Published in final edited form as:

Paediatr Perinat Epidemiol. 2015 November ; 29(6): 546–551. doi:10.1111/ppe.12227.

Social Environments, Genetics, and Black–White Disparities in Infant Mortality

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Abstract

Background—Genes and environments often interplay to produce population health. However, in some instances, the scientific literature has favoured one explanation, underplaying the other, even in the absence of rigorous support. We examine parental race disparity on the risk of infant mortality to see if such an analysis might provide clues to understanding the extent to which genes and environment may shape perinatal risks.

Methods—We assessed parental racial disparities in infant mortality among singletons by analysing the risk of infant mortality among racially consonant vs. dissonant couples over time between 1989–1997 and 1998–2006 in the state of Michigan ($n = 1\,428\,199$). We calculated the degree of modification of the relation between maternal race and infant mortality by paternal race dynamically across the two time periods.

Results—Infant mortality among interracial couples decreased with time relative to white–white couples, while infant mortality among black–black couples increased with time after adjusting for socio-economic, demographic, and prenatal care differences. The degree to which paternal black race strengthened the relation between maternal black race and higher infant mortality risk relative to white mothers increased with time throughout our study.

Conclusions—Evidence from these data suggests that environmental factors likely play the greater role in explaining the parental race disparity and risk of infant mortality.

Keywords

race; genetics; infant mortality; racial disparities

Environments interact with genetics in multiple ways to shape human health. There is a large body of literature that has attempted to isolate which of these factors may matter most in explaining the production of particular health indicators.^{1,2} The genes vs. environment discussion has consistently arisen in the area of racial inequalities in health, including infant mortality. Substantial evidence indicates that race is largely a social construct and that race

influences health principally through social mechanisms. By contrast, biological literature has focused on the concrete, observable differences that differentiate the biological phenotypes underlying race, suggesting that these differences are a product of genotypic differences that may lead to worse health.³

Here we studied infants born to racially dissonant couples, wherein one partner is black and the other white, relative to infants of racially consonant couples. We examined how dynamic the differences were in birth outcomes among racially dissonant and consonant couples over time. We also calculated the degree of modification of the relation between maternal race and infant mortality by paternal race over time. We reason that if paternal contributions to racial disparities in infant mortality are mediated mainly via genetic mechanisms, then (i) the contribution of paternal race to risk for perinatal outcomes should be stable over time, assuming no changes in genotypic structure occurring among individuals who ascribe to specific racial categories; and (ii) that the nature of the interaction between maternal and paternal race should be stable over time.

Methods

Data

The sample comprised all singleton births between January 1989 and December 2006 in Michigan as furnished by the Michigan Department Community of Health. We restricted our study to singleton infants born to married couples wherein both the mother and father self-reported as non-Hispanic white or black ($n = 1\,428\,199$), as marriage was the best available proxy for shared households, attempting to ensure that both mothers and fathers contributed to the social environments within which infants were born. Of the 2 454 552 birth records available for the state of Michigan from 1989 to 2006, 1 428 199 (58%) met inclusion criteria.

Data were grouped into four separate categories by maternal and paternal self-reported race for this analysis, including white mother–white father ($n = 1\,307\,544$), black mother–black father ($n = 105\,036$), white mother–black father ($n = 12\,249$), and black mother–white father ($n = 3370$). Infant mortality was defined as death of the infant prior to one completed year of life. Other covariates collected included maternal age (grouped as 19 and younger, 20–34, and 35 years), maternal education (less than high school, high school or some college, or college or greater), parity (the number of previous pregnancies lasting 20 weeks gestation, analysed as 0, 1–2, or 3), prenatal care (analysed using the Kessner index of prenatal care adequacy indicating adequate or inadequate prenatal care⁴), and payment source for labour and delivery fees (private or not private).

