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Risk of Childhood Cancer by Maternal Birthplace:

A Test of the Hispanic Paradox

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Abstract

IMPORTANCE—The *Hispanic epidemiologic paradox* is the phenomenon that non-US–born Hispanic mothers who immigrate to the United States have better pregnancy outcomes than their US-born counterparts. It is unknown whether this advantage extends to childhood cancer risk.

OBJECTIVE—To determine whether the risk for childhood cancers among Hispanic children varies by maternal birthplace.

DESIGN, SETTING, AND PARTICIPANTS—In this population-based case-control study conducted in June 2015, cohort members were identified through California birth records of children born in California from January 1, 1983, to December 31, 2011. Information on cancer diagnoses was obtained from California Cancer Registry records from 1988 to 2012. Cases (n = 13 666) were identified from among children younger than 6 years in the California Cancer Registry and matched to California birth certificates. Control children (n = 15 513 718) included all other

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children born in California during the same period. Maternal birthplace and ethnic ancestry were identified from the birth certificate.

MAIN EXPOSURES—Maternal race/ethnicity and birthplace.

MAIN OUTCOMES AND MEASURES—We used Cox proportional hazards modeling to estimate hazard ratios (HRs) of childhood cancer.

RESULTS—Included in the study were 4 246 295 children of non-Hispanic white mothers (51.3% male), 2 548 822 children of US-born Hispanic mothers (51.0% male), and 4 397 703 children of non-US–born Hispanic mothers (51.0% male). Compared with children of non-Hispanic white mothers, the children of non-US–born Hispanic mothers had a reduced risk for glioma (HR, 0.50; 95% CI, 0.44–0.58), astrocytoma (HR, 0.43; 95% CI, 0.36–0.51), neuroblastoma (HR, 0.47; 95% CI, 0.40–0.54), and Wilms tumor (HR, 0.70; 95% CI, 0.59–0.82). For these cancer types, the risk estimates for children of US-born Hispanic mothers fell between those of the children of US-born white and non-US–born Hispanic mothers. Children of Mexican-born mothers had a higher risk of yolk sac tumors (HR, 1.46; 95% CI, 0.99–2.17), while children of US-born Hispanic mothers with ancestry from countries other than Mexico had a higher risk for unilateral retinoblastoma (HR, 2.03; 95% CI, 1.33–3.11).

CONCLUSIONS AND RELEVANCE—For several cancers, we observed differential risk by maternal place of birth. Examining the differences in health behaviors and environment between Hispanic groups may shed light on childhood cancer etiology.

The relative importance of an individual's genetics, environment, and lifestyle in cancer risk is nevermore evident than in studies of migrant populations. In an increasingly globalized world, the United States is the top destination country, hosting 20% (42.8 million) of all migrants.[1] The fact that 22% of young children (<6 years) born in the United States have immigrant parents[2] opens a unique opportunity to consider the influence of nativity and race/ethnicity on the development and etiology of childhood cancers. In addition, there are many native racial/ethnic counterparts living in the United States who, when studied, might provide additional insights concerning the positive or negative consequences of the social, economic, and environmental factors that they may face in the host country.

At present, nearly 17% of the US population is of Hispanic origin, and this proportion is expected to reach 30% by 2050.[3] In adults, the incidence of cancer differs between Hispanic and white populations.[4] This is also true of childhood cancers, where it has been noted that compared with non-Hispanic white children, Hispanic children exhibit higher rates of leukemias, osteosarcoma, germ-cell tumors, and retinoblastoma, as well as lower rates of Wilms tumor and central nervous system (CNS)tumors.[5] In particular, CNS tumor rates among white American children appear to be 2 to 3 times higher than those reported in children in Latin American nations.[6] Further, differential cancer risks are seen between non-US–born and US-born Hispanic individuals, which has been attributed to behavioral differences such as tobacco use or reproductive history.[7] While there have been sporadic reports on childhood cancer incidence among children of immigrants in other nations,[8,9] childhood cancer rates among immigrant families in the United States have not, to our knowledge, been compared to date. It is of particular importance to study childhood cancer

risk in this large and growing population, as the Hispanic population in California has among the highest rates of childhood cancers worldwide.[10]

Given the importance of the prenatal environment on childhood cancer, the *Hispanic epidemiologic paradox* may help to shed light on childhood cancer risk. This paradox describes the phenomenon that non-US–born Hispanic mothers who immigrate to the United States have better pregnancy outcomes than their US-born counterparts, such as decreased rates of low birthweight. This advantage is observed in immigrants despite high levels of poverty, lower maternal educational attainment, and late entry into prenatal care services. Although this pattern has been seen in women from many nations, it is particularly evident among women from Mexico.[11] Our hypothesis was that this perinatal advantage may extend to childhood cancer risk.

