncases as cases. However, we minimized this potential bias by selecting phenotypes that were, for the most part, consistently diagnosed. Moreover, the mortality risk estimates reported in the current study were adjusted for case ascertainment methods as well as other risk factors using multivariable regression.

Another potential limitation includes the possible lack of accuracy of coding race/ethnicity on birth certificates across programs, defects, and time periods, which could lead to a misclassification of Hispanic subgroups and impact findings from our study. We attempted to ameliorate this by using several sources that identify the patient race/ethnicity, such as birth and death certificates, and maternal self-report.

Another potential limitation is that our finding of differences in survival among infants with specific birth defects such as atrioventricular septal defects, cleft lip/palate, and omphalocele could be due, in part, to differences in the prevalence of trisomies (e.g., trisomy 13 or 18) or other chromosomal anomalies among the different Hispanic subpopulations.

Finally, we were unable to adjust for other important factors, such as timing and age at initial diagnosis, clinical severity, socioeconomic status, maternal education, and whether the child had an isolated or nonisolated malformation. Unfortunately, these variables were not consistently available from all surveillance systems, and thus these may serve as confounders for our data. We limited our findings to three Hispanic subgroups, as the remaining data consisted of heterogeneous countries from Central and South America whose limited information made it challenge to be accurately analyzed. Many other rapidly growing populations of Hispanics in the United States, such as those from Central and South American countries (Zong & Batalova, 2015) were not captured in our analyses.

In conclusion, our study provides important estimates of survival probability and mortality risk for infants and children up to 8 years with selected birth defects using population-based birth defects programs. Differences in survival probabilities and mortality risks for Hispanic subgroups were found for selected congenital heart defects, gastrointestinal defects, oral clefts, and central nervous system defects. Additionally, we found a survival advantage for Cuban infants and children with birth defects, a finding requiring further investigation into other potential confounders, including socioeconomic status of the different Hispanic subgroups, as well as with NH Whites. Future studies should be performed to further ascertain differences in other Hispanic subgroups, and potential contribution of other relevant factors to infant and childhood survival among all Hispanic subgroups.

Acknowledgments

Appendix A

State Birth Cohort

State	Birth years	Death years[a]	Live births with birth defects	Surveillance methodology[b]	Data source(s) used for ascertaining deaths
AZ	1999–2007	1999–2010	2,413	Active	Death certificate, Medical records, hospital discharge files
CO	1999–2006	Not provided[c]	1,496	Passive	Death certificate
FL	1999–2007	1999–2010	3,952	Passive	Death certificate
GA	1999–2007	1999–2009	571	Active	Death certificate, NDI
IL	1999–2006	1999–2007	1,562	Passive	Death certificate
MA	2000–2007	2000–2008	374	Active	Death certificate
MI	1999–2006	1999–2009	529	Passive	Death certificate, NDI
NC	2003–2007	2003–2010	831	Passive	Death certificate
NE	1999–2006[d]	1999–2007	201	Passive	Death certificate
NJ	1999–2005[d]	1999–2006	1,253	Passive	Death certificate
NY	1999–2007	1999–2008	1,142	Passive	Death certificate
TX	1999–2007	1999–2009	14,173	Active	Death certificate, Medical records, hospital discharge files

[a]For records with death information beyond the cut-off death years, we treated them as alive.

[b]Active case finding methodology: birth defects cases are actively identified by individuals reviewing birth defects data. Passive case finding methodology: cases are reported by providers/facilities or administrative/other data sets.

[c]CO provided with age at death instead of death year.

[d]NE: 2007 births are excluded because they were not followed for a full year after birth; NJ: 2006–2007 births are excluded because they were not followed for a full year after birth.