Statistical analysis

We calculated descriptive statistics for the study sample, stratified by maternal–paternal racial dyads and time period (two time periods: 1989–97 and 1998–2006). We then fit bivariable and multivariable logistic regression models of infant mortality by racial dyads both within the overall sample of births and then separately for births between 1989 and 1997 and between 1998 and 2006. Multivariable models were adjusted for age, education,

parity, prenatal care, and payment source. Next, we calculated interaction metrics to assess the contribution of maternal and paternal black race on infant mortality risk following procedures described by Andersson and colleagues.⁵ We calculated the interaction contrast ratio, which measures the excess risk of infant mortality due to interaction between maternal and paternal black race [relative excess risk due to interaction (RERI); equation 1]; attributable proportion due to interaction (AP; equation 2), or the RERI divided by the risk of infant mortality among the infants of black–black couples; and synergy index (S; equation 3), which measures the excess risk of infant mortality in black mother–black father couples relative to the excess risk of infant mortality in black mother–white father or white mother–black father couples.⁵

$$RERI = RR_{11} - RR_{10} - RR_{01} + 1 \quad (1)$$

$$AP = ICR / RR_{11} \quad (2)$$

$$S = [RR_{11} - 1] / [(RR_{10} - 1) + (RR_{01} - 1)] \quad (3)$$

where RR is relative risk (here the odds ratio is substituted in accordance with the low prevalence assumption⁵); subscripts imply presence (1) or absence (0) of first or second exposure, respectively, in the interaction calculation.

Results

Table 1 shows demographic characteristics and infant mortality, stratified by racial dyad and birth year (1989–97, 1998–2006, and overall) in our study population. In the overall dataset, black–black couples had the highest infant mortality (1.2%), while white–white couples had the lowest (0.5%). Time-stratified estimates demonstrated substantial changes in dyad demographic characteristics with time. Mothers in all dyads aged substantially. Maternal education also increased among all groups. Private insurance payment for labour and delivery increased among all groups as well. However, the nature of these changes differed by demographic group. For example, private payment for labour and delivery fees increased most among black mother–white father dyads, from 65.9% to 78.4%, and increased least among white–white couples, from 83.1% to 86.0%.

Table 2 and Figure 1 show multivariable associations between racial dyad and infant mortality both overall and stratified by birth period (1989–97 and 1998–2006) after adjusting for age, education, parity, prenatal care adequacy, and payment source. Overall, compared with white–white couples, risk of infant mortality was highest among black–black couples [adjusted odds ratio (aOR) 2.29, 95% CI 2.15, 2.44], followed by black mother–white father dyads (aOR 1.55, 95% CI 1.04, 2.30), and then white mother–black father dyads (aOR 1.34, 95% CI 1.08, 1.67). Time-stratified analyses demonstrate a non-significant increase in the odds of infant mortality over time relative to white–white couples among black–black couples: aOR 2.14 (95% CI 1.97, 2.32) in 1989–97 and 2.55 (95% CI 2.30, 2.81) in 1998–2006, and a non-significant decrease in the odds of infant mortality among both of the racially dissonant dyads relative to white–white couples over time.

Table 3 shows three measures of the interaction between maternal and paternal race and infant mortality stratified by time period after adjusting for age, education, parity, prenatal care adequacy, and payment source. None of the three interaction indices were significantly different from the null. All three increased, although non-significantly, between 1989–97 and 1998–2006.

Comment

We conducted this analysis of the mortality outcomes of nearly 1.5 million singleton live infants born to racially dissonant and consonant married couples in the state of Michigan to compare genetic and environmental explanations for these disparities. We found that (i) among interracial couples, the risk of infant mortality decreased with time relative to white–white couples, while the risk of infant mortality among black–black couples increased with time; and (ii) the degree of synergy between maternal and paternal race and risk for infant mortality increased with time.

These findings suggest that the social contribution of paternal race to infant mortality may be of considerable import. Assuming no change in the genotypic structures of racial categories over our 17-year study period, a primarily genetic explanation for this contribution should imply that the contribution of race would be stable with time. Rather, we found that the contributions of both maternal and paternal race were dynamic, and that the risk for infant mortality among infants of interracial couples decreased over time, while that risk increased over time among black–black couples, although neither change was significant. Rather than a time-static genetic explanation of the influence of parental race on infant mortality, other time-dynamic race-associated features of the social environment, such as discrimination and structural socio-economic opportunities, may play the greater role in explaining racial disparities in infant mortality.⁶ We also calculated the degree of synergy between paternal and maternal race, respectively. We found that the degree to which maternal and paternal race was synergistic increased with time,⁷ although non-significantly. The interplay between maternal and paternal race may therefore be a consequence of time-dynamic factors associated with race, more likely to be a function of the social environmental rather than genetic contributions of race.