The goal of the present study was to compare childhood cancer risk between the children of US-born white, US-born Hispanic, and non-US–born Hispanic mothers.

Methods

Cohort

In this study conducted in June 2015, the cohort consisted of all children born in California from January 1, 1983, to December 31, 2011. Cohort members were identified through California birth records. Information on cancer diagnoses was ascertained from California Cancer Registry records of children younger than 6 years who were diagnosed as having cancer from 1988 to 2012.[12] Our interest was the younger age group because it is in that group that perinatal exposures should be of most relevance for cancer risk. The California Cancer Registry was established in 1988 and is believed to ascertain more than 99% of cancer cases diagnosed in the state. Using a probabilistic linkage program (LinkPlus; US Centers for Disease Control and Prevention), we matched 89% of cases to a California birth certificate using first name, last name, dates of birth, and, when available, social security number. Given prior reports of rates of residential mobility in early childhood among California children,[13] it is likely that most of the remaining 11% of cases were born out of state.

Key Points

Question

Does the *Hispanic epidemiologic paradox*, whereby non-US–born Hispanic mothers in the United States have better pregnancy outcomes than their US-born counterparts, extend to childhood cancer risk?

Findings

For some cancer types (gliomas, astrocytoma, neuroblastoma, and nephroblastoma), the patterns exhibited followed the Hispanic paradox, with lower risk among the children of non-US–born mothers. The patterns of other cancer types suggest other risk factors may be driving those tumors.

Meaning

The differential cancer risks by maternal place of birth supports that for some cancers, examining the different health behaviors and environment among Hispanic groups may shed light on childhood cancer etiology.

California birth certificates ask parents to report their race/ethnicity, Hispanic origin, and the mother's place of birth (state or country). (We use the word *Hispanic* instead of *Latino* herein because that is the nomenclature used by parents on California birth certificates.) Mothers of Hispanic origin were asked to identify their ethnic ancestry (Mexican/Mexican American/Chicano; Puerto Rican; Cuban; Central/South American; and other Spanish/Hispanic). Prior to 2009, California birth certificates did not collect all possible countries of birth of the mother. Thus, we categorized mothers as non-US–born if they were born in Puerto Rico, the Virgin Islands, Guam, Mexico, China, Japan, the Philippines, Vietnam, Canada, Cuba, or the rest of the world. Beginning in 2009, birth certificates began collecting birthplace from 292 countries. The present analysis was restricted to the children of US-born white, US-born Hispanic, or non-US–born Hispanic mothers and included 13 666 cases of those diagnosed as having cancer before age 6 years and 15 513 718 control children, who had no diagnosis in the Cancer Registry prior to age 6 years.

This study was approved by the institutional review boards of the University of California–Los Angeles, and the Committee for Protection of Human Subjects. Patient consent was not required because this was a noncontact study.

Statistical Analysis

In the main analyses, we reported on cancer subtypes for which there were at least 10 cases in each group. Childhood cancer types were coded according to International Classification of Childhood Cancer–3 or *International Classification of Diseases for Oncology* codes (eTable in the Supplement). Cohort members were followed up from date of birth until their first diagnosis of cancer, death, until age 6 years, or until December 31, 2012, whichever occurred first. The study design did not allow us to ascertain whether a child left California during the study period. To determine whether risks are converging to those of the US white population for the children of US-born Hispanic mothers, we used children of non-Hispanic white mothers as the comparison group. Estimation of hazard ratios (HRs) was based on Cox proportional hazards models. All analyses adjusted for the mother's age and father's age. Additional adjustment for urban/rural area of residence and for gestational factors (parity and multiple birth pregnancies, as described previously[14]) did not change effect estimates by more than 10% and were left out of final models. Although socioeconomic status is not clearly associated with childhood cancer risk,[15] we conducted sensitivity analyses examining the change in results with adjustment for socioeconomic status variables. Two proxies for socioeconomic status, maternal education and the method of payment for prenatal care (private insurance vs Medi-Cal, other governmental insurance, or self-pay) were collected starting in 1989. The addition of these factors widened confidence intervals owing to the loss of 6 years of data; however, the overall pattern of results did not change. Thus, we left these factors out of final models.