Appendix B

Selected Major Birth Defects, ICD-9-CM codes, and CDC/BPA codes

Birth defects	ICD-9-CM codes	CDC/BPA codes
Central nervous system defects		
Spina bifida without anencephalus	741.0–741.9 w/o 740.0–740.1	741.00–741.99 w/o 740.00–740.10
Encephalocele	742.0	742.00–742.09
Congenital heart defects		
Common truncus	745.0	745.00–45.01
Transposition of the great arteries	745.10, .11, .12, .19	745.10, .11, .12, .19
Tetralogy of Fallot	745.2	745.20–745.21, 746.84, 747.31
Atrioventricular septal defect	745.60, .61, .69 w 758.0	745.60–745.69 w 758.00–758.09
Atrioventricular septal defect (occurring without Down	syndrome) 745.60, .61, .69 wo758.0	745.60–745.69 wo758.00–758.09

Birth defects	ICD-9-CM codes	CDC/BPA codes
Aortic valve stenosis	746.3	746.30
Hypoplastic left heart syndrome	746.7	746.70
Coarctation of aorta	747.10	747.10–747.19
Oral clefts		
Cleft palate without cleft lip	749.0	749.00–749.09
Cleft lip with or without cleft palate	749.1, 749.2	749.10–749.29
Gastrointestinal defects		
Esophageal atresia/tracheoesophageal fistula	750.3	750.30–750.35
Pyloric stenosis	750.5	750.51
Rectal and large intestinal atresia/stenosis	751.2	751.20–751.24
Musculoskeletal defects		
Upper limb deficiencies	755.20–755.29	755.20–755.29
Lower limb deficiencies	755.30–755.39	755.30–755.39
Diaphragmatic hernia	756.6	756.610–756.617
Gastroschisis	756.79	756.71
Omphalocele	756.79	756.70
Chromosomal defects		
Trisomy 21 (Down syndrome)	758.0	758.00–758.09

ICD-9-CM 5 International Classification of Diseases, 9th Revision, Clinical Modifications; CDC/BPA 5 Centers for Disease Control and Prevention/British Pediatric Association Classification.

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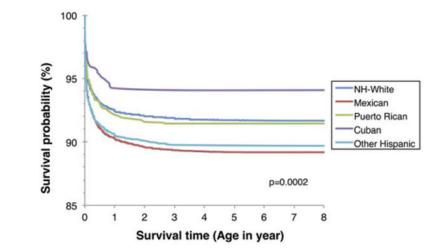
Figure 1. Survival curves of children born with birth defects to Hispanic women in the United States, by Hispanic subgroups, 1999–2005s

Table 1

Overall survival for children with selected birth defects born to Hispanic women by demographic and clinical characteristics in the United States, 1999–2007

Characteristic	Infant (<1 year)[a]			Childhood (1–8 years)[b]		
	No. of birth	No. of death (%)	Survival probability (95% CI)	No. of birth	No. of death (%)	Survival probability (95% CI)
Maternal ethnicity			p<.0001			p=.0797
Mexican	19,881	1,955 (9.8)	90.2 (89.7–90.6)	12,829	154 (1.2)	98.8 (98.6–99.0)
Puerto Rican	2,024	163 (8.1)	91.9 (90.7–93.1)	1,369	11 (0.8)	99.2 (98.6–99.6)
Cuban	773	42 (5.4)	94.6 (92.7–96.0)	541	1 (0.2)	99.8 (98.7–100.0)
Other Hispanic	5,819	528 (9.1)	90.9 (90.2–91.6)	3,603	36 (1.0)	99.0 (98.6–99.3)
NH White[c]	54,519	4,165 (7.6)	92.4 (92.1–92.6)	35,954	327 (0.9)	99.1 (99.0–99.2)
Infant sex			p<.0001			p=.0567
Male	17,334	1,461 (8.4)	91.6 (91.1–92.0)	11,355	112 (1.0)	99.0 (98.8–99.2)
Female	11,152	1,218 (10.9)	89.1 (88.5–89.6)	6,987	90 (1.3)	98.7 (98.4–99.0)
Gestation/birth weight			p<.0001			p<.0001
<37 week/<2,500 g	3,892	1,028 (26.4)	73.6 (72.2–74.9)	1,964	47 (2.4)	97.6 (96.8–98.2)
<37 week/>2,500 g	2,210	247 (11.2)	88.8 (87.4–90.1)	1,356	13 (1.0)	99.0 (98.4–99.4)
>37 week/<2,500 g	1,877	423 (22.5)	77.5 (75.5–79.3)	1,058	26 (2.5)	97.5 (96.4–98.3)
>37 week/>2,500 g	20,518	990 (4.8)	95.2 (94.9–95.5)	13,964	116 (0.8)	99.2 (99.0–99.3)
Plurality			p<.0001			p=.3992
Single	27,706	2,554 (9.2)	90.8 (90.4–91.1)	17,885	199 (1.1)	98.9 (98.7–99.0)
Multiple	755	130 (17.2)	82.8 (79.9–85.3)	437	3 (0.7)	99.3 (97.9–99.8)
Maternal age			p=.0059			p=.0257
<19 years	4,796	428 (8.9)	91.1 (90.2–91.8)	3,106	50 (1.6)	98.4 (97.9–98.8)
20–24 years	7,836	700 (8.9)	91.1 (90.4–91.7)	5,142	54 (1.1)	98.9 (98.6–99.2)
25–29 years	6,744	680 (10.1)	89.9 (89.2–90.6)	4,305	45 (1.0)	99.0 (98.6–99.2)
30–34 years	4,845	431 (8.9)	91.1 (90.3–91.9)	3,163	34 (1.1)	98.9 (98.5–99.2)
>35 years	4,275	449 (10.5)	89.5 (88.5–90.4)	2,625	19 (0.7)	99.3 (98.9–99.5)