Our study is not without a number of limitations. First, we did not collect genetic data directly, and therefore we were unable to assess the direct contribution of genetic variation to infant mortality in this population.⁸ Second, infant mortality is a rare event. Although we collected data about nearly 1.5 million births, the outcome occurred in less than 1% of births overall. Therefore, the degree of time stratification that our data could support was limited. Third, infant mortality is also a highly complex outcome, and a less complex but similar outcome, such as neonatal mortality, may have been preferable for our study aims. However, even with data of about nearly 1.5 million births, the analyses of neonatal deaths may have been under-powered to explore variance in neonatal mortality among interracial couples. Fourth, there was potential for false paternity, which occurs when a man who is reported to be the father of a child is not actually the father, although this has been shown to be uncommon.⁹

Acknowledgements

Abdulrahman M. El-Sayed was funded by the Medical Scientist Training Program at Columbia University, NY. The authors thank Glenn Radford and Glenn Copeland for their support in acquiring the data.

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Figure 1.

Trends in multivariable associations between couple race categories and infant mortality among singleton livebirths to married black or white mothers in Michigan between 1989 and 2006.

^aModel adjusted for age, education, parity, adequate prenatal care, and private source of payment.

^bRelative to infants born to two white parents.

Table 1

Sociodemographic characteristics and infant mortality among singleton livebirths to married black or white mothers in Michigan, 1989–2006^a

	White mother, white father <i>n</i> (%)	Black mother, white father <i>n</i> (%)	White mother, black father <i>n</i> (%)	Black mother, black father <i>n</i> (%)
Time period: 1989–2006 (<i>n</i> = 1 428 199)				
Maternal age (years)				
19	36 052 (2.8)	152 (4.5)	696 (5.7)	4347 (4.1)
20–34	1 088 375 (83.2)	2648 (78.6)	10 061 (82.1)	84 503 (80.5)
35	183 117 (14)	570 (16.9)	1492 (12.2)	16 186 (15.4)
Education				
Less than high school	91 494 (7.1)	268 (8)	1625 (13.4)	10 156 (9.8)
High school, some college	787 680 (60.8)	2063 (61.8)	7885 (64.9)	70 289 (68.1)
College or greater	417 333 (32.2)	1006 (30.2)	2640 (21.7)	22 762 (22.1)
Parity				
0	374 870 (28.9)	826 (24.8)	2787 (22.9)	19 212 (18.5)
1–2	680 055 (52.4)	1657 (49.7)	5932 (48.8)	48 282 (46.5)
3	244 114 (18.8)	853 (25.6)	3437 (28.3)	36 451 (35.1)
Adequate prenatal care	1 100 432 (84.2)	2581 (76.6)	9315 (76.1)	76 972 (73.3)
Private source of payment	1 073 691 (84.4)	2395 (73)	7868 (65.9)	71 249 (68.8)
Infant died	5873 (0.5)	25 (0.7)	84 (0.7)	1272 (1.2)
Time period: 1989–97 (<i>n</i> = 785 917)				
Maternal age (years)				
19	26 361 (3.7)	93 (6.4)	526 (8.9)	3497 (6)
20–34	609 866 (84.7)	1177 (80.8)	4714 (80)	47 421 (80.9)
35	83 721 (11.6)	187 (12.8)	656 (11.1)	7698 (13.1)
Education				
Less than high school	58 301 (8.1)	149 (10.3)	938 (16)	6907 (11.9)
High school, some college	468 980 (65.5)	956 (65.9)	3892 (66.4)	41 183 (70.7)
College or greater	188 972 (26.4)	345 (23.8)	1030 (17.6)	10 159 (17.4)
Parity				
0	204 060 (28.6)	351 (24.5)	1463 (25.1)	10 894 (18.8)
1–2	375 030 (52.6)	704 (49.1)	2848 (48.9)	26 941 (46.4)
3	134 605 (18.9)	378 (26.4)	1517 (26)	20 177 (34.8)
Adequate prenatal care	598 716 (83.2)	1074 (73.7)	4285 (72.7)	42 031 (71.7)
Private source of payment	582 330 (83.1)	939 (65.9)	3437 (59.9)	37 210 (64.4)
Infant died	3586 (0.5)	13 (0.9)	49 (0.8)	738 (1.3)
Time period: 1998–2006 (<i>n</i> = 642 282)				
Maternal age (years)				
19	9691 (1.7)	59 (3.1)	170 (2.7)	850 (1.8)
20–34	478 509 (81.4)	1471 (76.9)	5347 (84.2)	37 082 (79.9)
35	99 396 (16.9)	383 (20)	836 (13.2)	8488 (18.3)