Because 80% of Hispanic mothers in California identify their ethnic ancestry as Mexican,[16] we conducted additional analyses stratifying by Mexican and Mexican American vs all other Hispanic ethnicities, although sample sizes were small for some cancer types. We defined Mexican individuals as both identified as being of Mexican ethnic ancestry and born in Mexico; Mexican American individuals identified themselves as being of Mexican ethnic ancestry and were born in the United States. SAS version 9.4 (SAS Institute)was used to perform all analyses in this study.

Results

Demographic and socioeconomic characteristics of participants are shown in Table 1. Compared with white parents, non-US–born Hispanic mothers and fathers were younger, more likely to live in urban areas in California, and had fewer years of educational attainment. In comparison with non-US–born Hispanic parents, US-born Hispanic parents were younger and had more years of formal education.

Children of US-born Hispanic mothers had minimally higher rates of low birth weight and early gestational age (Table 2). Hispanic parents were less likely than white parents to have private health insurance or to have multiple-birth pregnancies. Parity was higher among Hispanic parents, particularly when the mother was not born in the United States.

Several cancer types showed differences in risk among all Hispanic children in comparison with white children (Table 3 and eFigure in the Supplement). Acute lymphoblastic leukemia (HR, 1.20; 95% CI, 1.10–1.32 for children of US-born Hispanic mothers; HR, 1.06; 95% CI, 0.98–1.15 for children of non-US–born Hispanic mothers) and Hodgkin lymphoma(HR, 2.49; 95% CI, 1.21–5.13 for children of US-born Hispanic mothers; HR, 2.35; 95% CI, 1.24–4.47 for children of non-US–born Hispanic mothers) were higher among Hispanic children regardless of maternal nativity, while most types of CNS tumors were lower among Hispanic children. Glioma (HR, 0.71; 95% CI, 0.61–0.83 for children of US-born Hispanic mothers; HR, 0.50; 95% CI, 0.44–0.58 for children of non-US–born Hispanic mothers) and neuroblastoma (HR, 0.66; 95% CI, 0.56–0.78 for children of US-born Hispanic mothers; HR, 0.47; 95% CI, 0.40–0.54 for children of non-US–born Hispanic mothers) HRs were lower among all Hispanic children compared with white children. And for both gliomas and neuroblastoma, the HRs were lowest among children of non-US–born Hispanic mothers. The rate of Wilms tumor was lower only among children of non-US–born Hispanic mothers (HR, 0.70; 95% CI, 0.59–0.82). An elevated HR for bone tumors, with wide confidence intervals, was found among children of US-born Hispanic mothers only (HR, 1.38; 95% CI, 0.83–2.31).

When we further restricted the Hispanic category to Mexican individuals, we observed more sharply decreased HRs for non-Hodgkin lymphoma(HR, 0.59; 95% CI, 0.37–0.92), ependymomas(HR, 0.69; 95% CI, 0.49–0.97), and Wilms tumor(HR, 0.69; 95% CI, 0.58–0.82) among the offspring of Mexican born mothers, while yolk sac tumors were found to be increased in children of Mexican mothers (HR, 1.46; 95% CI, 0.99–2.17) (Table 4).

Among the children of non-Mexican US-born Hispanic mothers, we observed an increased risk for unilateral retinoblastoma (HR, 2.03; 95% CI, 1.33–3.11), but otherwise similar patterns of cancer to those seen among Hispanic children as a whole (Table 5).

Discussion

Although numerous migrant studies have been published in the literature, to our knowledge, few have examined cancer risk among Hispanic immigrants to the United States and no previous study has examined childhood cancer risk among US immigrant populations. Studies in Sweden and the United Kingdom suggested that differences exist in childhood cancer incidence between immigrant and native populations.[8,9] For many cancer types, research on migrant groups has often shown that the initial difference in the incidence of cancer of immigrants changes over 1 or 2 generations to converge to the incidence in the new host population.[17] Similarly, our study suggests that the children of non-US–born Hispanic mothers retain, at least in part, the cancer risk observed in their countries of origin.[18] In this study, we observed notable differences across groups in risk for gliomas and several specific CNS tumor types (high-grade gliomas, low-grade gliomas, ependymoma, astrocytoma, and intracranial and intraspinal embryonal tumors), as well as unilateral retinoblastoma, bone tumors, yolk sac tumors, and neuroblastoma.

