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Community Socioeconomic Disadvantage and the Survival of Infants With Congenital Heart Defects

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Abstract

Objectives—We examined the association between survival of infants with severe congenital heart defects (CHDs) and community-level indicators of socioeconomic status.

Methods—We identified infants born to residents of Arizona, New Jersey, New York, and Texas between 1999 and 2007 with selected CHDs from 4 population-based, statewide birth defect

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Contributors

J. E. Kucik conceptualized and designed the study, carried out the analyses, drafted the initial manuscript, and approved the final manuscript as submitted. W. N. Nembhard, P. Donohue, O. Devine, C. S. Minkovitz, T. Burke, and Y. Wang contributed to the conceptualization and study design, reviewed and revised the manuscript, and approved the final manuscript as submitted.

Human Participant Protection

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surveillance programs. We linked data to the 2000 US Census to obtain 11 census tract–level socioeconomic indicators. We estimated survival probabilities and hazard ratios adjusted for individual characteristics.

Results—We observed differences in infant survival for 8 community socioeconomic indicators ($P < .05$). The greatest mortality risk was associated with residing in communities in the most disadvantaged deciles for poverty (adjusted hazard ratio [AHR] = 1.49; 95% confidence interval [CI] = 1.11, 1.99), education (AHR = 1.51; 95% CI = 1.16, 1.96), and operator or laborer occupations (AHR = 1.54; 95% CI = 1.16, 1.96). Survival decreased with increasing numbers of indicators that were in the most disadvantaged decile. Community-level mortality risk persisted when we adjusted for individual-level characteristics.

Conclusions—The increased mortality risk among infants with CHDs living in socioeconomically deprived communities might indicate barriers to quality and timely care at which public health interventions might be targeted.

Advances in medical and surgical care for individuals born with congenital heart defects (CHDs) has improved survival in recent years, yet despite this progress, mortality due to CHDs remains a significant public health issue.[1,2] CHDs are the most common type of birth defect and are the leading cause of death among those born with birth defects.[3,4] CHDs necessitate medical and often surgical intervention early in life, and timely detection and quality care can improve health outcomes.[5,6] Medical factors such as low birth weight, preterm birth, severity of the condition, and the presence of comorbidities are well-established risk factors for mortality, particularly during the neonatal period.[7] Nonmedical factors (particularly race/ethnicity) also play an important role in the survival of infants with birth defects and potentially contribute significantly to unexplained survival differences.[8] Several factors that influence access to and use of care have been examined among cohorts of infants born with CHDs, but these have been limited to race/ethnicity,[2,9–16] medical insurance,[9,16–20] and distance to specialty care.[10,17,21,22] Assessment of the potential impact of socioeconomic status (SES) on survival has been challenging, largely because SES has been defined and measured in many ways and is often unavailable in large, population-based data sets. SES has been investigated as a risk factor for the occurrence of different types of birth defects,[23–28] but few published population-based studies have included SES as a risk factor for CHD-related mortality.

Community-level factors related to socioeconomic conditions have been associated with decreased access to pediatric subspecialty care and early mortality of infants with low birth weight,[29,30] and they might provide evidence of contextual factors that could potentially influence the survival of infants with CHDs, who require timely medical intervention.[31–33] In this population-based study, we estimated the association of census tract–level indicators of SES with the survival of infants born with CHDs and examined the potential impact of communities on observed racial/ethnic disparities in infant survival.

METHODS

We used population-based data from 4 state-based birth defect surveillance programs (Arizona, New York, New Jersey, and Texas) to conduct a retrospective cohort study. The

study population included live-born infants delivered from 1999 to 2007 with a diagnosis of 1 of the following 7 CHDs: common truncus arteriosus, transposition of the great vessels, tetralogy of Fallot, atrioventricular septal defect, aortic valve stenosis, hypoplastic left heart syndrome, and coarctation of the aorta. We selected these defects for inclusion in the analysis because of the high reliability with which they are ascertained by public health birth defect surveillance programs and because of the relatively high mortality associated with each defect. We classified infants as having one of the included CHDs by using a modified British Pediatrics Association (BPA) coding system[34] for births in Arizona, New York, and Texas, and the International Classification of Diseases, Ninth Revision, Clinical Modification (*ICD-9-CM*)[35] codes for births in New Jersey.