	White mother, white father <i>n</i> (%)	Black mother, white father <i>n</i> (%)	White mother, black father <i>n</i> (%)	Black mother, black father <i>n</i> (%)
Education				
Less than high school	33 193 (5.7)	119 (6.3)	687 (10.9)	3249 (7.2)
High school, some college	318 700 (54.9)	1107 (58.7)	3993 (63.5)	29 106 (64.7)
College or greater	228 361 (39.4)	661 (35)	1610 (25.6)	12 603 (28)
Parity				
0	170 810 (29.2)	475 (25)	1324 (20.9)	8318 (18.1)
1–2	305 025 (52.1)	953 (50.1)	3084 (48.7)	21 341 (46.5)
3	109 509 (18.7)	475 (25)	1920 (30.3)	16 274 (35.4)
Adequate prenatal care	501 716 (85.4)	1507 (78.8)	5030 (79.2)	34 941 (75.3)
Private source of payment	491 361 (86)	1456 (78.4)	4431 (71.5)	34 039 (74.4)
Infant died	2287 (0.4)	12 (0.6)	35 (0.6)	534 (1.2)

^a All comparisons were different to $P < 0.01$.

Table 2

Bivariate and multivariable^a associations between couple race categories and infant mortality among singleton livebirths to married black or white mothers in Michigan overall (1989–2006) and by time periods 1989–97 and 1998–2006

Variable	1989–2006 aOR (95% CI) OR (95% CI)	1989–97 aOR (95% CI) OR (95% CI)	1998–2006 aOR (95% CI) OR (95% CI)
White mother, white father	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Black mother, white father	1.55 (1.04, 2.30)	1.63 (0.94, 2.82)	1.54 (0.87, 2.72)
	1.66 (1.12, 2.46)	1.8 (1.04, 3.11)	1.62 (0.91, 2.85)
White mother, black father	1.34 (1.08, 1.67)	1.45 (1.10, 1.93)	1.26 (0.90, 1.77)
	1.53 (1.23, 1.90)	1.67 (1.26, 2.22)	1.42 (1.01, 1.98)
Black mother, black father	2.29 (2.15, 2.44)	2.14 (1.97, 2.32)	2.55 (2.3, 2.81)
	2.72 (2.56, 2.89)	2.55 (2.35, 2.76)	2.98 (2.71, 3.27)

^aModel adjusted for age, education, parity, adequate prenatal care, and private source of payment. aOR, adjusted odds ratio; OR, unadjusted odds ratio; CI, confidence interval.

Table 3

Measures of additive interaction between maternal and paternal race and infant mortality^a in a sample of singleton livebirths to married black or white women in Michigan by time periods 1989–97 and 1998–2006

Variable	1989–2006 Estimate (95% CI)	1989–97 Estimate (95% CI)	1998–2006 Estimate (95% CI)
Interaction contrast ratio ^b	0.40 (−0.29, 1.09)	0.05 (−0.94, 1.05)	0.74 (−0.25, 1.74)
Attributable proportion ^c	0.17 (−0.13, 0.47)	0.03 (−0.44, 0.49)	0.29 (−0.1, 0.68)
Synergy index ^d	1.45 (0.67, 3.11)	1.05 (0.42, 2.62)	1.93 (0.57, 6.57)

^a Model adjusted for age, education, parity, adequate prenatal care, and private source of payment.

^b Measures the excess risk due to interaction relative to the risk of infant death among white mother, white father couples; null is 0.

^c The proportion of infant death that is attributable to interaction among black mother, black father couples; null is 0.

^d The excess risk from exposure to the joint effect (black mother, black father couple) relative to the excess risk independent exposures (black mother, white father couple and white mother, black father couple); null is 1.