As has been reported elsewhere,[5,18] we observed that Hispanic children experience overall higher risk for acute lymphoblastic leukemia and lower risk for CNS tumors, Wilms tumors, and neuroblastoma compared with non-Hispanic white children. There are several hypotheses why Hispanic children may have these differing childhood cancer rates compared with white children, including both genetic variation or differing rates of exposure to infections in early life.[19,20] We also observed excesses of Hodgkin lymphoma among Hispanic children, which may be attributable in part to higher infection rates with Epstein-Barrvirus. Epstein-Barrvirus–positive Hodgkin lymphoma is more common among Hispanic individuals and is associated with mixed cellularity subtype, which we previously observed to be more common among Hispanic children in our sample.[21]

The elevated risks for bone tumors among the children of US-born Hispanic mothers, in comparison with the lower risk among the children of non-US–born Hispanic mothers, was notable given what is known about differences in height between Mexican and Mexican American individuals.[22] Height is a risk factor for several adult cancers[23] and has been implicated in some studies of osteosarcoma and Ewing sarcoma.[24] Possible mechanisms explaining a mediating effect of height on cancer risk include increases in the number of skeletal cells; growth hormones, such as insulin-like growth factor; or greater energy intake of the child in early life.[25]

For neuroblastoma, gliomas, and Wilms tumor, we observed a decreased risk with mother's non-US–born status and intermediate risks among the children of US-born Hispanic mothers. Because little is known about the causes of these cancers,[26–28] our results suggest that it may be fruitful to investigate certain risk factors that differ between Hispanic immigrants by nativity. With regard to birth outcomes, the epidemiologic paradox is thought to be explained by the positive influence of traditional Mexican culture, eg, positive attitudes

about pregnancy as well as good care and support of the pregnant woman by her family, which lowers stress; a healthier diet, with low levels of over weight; high uptake of breastfeeding; and extremely low rates of smoking, drinking, or drug use during pregnancy.[11,29] Mexican-born women also have low rates of pregnancy complications.[30] In contrast to their non-US–born counterparts, US-born Hispanic women experience more stress during pregnancy; are more likely to have lower-quality diets, higher levels of overweight, and excessive weight gain in pregnancy; are less likely to breastfeed; and are more likely to report any substance use during pregnancy, although not as likely as white women.[11,29,31,32] There are other potentially relevant ways in which the exposures of US-born and non-US–born Hispanic mothers differ, such as residence in over-crowded housing (leading to differing exposure to infectious pathogens), exposure to environmental pollution, occupational exposures, maternal comorbid conditions, the use of prescription medications in pregnancy, or variation in hormone levels.[33–37] Alternatively, the different incidence between Hispanic, white, and mixed-race families may be in part a result of underlying genetic variation. Genetic admixture fractions have previously been shown to be associated with a child's risk for specific leukemia immunophenotypes.[20]

For several other cancer types (non-Hodgkin lymphoma, medulloblastoma, and rhabdomyosarcoma), we observed similar risk estimates between US-born and non-US–born Hispanic mothers, suggesting that the behavioral and environmental factors mentioned here play little role in the etiology of these tumors. Little is known on the etiology of yolk sac tumors; however, higher rates of nonseminomas have been previously reported among Hispanic individuals.[38]

A validation study examining the accuracy of race and ethnicity on California birth certificates found very high sensitivity (99%) in capturing Hispanic ethnicity.[39] A source of bias in our study would be whether non-US–born parents returned to their country of origin for the child's diagnosis and treatment or whether non-US–born parents have greater residential mobility than US-born Hispanic parents. However, one study of California children with leukemia did not find any differences in residential mobility by maternal nativity.[12] Also, the very high rates of childhood cancers among Los Angeles Hispanic children—as noted by Kaatsch,[10] Hispanic children in Los Angeles County have among the highest childhood cancer rates worldwide—would support that most are diagnosed as having cancer while in the United States.

Study limitations included a lack of information on the duration of a mother's residence in the United States, nor any measures of acculturation, so we were not able to conduct more precise analyses on the effects of immigration on cancer risk. Californiabirthcertificatesdonotcollectthefather'scountryofbirth.