Variables

We matched infants with CHDs identified by state surveillance programs to state-specific linked birth-infant death files to determine vital status and to retrieve sociodemographic variables (state, county, and census tract number of the maternal residence at birth, maternal race, maternal nativity, maternal education, and maternal age) and clinical variables (infant's birth weight, parity, and infant's sex). Census tracts are small-area groupings (approximately 4000 residents) consisting of relatively homogeneous population characteristics. We obtained census tract information by linking individual-level data to the 2000 US Census by the census tract number of the maternal residence, and then extracted the following 11 census tract–level socioeconomic variables, selected through a literature review[28,30]: proportion of the population aged 18 years or older who did not graduate from high school, proportion of people aged 16 years or older who were unemployed, proportion of the population aged 16 years or older who had operator or laborer occupations (i.e., low-skill occupations), proportion of the noninstitutionalized population living below the federal poverty level, proportion of all occupied housing units with more than 1 person per room, proportion of all occupied housing units that were renter occupied, proportion speaking a language other than English at home, proportion of population foreign born, proportion Hispanic, proportion Black, and per capita income.[36] For each census tract variable, we determined deciles on the basis of the distribution of values across all census tracts in the 4 study states.

Data Analysis

Using the Kaplan-Meier product-limit method, we estimated survival probabilities for infancy (0–364 days) and for the neonatal (< 28 days) and postneonatal (28–364 days) periods.[37] In estimating survival probabilities for the postneonatal period, we assumed survival through the first 27 days. We used Greenwood's method to calculate the variance of the estimated survival probability and 95% confidence intervals.[38] We used a log-rank test to determine whether the survival probabilities were significantly different between the highest and lowest deciles for each of the 11 socioeconomic indicators.[39] We visually examined Kaplan–Meier curves to assess whether the proportional hazard assumption was met.

To examine the possibility that each community SES indicator was an observable measure of a common underlying risk factor, we estimated survival probabilities for an index score,

which was based on the cumulative number of indicators for which the infant's census tract was in the lowest, or most disadvantaged, decile. On the basis of the distribution of the number of indicators in the most disadvantaged decile, we created levels 1 through 4 of the variable, consisting of infants who had 0, 1, 2 to 4, or 5 or more of the 11 socioeconomic indicators in the lowest decile, respectively.

For the census tract indicators that showed an association with survival and for which there was a corresponding individual-level variable (i.e., education, race/ethnicity), we stratified survival estimates by the individual-level variable to examine whether the magnitude of risk associated with the community-level variable was consistent across individual-level risk factors.

We used Cox proportional hazard regression models to estimate the effect of census tract–level socioeconomic factors on mortality, controlling for individual-level variables that were statistically significant in the univariate analyses.[39] We created separate models for each SES indicator and compared the lowest decile with the highest (i.e., least disadvantaged) decile (referent group). We assessed statistical interaction between all individual-level covariates and all census tract–level economic factors, and we stratified hazard models as appropriate.

We also used crude proportional hazard regression models to assess the relationship between maternal race/ethnicity and survival. We then adjusted these models with community measures of SES to examine whether the estimates of racial/ethnic disparities in survival were attenuated. All proportional hazard regression models for the postneonatal period assumed survival through the first 27 days. We performed computations using SAS version 9.2 (SAS Institute, Cary, NC).

RESULTS

Overall, we identified 10 578 infants with at least 1 of the 7 selected CHDs from the 4 population-based birth defect surveillance programs. Of those, 9853 infants (93%) had census tract information that could be used for linkage with the 2000 US Census. Maternal and infant characteristics of the final cohort by participating state are provided in Table A and infant mortality by CHD type are provided in Figure A (both available as supplements to the online version of this article at http://www.ajph.org).

Survival Probabilities

The overall infant survival was 80.3% (95% confidence interval [CI] = 79.5%, 81.1%) (Table 1). When we compared the lowest, or most socioeconomically disadvantaged, decile with the highest decile for each census tract indicator, infant survival was lower for the most disadvantaged decile for every indicator; however, data for the proportions of those foreign born, unemployed, or Black were not statistically significant (Table 1). The greatest disparity in infant survival among the socioeconomic indicators was for per capita income (76.3% for the most disadvantaged decile vs 85.2% for the least disadvantaged decile; $P < .001$), the proportion of the population below the poverty level (76.3% vs 83.8%; $P < .001$), and the proportion of the population with less than a high school education (76.3% vs

85.2%; $P < .001$). The survival differences were greater and observed for more of the indicators during the postneonatal period compared with the neonatal period. The indicator with the greatest disparity in neonatal survival was the proportion of the population in an operator or laborer occupation (88.7% vs 92.9%; $P = .004$), and the indicator with the greatest disparity in postneonatal survival was the proportion of the population that was Hispanic (86.4% vs 92.7%; $P < .001$). Using the 4-level composite variable of SES, we found that infant survival was highest among infants with no socioeconomic indicators in the most disadvantaged decile (level 1) and lowest among infants with 5 or more indicators in that decile (level 4; 81.7% vs 76.0%; $P < .001$; Figure 1).