Characteristic	Infant (<1 year)[a]			Childhood (1–8 years)[b]		
	No. of birth	No. of death (%)	Survival probability (95% CI)	No. of birth	No. of death (%)	Survival probability (95% CI)
Maternal education			p=.1180			p=.1655
<High school	13,537	1,290 (9.5)	90.5 (90.0–91.0)	8,767	108 (1.2)	98.8 (98.5–99.0)
High school	8,360	785 (9.4)	90.6 (90.0–91.2)	5,428	52 (1.0)	99.0 (98.7–99.3)
>High school	6,115	526 (8.6)	91.4 (90.7–92.1)	3,821	35 (0.9)	99.1 (98.7–99.3)
Maternal diabetes			p=.0012			p=.9170
Yes	1,468	177 (12.1)	87.9 (86.2–89.5)	856	10 (1.2)	98.8 (97.8–99.4)
No	25,014	2,372 (9.5)	90.5 (90.1–90.9)	15,672	177 (1.1)	98.9 (98.7–99.0)
Maternal nativity			p=.1644			p=.1217
U.S. born	12,349	1,122 (9.1)	90.9 (90.4–91.4)	8,083	100 (1.2)	98.8 (98.5–99.0)
Non-U.S. born	15,933	1,524 (9.6)	90.4 (90.0–90.9)	10,144	101 (1.0)	99.0 (98.8–99.2)
Geographic area			p=.0212			p=.1210
Metro	26,106	2,432 (9.3)	90.7 (90.3–91.0)	16,796	179 (1.1)	98.9 (98.8–99.1)
Nonmetro	2,380	255 (10.7)	89.3 (88.0–90.5)	1,537	23 (1.5)	98.5 (97.8–99.0)
Method of delivery			p<.0001			p=.0504
Vaginal	17,069	1,341 (7.9)	92.1 (91.7–92.5)	11,415	113 (1.0)	99.0 (98.8–99.2)
Caesarean	11,275	1,338 (11.9)	88.1 (87.5–88.7)	6,830	89 (1.3)	98.7 (98.4–98.9)
Prenatal care			p<.0001			p=.1398
Yes	27,099	2,474 (9.1)	90.9 (90.5–91.2)	17,566	194 (1.1)	98.9 (98.7–99.0)
No	854	123 (14.4)	85.6 (83.1–87.8)	494	2 (0.4)	99.6 (98.4–99.9)
Birth period			p=.0254			p=.0034
1999–2002	11,134	1,104 (9.9)	90.1 (89.5–90.6)	9,372	124 (1.3)	98.7 (98.4–98.9)
2003–2007 (2005)	17,363	1,584 (9.1)	90.9 (90.4–91.3)	8,970	78 (0.9)	99.1 (98.9–99.3)
Total	28,497	2,688 (9.4)	90.6 (90.2–90.9)	18,342	202 (1.1)	98.9 (98.7–99.0)

[a]Children born in 1999–2007 from all 12 states, n=28,497.

[b]Children born in 1999–2005 from 10 states; data from IL and NE were excluded because no vital status data beyond infancy were available, n=18,342.

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[c]For comparison, data for NH Whites were added.