Conclusions

The differing risk observed among children of immigrant and US-born Hispanic mothers was evident for several childhood cancer types. At present, to our knowledge, there are limited studies on the distribution of genotypes related to childhood cancer among Hispanic individuals, and small sample sizes in most childhood cancer studies limit further

explorations of genetic variation among ethnic subgroups. Incorporating the immigrant experience into studies of childhood cancer may help to inform research on disease etiology, identify vulnerable populations, and highlight opportunities for cancer prevention. Further studies should explore the differences in risk incurred by variation in environmental, behavioral, and infectious exposures between non-US– and US-born Hispanic mothers.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Participants' Demographic Characteristics by the Mother's Ethnicity and Birthplace

Characteristic	No. (%)		
	White Non-Hispanic, US Born (n = 4 246 295)	Hispanic, US Born (n = 2 548 822)	Hispanic, Non-US Born (n = 4 397 703)
Child's sex			
Male	2 180 021 (51.3)	1 300 930 (51.0)	2 241 299 (51.0)
Female	2 066 274 (48.7)	1 247 892 (49.0)	2 156 404 (49.0)
Mother's age at child's birth, y			
25th percentile	24	20	22
Median	29	24	26
75th percentile	33	29	31
Father's age at child's birth, y			
25th percentile	27	22	25
Median	31	27	30
75th percentile	36	33	35
Father's race/ethnicity			
White non-Hispanic	3 364 729 (79.2)	381 494 (15.0)	127 915 (2.9)
Hispanic of any race	484 363 (11.4)	1 846 129 (72.4)	4 040 579 (91.9)
Black	104 316 (2.2)	83 911 (3.3)	23 423 (0.5)
Asian/Pacific Islander	82 023 (1.9)	38 864 (1.5)	16 734 (0.4)
Other/not specified	210 864 (5.0)	198 424 (7.8)	189 052 (4.3)
Mother's educational attainment, y[a]			
<9	26 672 (0.6)	65 938 (2.6)	1 339 982 (30.5)
9–<12	323 366 (7.6)	594 022 (23.3)	1 068 943 (24.3)
12	1 105 259 (26.0)	840 989 (33.0)	838 201 (19.1)
13–<16	1 016 105 (23.9)	504 236 (19.8)	331 920 (7.6)
≥16	1 307 857 (30.8)	206 186 (8.1)	197 514 (4.5)
Missing	467 036 (11.0)	337 451 (13.2)	621 134 (14.1)
Father's educational attainment, y[a]			
<9	55 975 (1.3)	134 684 (5.3)	1 280 039 (29.1)
9–<12	235 777 (5.6)	456 432 (17.9)	906 993 (20.6)
12	1 131 418 (26.6)	836 179 (32.8)	796 684 (18.1)
13–<16	885 474 (20.9)	376 354 (14.8)	294 670 (6.7)
≥16	1 428 676 (33.7)	320 806 (12.6)	432 050 (9.8)
Missing	508 975 (12.0)	424 367 (16.7)	687 267 (15.6)

[a]Data only available for years 1989–2011.

Table 2

Gestational Characteristics by the Mother's Ethnicity and Birthplace

Characteristic	No. (%)		
	White Non-Hispanic, US Born (n = 4 246 295)	Hispanic, US Born (n = 2 548 822)	Hispanic, Non-US Born (n = 4 397 703)
Birthweight, g			
25th percentile	3115	3033	3070
Median	3450	3360	3385
75th percentile	3776	3685	3710
Gestational age, wk			
25th percentile	38	38	38
Median	39	39	39
75th percentile	40	40	40
Source of payment for prenatal care[a]			
Private insurance	2 679 282 (63.1)	994 135 (39.0)	894 420 (20.3)
Medi-Cal/other government/self-pay	1 079 123 (25.4)	1 203 596 (47.2)	2 849 752 (64.8)
Missing	487 890 (11.5)	351 091 (13.8)	653 531 (14.9)
Multiple birth pregnancy			
Singleton	4 104 396 (96.7)	2 492 985 (97.8)	4 315 095 (98.1)
Multiple	141 867 (3.3)	55 833 (2.2)	82 597 (1.9)
Missing	32 (0)	4 (0)	11 (0)
Parity			
0	1 825 618 (43.0)	1 062 066 (41.7)	1 407 794 (32.0)
1	1 432 722 (33.7)	754 103 (29.6)	1 305 260 (29.7)
≥2	987 955 (23.3)	732 653 (28.7)	1 684 649 (38.3)

[a]Data only available for years 1989–2011.