We stratified community indicators for race/ethnicity and education by the corresponding individual-level factor. Being born to a mother with less than a high school education was associated with poorer infant survival ($P < .001$; Table B, available as supplements to the online version of this article at http://www.ajph.org), and living in a census tract with a high proportion of residents with less than a high school education was associated with lower infant survival for all levels of the mother's individual level of education, although statistical significance was not achieved for those with less than a high school education (Figure 2). Similarly, infant survival was higher among non-Hispanic White infants compared with Hispanic infants ($P < .001$; Table B), but non-Hispanic White infants experienced lower survival if they lived in a census tract in which a high proportion of the population was Hispanic (Figure 2).

Hazard Ratios

Individual-level covariates that were associated with survival were birth weight, infant's sex, maternal age, maternal nativity, maternal education, parity, birth period, and state of residence. There were significant interactions between maternal age and 2 SES indicators: the proportion speaking a language other than English and the proportion foreign born; both were more strongly associated with infant mortality among older mothers. There were additional interactions between maternal race/ethnicity and 2 SES indicators: the proportion of the population in an operator or laborer occupation was more strongly associated with non-Hispanic White infants, and residential crowding was more strongly associated with Hispanic ethnicity. We also found an interaction between per capita income and infant birth weight. The greatest infant mortality risk was among Hispanic infants for residential crowding (adjusted hazard ratios [AHR] = 4.24; 95% CI = 1.56, 11.54; Table 2). We also observed an increased mortality risk among Hispanic infants for proportion of the population in an operator or laborer occupation (AHR = 2.03; 95% CI = 1.09, 3.77) and among infants with mothers older than 35 who lived in communities with the highest proportion of non-English-speaking residents (AHR = 2.28; 95% CI = 1.34, 3.87) or foreign-born residents (AHR = 2.75; 95% CI = 1.50, 5.06). The indicators for the proportion of the population below the poverty level and the proportion with less than a high school education were associated with a 46% increased infant mortality risk (Table 2).

To examine the increased mortality risk associated with extreme socioeconomic disadvantage, we modeled a composite socioeconomic variable, as described in Methods, to determine the increased risk of living in communities with more indicators of

socioeconomic disadvantage, adjusting for individual-level factors. Compared with infants living in a census tract with none of the indicators in the lowest decile, infants living in a census tract with 1 indicator, 2 to 4 indicators, and 5 or more indicators in the lowest decile had 10%, 15%, and 25% increased mortality risk, respectively, after adjustment for individual-level factors (Table 2).

The greatest observed racial disparity was in the postneonatal period, during which crude mortality risk was 86% higher for non-Hispanic Blacks and 57% higher for Hispanics compared with non-Hispanic Whites (data not shown). Statistical adjustment for individual-level factors reduced the excess postneonatal mortality risk to non-Hispanic Blacks by 29% and the excess mortality risk to Hispanics by 23%. Adjustment for only the census tract–level measures of socioeconomic factors that were associated with survival had no notable impact on the crude hazard ratio for non-Hispanic Blacks and Hispanics.

DISCUSSION

Socioeconomic disadvantage was adversely associated with the survival of infants born with CHDs. Survival varied by most but not all community indicators that we examined, and the statistical significance of the survival difference was stronger in the postneonatal period than in the neonatal period. The community factors most predictive of infant death were related to income, poverty, education, and occupation. Socioeconomic disadvantage related to these factors increased the infant mortality risk by up to 47%, and the associated mortality risk increased significantly in some subpopulations, such as those of Hispanic ethnicity. Among infants born to Hispanic mothers, those who lived in communities with high residential crowding had more than a fourfold increased infant mortality risk compared with those living in communities with the least residential crowding.

Because infants with severe CHDs require early and continued surgical and medical intervention, increased access to and use of specialized health care resources would be expected to improve the likelihood of survival; however, measuring access or barriers to care in population-based studies is challenging.[5,29] Individual-level information on health insurance and SES is not frequently available in population-based data in the United States; therefore, a growing body of research has focused on determining appropriate community measures of SES that might serve as a proxy for unavailable individual-level information.[40] Previous studies observed an association between individual- and area-level SES and the etiology of birth defects,[25,27,28,41,42] but population-based survival studies in the United States have yet to incorporate community measures of SES to better understand factors influencing survival among infants born with birth defects. Limited studies in Canada, which has universal health care coverage, found inconsistent evidence that neighborhood income was associated with survival of medically needy infants,[43,44] but this association has not been thoroughly examined in the United States. On the basis of findings from previous work, our study included a range of measures to better understand the type of SES factors that might be associated with mortality in our study population.[28,30,45]