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Table 2

Survival estimates by type of birth defect for children born to Hispanic women in the United States and by Hispanic subgroup, 1999-2007

	Infancy (<1 year) survival probability[a] (95% CI)				Childhood (≤ 8 years) survival probability[b] (95% CI)			
	NH White[c]	Mexican	Puerto Rican	Cuban	NH White[c]	Mexican	Puerto Rican	Cuban
Central nervous system								
Spina bifida without anencephalus	92.0 (90.7–93.1)	92.4 (90.6–93.9)	95.5 (88.3–98.3)	91.3 (69.5–97.8)	90.5 (88.8–91.9)	90.7 (88.2–92.6)	96.3 (86.0–99.1)	91.3 (69.5–97.8)
Encephalocele	73.6 (68.9–77.7)	66.0 (59.0–72.1)	84.2 (58.7–94.6)	66.7 (5.4–94.5)	72.8 (67.0–77.8)	62.3 (53.9–69.6)	100, no death	66.7 (5.4–94.5)
Cardiovascular and respiratory system								
Common truncus	80.3 (76.7–83.5)	64.7 (57.0–71.4)	81.8 (58.5–92.8)	100, no death	76.4 (71.7–80.4)	59.5 (50.4–67.5)	85.7 (53.9–96.2)	100, no death
Transposition of great arteries	86.0 (84.6–87.4)	82.8 (79.9–85.2)	84.4 (74.2–90.8)	86.0 (72.9–93.1)	84.2 (82.4–85.8)	80.6 (77.2–83.6)	78.7 (66.1–87.0)	87.2 (71.9–94.5)
Tetralogy of Fallot	89.5 (88.3–90.6)	83.2 (80.4–85.6)	85.1 (77.1–90.5)	96.3 (86.0–99.1)	87.8 (86.3–89.1)	80.0 (76.5–83.1)	81.8 (72.0–88.4)	95.2 (82.3–98.8)
Atrioventricular septal defect	84.1 (82.7–85.5)	72.6 (69.3–75.7)	78.3 (67.8–85.7)	78.6 (58.4–89.8)	81.6 (79.8–83.2)	67.9 (63.9–71.6)	72.1 (59.1–81.7)	81.0 (56.9–92.4)
Atrioventricular septal defect (occurring w/o DS)	75.6 (73.1–77.9)	64.6 (60.0–68.8)	63.4 (46.8–76.1)	68.4 (42.8–84.4)	73.1 (70.1–75.8)	58.8 (53.3–63.9)	62.1 (42.1–76.9)	69.2 (37.3–87.2)
Aortic valve stenosis	85.5 (83.7–87.1)	78.0 (74.2–81.4)	97.2 (81.9–99.6)	100, no death	83.9 (81.7–85.8)	75.7 (71.3–79.6)	95.8 (73.9–99.4)	100, no death
Hypoplastic left heart syndrome	57.8 (55.4–60.2)	50.1 (45.6–54.5)	53.3 (37.9–66.6)	72.7 (49.1–86.7)	54.0 (51.1–56.8)	44.9 (39.4–50.3)	45.9 (29.6–60.9)	71.4 (40.6–88.2)
Coarctation of aorta	86.3 (85.1–87.3)	83.4 (81.1–85.4)	87.9 (80.5–92.7)	86.2 (74.3–92.9)	84.0 (82.5–85.3)	80.1 (77.2–82.7)	82.7 (72.6–89.4)	85.7 (69.0–93.8)
Oral clefts								
Cleft palate without cleft lip	93.0 (92.2–93.7)	86.6 (84.6–88.3)	89.5 (83.4–93.4)	87.0 (73.2–93.9)	92.3 (91.3–93.2)	86.2 (83.8–88.2)	89.7 (82.5–94.0)	86.1 (69.8–94.0)
Cleft lip with and without cleft palate	93.5 (92.9–94.1)	89.7 (88.4–90.8)	90.3 (85.2–93.7)	94.5 (84.0–98.2)	92.8 (92.0–93.5)	88.9 (87.3–90.2)	88.3 (81.8–92.5)	92.9 (79.5–97.6)
Gastrointestinal								
Esophageal atresia/tracheoesophageal Fistula	88.2 (86.7–89.6)	79.5 (75.6–82.8)	82.0 (69.8–89.6)	90.6 (73.7–96.9)	86.7 (84.8–88.5)	79.3 (74.6–83.2)	88.9 (75.3–95.2)	91.7 (70.6–97.8)
Pyloric stenosis	99.5 (99.4–99.6)	99.4 (99.1–99.6)	99.3 (98.1–99.7)	99.6 (97.1–99.9)	99.3 (99.2–99.5)	99.1 (98.7–99.4)	99.3 (97.7–99.8)	99.4 (96.0–99.9)
Rectal and large intestinal atresia/stenosis	90.3 (89.2–91.4)	81.7 (79.2–83.8)	85.2 (77.0–90.6)	85.7 (70.9–93.3)	90.1 (88.7–91.3)	80.7 (77.8–83.3)	84.7 (75.1–90.8)	82.8 (63.4–2.4)
Musculoskeletal								
Upper limb deficiencies	91.4 (90.1–92.6)	87.4 (84.8–89.5)	87.5 (77.4–93.3)	91.3 (69.5–97.8)	89.9 (88.1–91.4)	86.2 (83.1–88.7)	91.2 (80.2–96.3)	89.5 (64.1–97.3)
Lower limb deficiencies	90.7 (88.7–92.3)	81.5 (77.0–85.3)	100, no death	100, no death	91.0 (88.6–92.9)	80.8 (75.4–85.1)	100, no death	100, no death
Diaphragmatic hernia	70.6 (68.3–72.7)	70.6 (67.0–74.0)	72.9 (60.8–81.7)	62.5 (40.3–78.4)	70.2 (67.4–72.8)	69.1 (64.6–73.1)	74.5 (59.4–84.6)	55.6 (30.5–74.8)
Gastroschisis	93.0 (91.8–94.1)	93.2 (91.5–94.5)	94.0 (86.3–97.5)	100, no death	92.5 (90.8–93.9)	92.7 (90.5–94.4)	90.9 (79.5–96.1)	100, no death