Table 3

HRs of Childhood Cancer Among Children Age 5 Years and Younger by Mother's Ethnicity and Birthplace[a]

	US-Born White Mothers (n = 4368)	US-Born Hispanic Mothers (n = 2320)		Non-US–Born Hispanic Mothers (n = 3798)	
Cancer Type	**No. (%)**	**No. (%)**	**Adjusted HR (95% CI)**	**No. (%)**	**Adjusted HR (95% CI)**
Acute lymphoblastic leukemia	1204 (36.9)	748 (22.9)	1.20 (1.10–1.32)	1314 (40.2)	1.06 (0.98–1.15)
Acute myeloid leukemia	200 (36.6)	132 (24.2)	1.28 (1.02–1.61)	214 (39.2)	1.05 (0.87–1.28)
Hodgkin lymphoma	13 (19.7)	19 (28.8)	2.49 (1.21–5.13)	34 (51.5)	2.35 (1.24–4.47)
Non-Hodgkin lymphoma	56 (45.5)	23 (18.7)	0.79 (0.48–1.30)	44 (35.8)	0.76 (0.51–1.14)
Burkitt lymphoma	46 (48.4)	15 (15.8)	0.69 (0.38–1.25)	34 (35.8)	0.73 (0.47–1.15)
Ependymoma	93 (43.5)	58 (27.1)	1.24 (0.88–1.74)	63 (29.4)	0.68 (0.49–0.93)
Glioma	629 (53.2)	231 (19.5)	0.71 (0.61–0.83)	323 (27.3)	0.50 (0.44–0.58)
High grade	58 (53.2)	20 (18.3)	0.58 (0.34–0.97)	31 (28.4)	0.49 (0.32–0.77)
Low grade	165 (53.4)	49 (15.9)	0.61 (0.44–0.85)	95 (30.7)	0.58 (0.45–0.75)
Astrocytoma	442 (56.5)	143 (18.3)	0.62 (0.51–0.75)	197 (25.2)	0.43 (0.36–0.51)
Intracranial and intraspinal embryonal tumors	250 (45.0)	118 (21.3)	0.85 (0.68–1.07)	187 (33.7)	0.71 (0.59–0.86)
PNET	96 (40.9)	50 (21.3)	0.86 (0.61–1.23)	89 (37.9)	0.86 (0.64–1.14)
Medulloblastoma	101 (47.9)	43 (20.4)	0.78 (0.54–1.13)	67 (31.8)	0.63 (0.46–0.86)
Neuroblastoma	569 (54.0)	206 (19.5)	0.66 (0.56–0.78)	279 (26.5)	0.47 (0.40–0.54)
Retinoblastoma	213 (37.8)	133 (23.6)	1.14 (0.91–1.42)	217 (38.5)	0.97 (0.80–1.18)
Unilateral	142 (37.2)	99 (25.9)	1.27 (0.97–1.65)	141 (36.9)	0.94 (0.74–1.19)
Bilateral	71 (40.1)	33 (18.6)	0.83 (0.54–1.28)	73 (41.2)	0.99 (0.72–1.38)
Wilms tumor	369 (45.8)	171 (21.2)	0.88 (0.73–1.06)	266 (33.0)	0.70 (0.59–0.82)

	US-Born White Mothers (n = 4368)	US-Born Hispanic Mothers (n = 2320)		Non-US–Born Hispanic Mothers (n = 3798)	
Cancer Type	**No. (%)**	**No. (%)**	**Adjusted HR (95% CI)**	**No. (%)**	**Adjusted HR (95% CI)**
Hepatoblastoma	100 (36.8)	61 (22.4)	1.16 (0.83–1.61)	111 (40.8)	1.09 (0.83–1.44)
Bone tumors	37 (44.0)	27 (32.1)	1.38 (0.83–2.31)	20 (23.8)	0.50 (0.29–0.87)
Ewings sarcoma	22 (45.8)	14 (29.2)	1.23 (0.61–2.46)	12 (25.0)	0.52 (0.26–1.06)
Soft-tissue sarcomas	209 (40.7)	115 (22.4)	1.05 (0.83–1.32)	189 (36.8)	0.87 (0.71–1.06)
Rhabdomyosarcoma	142 (42.4)	71 (21.2)	0.97 (0.72–1.30)	122 (36.4)	0.83 (0.65–1.06)
Germ-cell tumors	126 (39.5)	61 (19.1)	0.81 (0.59–1.11)	132 (41.4)	0.97 (0.76–1.24)
Yolk sac tumors	44 (33.8)	23 (17.7)	0.82 (0.49–1.38)	63 (48.5)	1.29 (0.88–1.91)
Teratoma	58 (40.0)	33 (22.8)	0.95 (0.61–1.47)	54 (37.2)	0.85 (0.59–1.24)

Abbreviations: HR, hazard ratio; PNET, primitive neuroectodermal tumor.