CHD subtypes can range in severity. Those included in this study are considered severe and were selected because of the reliability with which they are clinically diagnosed and

accurately detected by birth defect surveillance programs. Because of the severe nature of these conditions, infants require surgical intervention and appropriate follow-up care, with additional surgeries frequently required. The complexity of continued care might explain why the impact of SES was greater on postneonatal survival. Higher levels of education might be needed to understand and process sophisticated medical information and to research and make selection decisions about the physicians and institutions that might provide higher-quality care. Family income is associated with gradients in both children's health and access to health care, and it might influence the ability to seek out and use high-quality care, especially to overcome barriers presented by significant travel distances.[46] Teaching hospitals and institutions that conduct a high volume of pediatric cardiac surgeries have been shown to have better outcomes than low-volume hospitals, and the ability to control for differential patterns of referrals and for the risk-adjusted mortality of hospitals might elucidate the association between SES factors and survival.[47–51]

The finding that occupation influenced survival was interesting and potentially more difficult to explain. This variable might serve as a proxy for health literacy or family resources, although it was not highly correlated with the measures for income and education. It is more likely that occupation type is an indicator of the level of medical insurance coverage, which is often employer based. Unemployment was not associated with mortality; however, Medicaid eligibility might be higher in areas of high unemployment, with covered individuals having sufficient insurance coverage and access to care. Those more likely to be in operator or laborer occupations might have incomes too high to qualify for Medicaid but have no employer-provided coverage or have plan options that provide inadequate coverage. The impact of medical insurance on infant survival among individuals born with CHDs has not been well examined, although several hospital-based studies found that infants with public insurance had higher postoperative mortality than infants covered by private insurance.[18,19]

The consistency with which we observed lower infant survival for the most disadvantaged decile across all the SES indicators raised the issue of whether each indicator was indicative of some common underlying factor associated with economic disadvantage. If that were the case, having multiple indicators in the lowest decile would not be expected to increase the risk above that associated with a single indicator; however, we found a decrease in infant survival with an increasing number of indicators that were in the most disadvantaged decile. This suggests that different community indicators of SES might be separable measures of differing underlying risks, and analyses limited to 1 community indicator might underestimate the impact of disadvantaged communities on health outcomes. Another unknown was whether the community indicators were simply reflecting an individual-level risk or if the community risk was independent of the individual risk. For the most direct test, we examined constructs for which both the individual and community variables were associated with survival. Low maternal education was associated with lower survival, but even infants born to mothers with higher education had significantly lower survival if they lived in a community with a high proportion of residents with a low level of education. In fact, the community effect associated with low education appeared to be larger than the individual-level effect. Similarly, even though non-Hispanic White infants had a survival advantage compared with Hispanic infants, non-Hispanic White infants in communities with

a high proportion of Hispanic residents experienced lower survival than non-Hispanic White infants living in communities with a low proportion of Hispanic residents, which is in notable contrast to the "Hispanic paradox" observed in the general population.[52]

The observed racial/ethnic disparities in mortality among infants with CHDs corroborate earlier findings that have not been well explained.[2,9,14,41,53–55] Racial and ethnic disparities in survival were highest in the postneonatal period, and adjustment for community factors did not appreciably reduce racial and ethnic disparities, a finding contrary to previous ones based on other health outcomes.[56] After adjustment for all individual- and community-level confounders, non-Hispanic Black and Hispanic infants still had a higher mortality risk than non-Hispanic White infants. Although we did not have information on the medical insurance status of infants, previous studies found that medical insurance explained some of the observed racial/ethnic disparities.[16,57] Therefore, it is plausible that referral patterns and access to and use of advances in pediatric cardiac care may be important predictors of disparity in survival among infants with a CHD, and that addressing these issues might be an important step in reducing these disparities. Because survival estimates vary across CHD subtypes, there might be a concern that unequal distribution of subtypes by race/ethnicity could explain differences in survival by race and ethnicity; however, a previous study showed modest variation in birth prevalence by race/ethnicity.[25] Data from that study showed that the CHD type with the highest mortality, hypoplastic left heart syndrome, was not higher among non-Hispanic Black infants (prevalence ratio [PR]=1.01) or Hispanic infants (PR=1.02) than among non-Hispanic White infants.

A strength of this study was that it combined data from several states to provide a larger study population size that was diverse racially and ethnically, regionally, and socioeconomically; however, a disproportionate number of infants were from urban communities. This large, diverse population reduced the level of random variability in the survival estimates and allowed evaluation of differences in these estimates across an array of factors that might influence survival of infants with CHDs. Birth defect surveillance programs use varying methodologies to identify and confirm cases of birth defects, and the programs from which these data were drawn are those that employ active or partially active case ascertainment, which provide more accurate clinical diagnoses and the most complete prevalence estimates.[34,58] Despite the increased accuracy gained by use of medical records, some misclassification of CHD types may occur; however, our approach of grouping the 7 severe CHDs reduces the impact of misclassification.