	Infancy (<1 year) survival probability[a] (95% CI)				Childhood (≥ 8 years) survival probability[b] (95% CI)			
	NH White[c]	Mexican	Puerto Rican	Cuban	NH White[c]	Mexican	Puerto Rican	Cuban
Omphalocele	73.9 (70.3–77.1)	65.2 (59.3–70.4)	81.3 (52.5–93.5)	no Case	73.2 (68.6–77.2)	64.3 (57.2–70.5)	90.9 (50.8–98.7)	no Case
Chromosomal								
Trisomy 21 (Down syndrome)	94.5 (94.0–95.0)	94.7 (93.9–95.4)	94.3 (90.9–96.4)	99.0 (93.4–99.9)	93.2 (92.5–93.8)	93.7 (92.6–94.6)	92.9 (88.5–95.7)	98.6 (90.7–99.8)

[a]Children born in 1999-2007 from all 12 states, n = 28,497.

[b]Children born in 1999-2005 from 10 states; data from IL and NE were excluded because no vital status data beyond infancy were available, n = 18,342.

[c]For comparison, data for NH Whites were added.

Table 3

Adjusted risk of death (HR) of children with selected birth defects born for Hispanic mothers compared with NH mothers in the United States, by Hispanic subgroups, Unites States, 1999–2007[1]