[a]Adjusted models control for maternal and paternal ages.

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Table 4

Results Examining Children of Mexican and Mexican American Mothers Only[a]

	White Non-Hispanic, US Born (n = 4368)	Mexican American, US Born (n = 1948)		Mexican, Non-US Born (n = 3201)	
Cancer Type	**No. (%)**	**No. (%)**	**HR (95% CI)**	**No. (%)**	**HR (95% CI)**
Acute lymphoblastic leukemia	1204 (40.6)	646 (21.8)	1.23 (1.12–1.36)	1119 (37.7)	1.08 (0.99–1.17)
Acute myeloid leukemia	200 (41.8)	102 (21.3)	1.18 (0.92–1.51)	177 (37.0)	1.04 (0.85–1.27)
Hodgkin lymphoma	13 (23.2)	18 (32.1)	2.90 (1.39–6.05)	25 (44.6)	2.11 (1.07–4.14)
Non-Hodgkin lymphoma	56 (52.8)	21 (19.8)	0.83 (0.49–1.39)	29 (27.4)	0.59 (0.37–0.92)
Burkitt lymphoma	46 (54.1)	12 (14.1)	0.63 (0.33–1.22)	27 (31.8)	0.68 (0.42–1.10)
Ependymoma	93 (48.2)	46 (23.8)	1.15 (0.80–1.66)	54 (28.0)	0.69 (0.49–0.97)
Glioma	629 (57.3)	195 (17.8)	0.72 (0.61–0.84)	274 (25.0)	0.51 (0.44–0.59)
High grade	58 (58.0)	18 (18.0)	0.61 (0.35–1.06)	24 (24.0)	0.45 (0.28–0.73)
Low grade	165 (57.3)	40 (13.9)	0.60 (0.42–0.85)	83 (28.8)	0.61 (0.47–0.80)
Astrocytoma	442 (60.0)	127 (17.2)	0.65 (0.53–0.80)	168 (22.8)	0.44 (0.37–0.52)
Intracranial and intraspinal embryonal tumors	250 (49.4)	95 (18.8)	0.80 (0.63–1.03)	161 (31.8)	0.72 (0.59–0.88)
PNET	96 (43.8)	42 (19.2)	0.86 (0.59–1.25)	81 (37.0)	0.92 (0.68–1.24)
Medulloblastoma	101 (52.9)	35 (18.3)	0.75 (0.51–1.12)	55 (28.8)	0.61 (0.44–0.85)
Neuroblastoma	569 (58.4)	170 (17.5)	0.64 (0.54–0.77)	235 (24.1)	0.47 (0.40–0.54)
Retinoblastoma	213 (43.1)	102 (20.6)	1.03 (0.81–1.32)	179 (36.2)	0.95 (0.78–1.16)
Unilateral	142 (43.2)	73 (22.2)	1.11 (0.83–1.49)	114 (34.7)	0.90 (0.70–1.15)
Bilateral	71 (43.3)	29 (17.7)	0.88 (0.56–1.37)	64 (39.0)	1.04 (0.74–1.46)
Wilms tumor	369 (50.1)	146 (19.8)	0.90 (0.74–1.10)	221 (30.0)	0.69 (0.58–0.82)

Cancer Type	White Non-Hispanic, US Born (n = 4368)	Mexican American, US Born (n = 1948)		Mexican, Non-US Born (n = 3201)	
	No. (%)	No. (%)	HR (95% CI)	No. (%)	HR (95% CI)
Hepatoblastoma	100 (39.8)	50 (19.9)	1.14 (0.80–1.63)	101 (40.2)	1.19 (0.90–1.58)
Bone tumors	37 (46.8)	24 (30.4)	1.43 (0.84–2.43)	18 (22.8)	0.53 (0.30–0.94)
Ewings sarcoma	22 (48.9)	12 (26.7)	1.25 (0.60–2.60)	11 (24.4)	0.57 (0.28–1.19)
Soft-tissue sarcomas	209 (45.2)	96 (20.8)	1.02 (0.79–1.31)	157 (34.0)	0.85 (0.69–1.05)
Rhabdomyosarcoma	142 (47.3)	60 (20.0)	0.96 (0.70–1.31)	98 (32.7)	0.79 (0.61–1.02)
Germ-cell tumors	126 (42.3)	52 (17.4)	0.82 (0.59–1.14)	120 (40.3)	1.04 (0.81–1.34)
Yolk sac tumors	44 (36.1)	18 (14.8)	0.76 (0.43–1.34)	60 (49.2)	1.46 (0.99–2.17)
Teratoma	58 (43.3)	30 (22.4)	1.01 (0.64–1.60)	46 (34.3)	0.86 (0.58–1.27)

Abbreviations: HR, hazard ratio; PNET, primitive neuroectodermal tumor.