A potential limitation of this study was the lack of information on pregnancies affected by a CHD that resulted in fetal deaths, especially those that were elective terminations. Socioeconomic and other barriers to prenatal care can result in differential prenatal diagnosis by race and SES.[15,59] Consequently, more severe defects could be detected and terminated at higher rates among those with greater access to care, which would artificially inflate the true mortality risk of disadvantaged populations.[60–62] Another limitation was that infants who moved out of state and died might be assumed to be alive; however, many states have interstate agreements to share information on infant deaths.

Although birth defects are a leading cause of infant death, public health strategies to address the overall burden of infant deaths have largely been concentrated on other causes such as preterm delivery, sudden infant death syndrome, and injuries.[63] This lack of attention might be in part the result of the inaccessibility of quality data or because mortality associated with birth defects is perceived as dependent primarily on surgical intervention. Yet a growing number of population-based studies of birth defects have identified unexplained racial and socioeconomic disparities, which represent opportunities for strategic and targeted interventions. Although previous survival studies of infants with birth defects focused primarily on clinical factors associated with early mortality, this study provides evidence that community measures of SES are potentially useful predictors of survival patterns in infants born with CHDs and are more strongly associated with survival than other established individual-level sociodemographic risk factors. This population-based study provides evidence suggesting that public health interventions such as home visitation programs and early intervention services might more effectively identify infants with the highest risk of infant death if integrated with information on residential communities.

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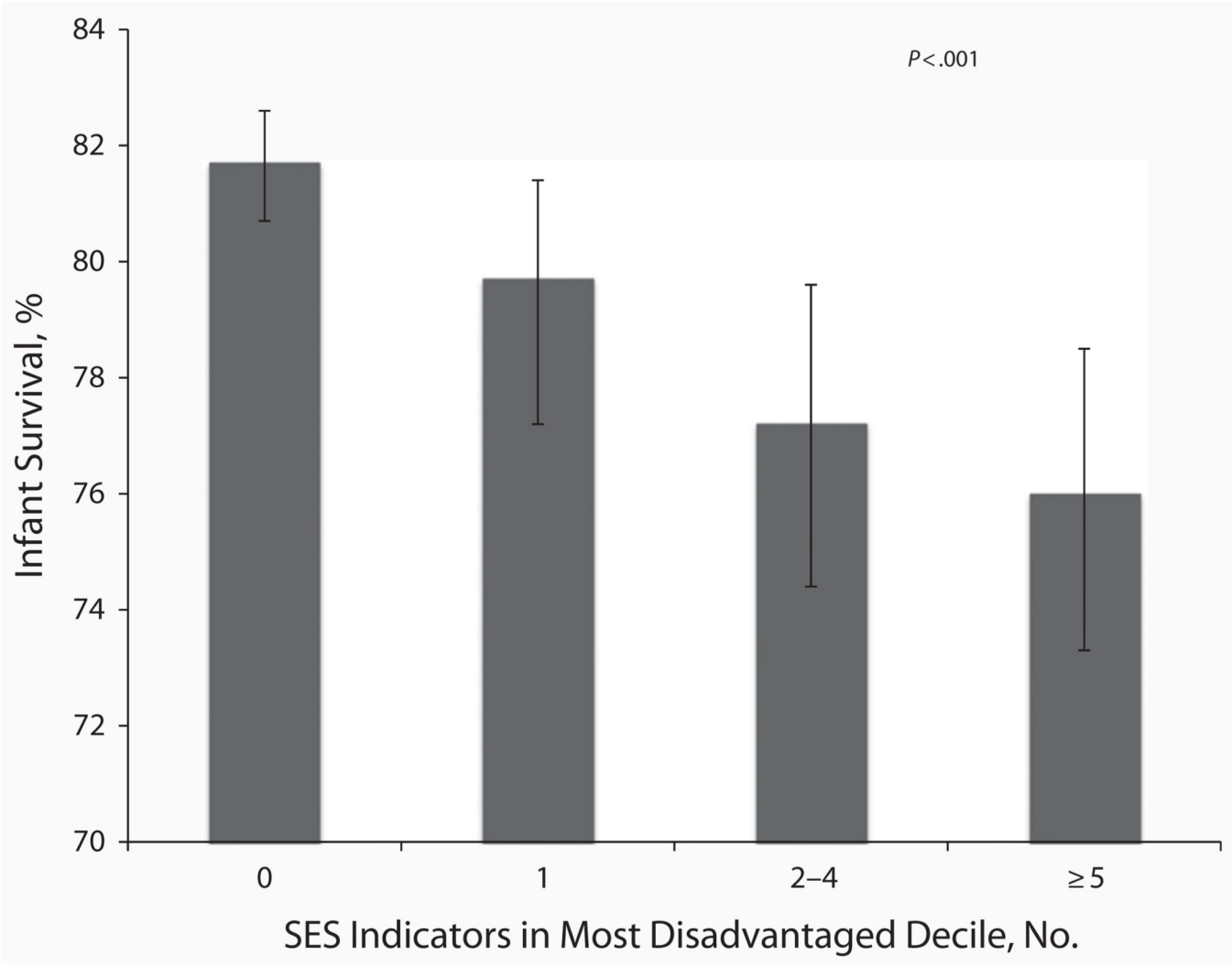