Characteristic	Infancy (<1 year) HR[a] (95% CI)			Childhood (1–8 years) HR[b,c] (95% CI)	
	Mexican	Puerto Rican	Cuban	Mexican	Puerto Rican
Central Nervous system					
Spina bifida without anencephalus	1.1 (0.7, 1.6)	0.6 (0.2, 1.7)	2.2 (0.5, 9.2)	0.9 (0.2, 3.7)	No death
Encephalocele	1.2 (0.7, 1.8)	0.5 (0.2, 1.6)	0.7 (0.1, 5.2)	0.3 (0.0, 10.5)	No death
Cardiovascular and respiratory system					
Common truncus	**1.8 (1.2, 2.8)**	1.1 (0.4, 3.2)	No death	0.7 (0.1, 8.8)	No death
Transposition of great arteries	**1.3 (1.0, 1.7)**	1.0 (0.6, 1.8)	1.0 (0.5, 2.1)	1.5 (0.6, 3.6)	1.7 (0.4, 7.8)
Tetralogy of Fallot	**1.6 (1.2, 2.0)**	1.2 (0.7, 2.1)	0.5 (0.1, 1.9)	1.3 (0.6, 2.6)	0.7 (0.2, 3.1)
Atrioventricular septal defect	**1.4 (1.1, 1.7)**	1.3 (0.8, 2.2)	1.3 (0.6, 3.0)	1.6 (0.8, 2.9)	2.5 (0.9, 7.0)
Atrioventricular septal defect(occurring w/o DS)	1.1 (0.9, 1.5)	1.5 (0.9, 2.6)	1.2 (0.5, 2.7)	1.9 (0.9, 4.2)	1.6 (0.2, 12.5)
Aortic valve stenosis	**1.6 (1.2, 2.2)**	0.2 (0.0, 1.3)	0.0 (0.0, 3E168)	0.9 (0.3, 2.5)	No death
Hypoplastic left heart syndrome	1.1 (0.9, 1.3)	1.0 (0.6, 1.6)	0.5 (0.2, 1.2)	**2.2 (1.1, 4.7)**	0.9 (0.1, 6.5)
Coarctation of aorta	1.0 (0.8, 1.3)	0.8 (0.5, 1.4)	0.9 (0.5, 1.9)	1.8 (0.9, 3.4)	1.8 (0.4, 7.8)
Oral Clefts					
Cleft palate without cleft lip	**1.4 (1.1, 1.8)**	1.2 (0.7, 2.0)	**2.7 (1.2, 6.2)**	1.6 (0.8, 3.2)	0.6 (0.1, 4.5)
Cleft lip with and without cleft palate	1.2 (1.0, 1.4)	1.1 (0.7, 1.8)	1.0 (0.3, 3.2)	1.1 (0.5, 2.3)	No death
Gastrointestinal					
Esophageal atresia/tracheoesophageal Fistula	**1.7 (1.3, 2.4)**	1.6 (0.8, 2.9)	0.7 (0.2, 2.2)	1.1 (0.3, 3.6)	No death
Pyloric stenosis	1.1 (0.6, 2.1)	1.3 (0.4, 3.6)	0.8 (0.1, 5.9)	0.7 (0.2, 2.5)	No death
Rectal and large intestinal atresia/stenosis	**1.5 (1.2, 1.9)**	1.5 (0.9, 2.5)	2.1 (0.9, 4.8)	1.6 (0.6, 4.6)	No death
Musculoskeletal					
Upper limb deficiencies	1.0 (0.7, 1.4)	1.2 (0.6, 2.4)	1.1 (0.3, 4.7v)	1.2 (0.4, 3.9)	No death
Lower limb deficiencies	1.4 (0.9, 2.3)	No death	No death	0.6 (0.0, 12.1)	No death
Diaphragmatic hernia	1.0 (0.8, 1.2)	0.9 (0.6, 1.5)	1.6 (0.8, 3.1)	0.4 (0.1, 3.2)	No death
Gastroschisis	0.9 (0.6, 1.2)	0.7 (0.3, 1.7)	No death	1.6 (0.4, 6.9)	9.5 (0.9, 104.0)

	Infancy (<1 year) HR[a] (95% CI)			Childhood (1–8 years) HR[b,c] (95% CI)	
Characteristic	**Mexican**	**Puerto Rican**	**Cuban**	**Mexican**	**Puerto Rican**
Omphalocele	1.3 (0.9, 1.8)	0.5 (0.1, 1.5)	No Case	1.6 (0.2, 12.4)	No death
Chromosomal					
Trisomy 21 (Down syndrome)	1.0 (0.8, 1.3)	1.0 (0.6, 1.6)	0.2 (0.0, 1.6)	0.7 (0.4, 1.4)	1.1 (0.3, 3.6)

[1] Notes. Adjusted covariates includes infant gender, birth weight/gestational age, maternal nativity, plurality, maternal age, maternal diabetes, geographic area, surveillance methodology, method of delivery, prenatal care, and birth period. NH Whites were the referent/comparison group. Bold entries are noted to have statistical significant HR when compared to NH Whites. CI that are bolded and include 1 are because those numbers were rounded for the purposes of fitting the table.

[a] Children born in 1999–2007 from all 12 states.

[b] Children born in 1999–2005 from 10 states; data from IL and NE were excluded because no vital status data beyond infancy were available.

[c] Data for Cuban subgroup is not show due to small numbers.

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