[a] Adjusted models control for maternal and paternal ages.

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Table 5

Results Examining Children of Non-Mexican Hispanic Mothers Only[a]

	White Non-Hispanic, US Born (n = 4368)	Hispanic Non-Mexican, US Born (n = 372)		Hispanic Non-Mexican, Non-US Born (n = 589)	
Cancer Type	**No. (%)**	**No. (%)**	**HR (95% CI)**	**No. (%)**	**HR (95% CI)**
Acute lymphoblastic leukemia	1204 (80.4)	102 (6.8)	1.04 (0.85–1.28)	192 (12.8)	0.99 (0.85–1.15)
Acute myeloid leukemia	200 (74.9)	30 (11.2)	1.77 (1.20–2.61)	37 (13.9)	1.14 (0.80–1.62)
Non-Hodgkin lymphoma	56 (76.7)	2 (2.7)	0.45 (0.11–1.86)	15 (20.5)	1.66 (0.94–2.94)
Ependymoma	93 (81.6)	12 (10.5)	1.56 (0.85–2.88)	9 (7.9)	0.61 (0.31–1.21)
Glioma	629 (88.1)	36 (5.0)	0.69 (0.49–0.97)	49 (6.9)	0.49 (0.36–0.65)
High grade	58 (86.6)	2 (3.0)	0.36 (0.09–1.50)	7 (10.4)	0.74 (0.34–1.63)
Low grade	165 (88.7)	9 (4.8)	0.73 (0.37–1.43)	12 (6.5)	0.46 (0.26–0.84)
Astrocytoma	442 (90.8)	16 (3.3)	0.43 (0.26–0.72)	29 (6.0)	0.41 (0.28–0.59)
Intracranial and intraspinal embryonal tumors	250 (83.6)	23 (7.7)	1.04 (0.68–1.61)	26 (8.7)	0.64 (0.42–0.95)
Medulloblastoma	101 (83.5)	8 (6.6)	0.90 (0.44–1.87)	12 (9.9)	0.71 (0.39–1.30)
PNET	96 (85.7)	8 (7.1)	0.86 (0.42–1.79)	8 (7.1)	0.51 (0.25–1.04)
Neuroblastoma	569 (87.8)	36 (5.6)	0.73 (0.52–1.03)	43 (6.6)	0.47 (0.34–0.64)
Retinoblastoma	213 (75.5)	31 (11.0)	1.58 (1.08–2.32)	38 (13.5)	1.08 (0.77–1.53)
Unilateral	142 (72.8)	26 (13.3)	2.03 (1.33–3.11)	27 (13.8)	1.15 (0.76–1.74)
Bilateral	71 (84.5)	4 (4.8)	0.56 (0.20–1.56)	9 (10.7)	0.77 (0.38–1.53)
Wilms tumor	369 (84.2)	25 (5.7)	0.80 (0.53–1.20)	44 (10.0)	0.74 (0.54–1.01)
Hepatoblastoma	100 (82.6)	11 (9.1)	1.28 (0.68–2.41)	10 (8.3)	0.62 (0.32–1.19)
Soft-tissue sarcomas	209 (80.7)	19 (7.3)	1.11 (0.69–1.78)	31 (12.0)	0.90 (0.62–1.32)

	White Non-Hispanic, US Born (n = 4368)	Hispanic Non-Mexican, US Born (n = 372)		Hispanic Non-Mexican, Non-US Born (n = 589)	
Cancer Type	**No. (%)**	**No. (%)**	**HR (95% CI)**	**No. (%)**	**HR (95% CI)**
Rhabdomyosarcoma	142 (80.7)	11 (6.3)	0.95 (0.51–1.77)	23 (13.1)	0.99 (0.63–1.54)
Germ-cell tumors	126 (85.7)	9 (6.1)	0.78 (0.39–1.54)	12 (8.2)	0.57 (0.32–1.04)

Abbreviations: HR, hazard ratio; PNET, primitive neuroectodermal tumor.

[a]Adjusted models control for maternal and paternal ages.