FIGURE 1. One-year survival probabilities for infants born with congenital heart defect, by number of census tract–level indicators (n = 11) of socioeconomic status (SES) in the most disadvantaged decile: Arizona, New Jersey, New York, and Texas birth defects surveillance programs, 1999–2007

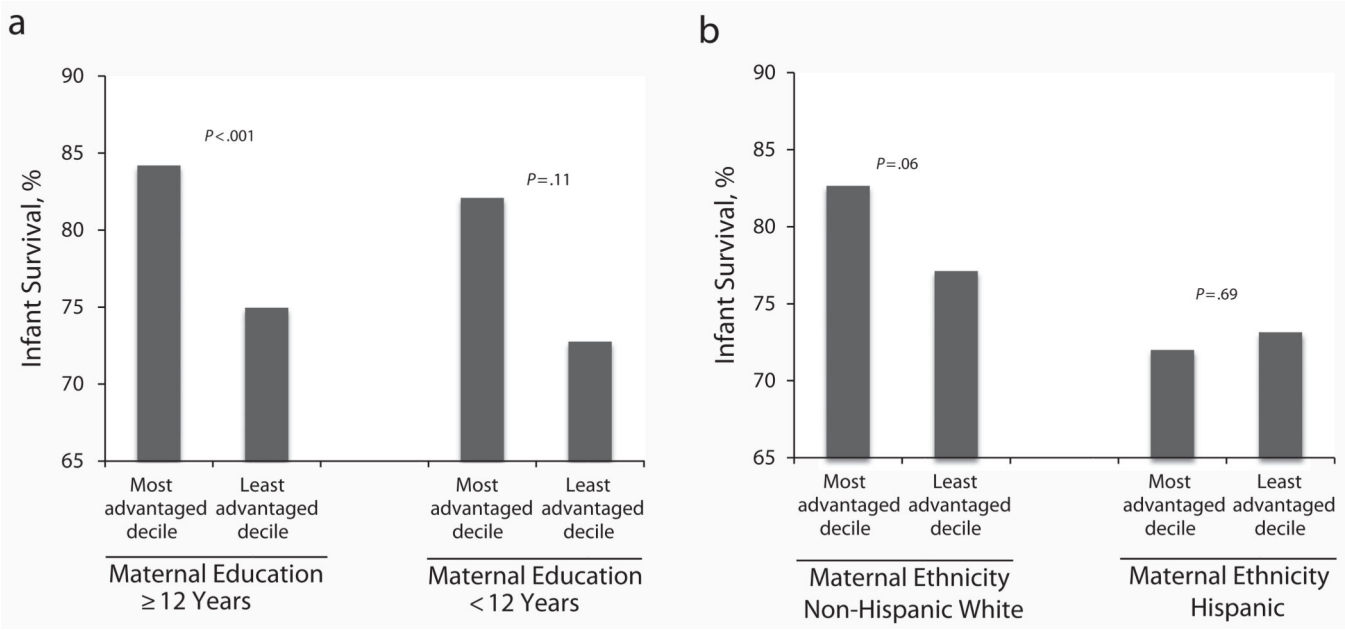

FIGURE 2. Interaction between census tract–level and individual-level variables on 1-year survival of infants with congenital heart defect by (a) education level and (b) ethnicity: Arizona, New Jersey, New York, and Texas birth defect surveillance programs, 1999–2007

Note. Individual-level variables are level of education and ethnicity. Census tract–level variables are most and least advantages deciles.

TABLE 1

Kaplan-Meier 1-Year Survival Probabilities for Infants With Congenital Heart Defect (CHD), by Decile of Census Tract–Level Indicators of Socioeconomic Status: Arizona, New Jersey, New York, and Texas Birth Defect Surveillance Programs, 1999–2007

		Neonatal			Postneonatal			Infant		
Census Tract Variable	No. of Infants Born With CHD	No. of Deaths	Survival, % (95% CI)	*P*	No. of Deaths	Survival, % (95% CI)	*P*	No. of Deaths	Survival, % (95% CI)	*P*
Total	9853	1019	89.7 (89.0, 90.2)		923	89.6 (88.9, 90.2)		1942	80.3 (79.5, 81.1)	
Per capita income				.02			.003			< .001
Most disadvantaged decile	1044	125	88.0 (85.9, 89.9)		122	86.7 (84.4, 88.8)		247	76.3 (73.6, 78.7)	
Least disadvantaged decile	633	52	91.8 (89.4, 937)		42	92.8 (90.3, 94.6)		94	85.2 (82.1, 87.7)	
Poverty[a]				.01			.004			< .001
Most disadvantaged decile	924	123	86.7 (84.3, 88.7)		96	88.0 (85.36, 90.1)		219	76.3 (73.4, 78.9)	
Least disadvantaged decile	734	69	90.6 (88.2, 92.5)		50	92.5 (90.2, 94.2)		119	83.8 (80.9, 86.3)	
Education[b]				.01			<.001			< .001
Most disadvantaged decile	1203	142	88.2 (86.2, 89.9)		138	87.0 (84.8, 88.9)		280	76.7 (74.2, 79.0)	
Least disadvantaged decile	765	63	91.8 (89.6, 93.5)		50	92.9 (90.7, 94.6)		113	85.2 (82.5, 87.6)	
Operator/laborer occupation[c]				.004			.004			< .001
Most disadvantaged decile	1420	161	88.7 (86.9, 90.2)		143	88.6 (86.8, 90.3)		304	78.6 (76.4, 80.6)	
Least disadvantaged decile	637	45	92.9 (90.7, 94.7)		42	92.9 (90.5, 94.7)		87	86.3 (83.4, 88.8)	
Hispanic, %				.42			< .001			.003
Most disadvantaged decile	1393	169	87.9 (86.0, 89.5)		167	86.4 (84.3, 88.2)		336	75.9 (73.5, 78.0)	
Least disadvantaged decile	968	106	89.1 (86.9, 90.9)		63	92.7 (90.7, 94.2)		169	82.5 (80.0, 84.8)	
Non-English speaking[d]				.33			.003			.007
Most disadvantaged decile	1099	145	86.8 (84.7, 88.7)		131	86.3 (83.9, 88.3)		276	74.9 (72.2, 77.3)	
Least disadvantaged decile	1212	143	88.2 (86.3, 89.9)		102	90.5 (88.5, 92.1)		245	79.8 (77.4, 81.9)	
Residential crowding[e]				.31			.004			.006
Most disadvantaged decile	1129	126	88.8 (86.9, 90.5)		130	87.0 (84.8, 89.0)		256	77.3 (74.8, 79.7)	
Least disadvantaged decile	599	57	90.5 (87.8, 92.7)		44	91.9 (89.2, 93.9)		101	83.1 (79.9, 85.9)	
Rental units[f]				.21			.04			.02
Most disadvantaged decile	626	65	89.6 (87.0, 91.8)		60	89.3 (86.4, 89.6)		125	80.0 (76.7, 83.0)	

Census Tract Variable	No. of Infants Born With CHD	Neonatal			Postneonatal			Infant		
		No. of Deaths	Survival, % (95% CI)	*P*	No. of Deaths	Survival, % (95% CI)	*P*	No. of Deaths	Survival, % (95% CI)	*P*
Least disadvantaged decile	681	57	91.6 (89.3, 93.5)		45	92.8 (90.5, 94.6)		102	85.0 (82.1, 87.5)	
Foreign born, %				.08			.48			.07
Most disadvantaged decile	642	94	85.4 (82.4, 87.9)		61	88.9 (85.9, 91.2)		155	75.9 (72.4, 79.0)	
Least disadvantaged decile	1320	156	88.2 (86.3, 89.8)		117	89.9 (88.1, 91.5)		273	79.3 (77.0, 81.4)	
Unemployed[g]				.54			.38			.29
Most disadvantaged decile	810	89	89.0 (86.7, 91.0)		84	88.4 (85.8, 90.5)		173	78.6 (75.7, 81.3)	
Least disadvantaged decile	647	64	90.1 (87.5, 92.2)		59	89.9 (87.1, 92.1)		123	81.0 (77.7, 83.8)	
Black, %				.56			.78			.54
Most disadvantaged decile	592	67	89.5 (88.8, 90.1)		61	88.4 (85.3, 90.8)		128	78.4 (74.8, 81.5)	
Least disadvantaged decile	922	94	89.8 (87.7, 91.6)		92	88.9 (86.5, 90.8)		186	79.8 (77.1, 82.3)	

Note. CI = confidence interval. *P* values were determined by log-rank test for homogeneity between strata.

[a]Proportion of the noninstitutionalized population living below the federal poverty level.

[b]Proportion of the population aged 18 years or older who did not graduate from high school.

[c]Proportion of population aged 16 years or older who had operator/laborer occupations.

[d]Proportion who spoke a language other than English at home.

[e]Proportion of all occupied housing units with more than 1.0 persons per room.

[f]Proportion of all occupied housing units that were renter occupied.

[g]Proportion of population aged 16 years or older who were not employed.

TABLE 2

Adjusted Hazard Ratios for Infant Death for Census Tract–Level Indicators of Socioeconomic Status: Arizona, New Jersey, New York, and Texas Birth Defect Surveillance Programs, 1999–2007

Variable	Neonatal, AHR (95% CI)	Postneonatal, AHR (95% CI)	Infant, AHR (95% CI)
Per capita income	1.39 (0.93, 2.07)	1.61 (1.05, 2.47)	1.49 (1.11, 1.99)
Birth weight, g			
<2500	1.37 (0.74, 2.57)	1.13 (0.58, 2.21)	1.28 (0.81, 2.01)
≥ 2500	1.35 (0.79, 2.28)	2.06 (1.18, 3.57)	1.65 (1.13, 2.42)
Poverty[a]	1.43 (1.00, 2.06)	1.62 (1.06, 2.47)	1.51 (1.15, 2.00)
Education[b]	1.34 (0.93, 1.92)	1.72 (1.18, 2.51)	1.51 (1.16, 1.96)
Operator/laborer occupation[c]	1.53 (1.06, 2.21)	1.54 (1.04, 2.28)	1.54 (1.17, 2.01)
Non-Hispanic White	2.09 (1.23, 3.54)	1.45 (0.81, 2.60)	1.78 (1.21, 2.63)
Non-Hispanic Black	0.75 (0.27, 2.15)	0.73 (0.27, 2.00)	0.73 (0.36, 1.51)
Hispanic	1.44 (0.66, 3.18)	3.08 (1.11, 8.52)	2.03 (1.09, 3.77)
Non-English speaking[d]	1.05 (0.78, 1.41)	1.23 (0.89, 1.71)	1.13 (0.91, 1.40)
Maternal age < 25 y	1.10 (0.67, 1.80)	1.16 (0.69, 1.94)	1.12 (0.78, 1.59)
Maternal age 25-34 y	0.81 (0.56, 1.32)	1.00 (0.62, 1.62)	0.91 (0.66, 1.26)
Maternal age ≥ 35 y	1.83 (0.91, 3.68)	3.20 (1.38, 7.39)	2.28 (1.34, 3.87)
Residential crowding[e]	1.33 (0.86, 2.01)	1.46 (0.96, 2.22)	1.39 (1.04, 1.86)
Non-Hispanic White	0.72 (0.38, 1.35)	1.38 (0.72, 2.64)	0.99 (0.63, 1.54)
Non-Hispanic Black	2.43 (0.44, 13.33)	1.16 (0.38, 3.55)	1.42 (0.56, 3.60)
Hispanic	3.99 (0.97, 16.56)	4.42 (1.07, 18.25)	4.24 (1.56, 11.54)
Foreign-born	1.28 (0.93, 1.78)	1.11 (0.76, 1.63)	1.20 (0.94, 1.54)
Maternal age < 25 y	1.28 (0.74, 2.21)	0.91 (0.50, 1.63)	1.09 (0.73, 1.62)
Maternal age 25-34 y	1.20 (0.75, 1.94)	0.84 (0.48, 1.56)	1.05 (0.72, 1.53)
Maternal age ≥ 35 y	2.22 (0.97, 5.04)	4.24 (1.62, 11.12)	2.75 (1.50, 5.06)
Unemployed[f]	1.37 (0.86, 1.22)	0.90 (0.62, 1.30)	1.10 (0.85, 1.44)
Rental units[g]	1.17 (0.76, 1.79)	1.14 (0.72, 1.79)	1.15 (0.84, 1.57)
Proportion Black	1.05 (0.74, 1.49)	0.95 (0.66, 1.38)	1.00 (0.78, 1.29)
Proportion Hispanic	1.07 (0.78, 1.49)	1.44 (0.99, 2.10)	1.22 (0.95, 1.55)
No. of indicators in most disadvantaged decile			
0 (Ref)	1.00	1.00	1.00
1	1.24 (1.04, 1.48)	0.94 (0.78, 1.15)	1.10 (0.97, 1.26)
2–4	1.33 (1.08, 1.63)	1.00 (0.80, 1.25)	1.15 (0.99, 1.34)
≥5	1.36 (1.11, 1.68)	1.17 (0.95, 1.45)	1.25 (1.08, 1.45)

Note. AHR = adjusted hazard ratio; CI = confidence interval. Models compared lowest decile (most disadvantaged) to highest decile (least disadvantaged). Models were created separately for each community-level indicator and adjusted for birth weight, sex, maternal age, maternal nativity, maternal education, parity, state, and birth period. Stratified adjusted hazard ratios are presented when there was statistically significant interaction between the census tract indicator and an individual-level covariate.

[a] Proportion of the noninstitutionalized population living below the federal poverty level.

[b] Proportion of the population aged 18 years or older who did not graduate from high school.

[c] Proportion of population aged 16 years or older who had operator/laborer occupations.

[d] Proportion who spoke a language other than English at home.

[e] Proportion of all occupied housing units with more than 1.0 persons per room.

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[g] Proportion of all occupied housing units that were renter occupied.