PNAS RESEARCH ARTICLE | DEMOGRAPHY OPEN ACCESS

Physician–patient racial concordance and newborn mortality

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Edited by Christopher Kuzawa, Northwestern University, Evanston, IL; received May 8, 2024; accepted July 16, 2024

The racial gap in infant mortality is a pressing public-health concern, and [B. N. Greenwood et al., *Proc. Natl. Acad. Sci. U.S.A.* 117, 21194–21200 (2020), 10.1073/pnas.1913405117] suggest that Black newborns are more likely to survive if cared for by Black physicians after birth, even in models that control for numerous variables, including hospital and physician fixed effects, and the 65 most common comorbidities affecting newborns (as described by International Classification of Disease codes). We acquired the data used in the study, covering Florida hospital discharges from 1992 through the third quarter of 2015, to replicate and extend the analysis. We find that the magnitude of the concordance effect is substantially reduced after controlling for diagnoses indicating very low birth weight (<1,500 g), which are a strong predictor of neonatal mortality but not among the 65 most common comorbidities. In fact, the estimated effect is near zero and statistically insignificant in the expanded specifications that control for very low birth weight and include hospital and physician fixed effects.

infant mortality | racial concordance | health care

Significance

An influential study suggests that Black newborns experience much lower mortality when attended by Black physicians after birth. Using the same data, we replicate those findings and estimate alternative models that include controls for very low birth weights, a key determinant of neonatal mortality not included in the original analysis. The estimated racial concordance effect is substantially weakened, and often becomes statistically insignificant, after controlling for the impact of very low birth weights on mortality. Our results raise questions about the role played by physician–patient racial matching in determining Black neonatal mortality and suggest that the key to narrowing the Black–White gap may continue to lie in reducing the incidence of such low birth weights among Black newborns.

An influential study (1) recently concluded that Black newborns experienced significantly lower mortality when attended by Black physicians. The research received considerable media attention (2, 3), was noted in Supreme Court Justice Ketanji Brown Jackson's dissent in 2023's *Students for Fair Admissions v. Harvard* (4), and has clear implications for medical school admissions, hospital practices, and Black expectant parents.

The analysis, which covered Florida births from 1992 through 2015, reported that White babies had a mortality rate of 0.3 percent regardless of the race of the attending physician; Black babies had a rate of 0.9 percent if cared for by White physicians, and 0.4 percent if cared for by Black physicians. A more sophisticated regression model, which controlled for the 65 most common comorbidities [as identified by the International Classification of Disease Clinical Modification (ICD-9-CM) codes assigned to the child] and other variables, found that the effect weakened but did not disappear. Nevertheless, the authors advised that some "caution regarding the persistence of omitted-variable bias is warranted" (1, p. 21996).

In fact, a crucial omitted variable is evident after examining the list of regressors (1, *SI Appendix*, Table S2). Because controls for the newborn's health condition are limited to only the 65 most common diagnoses across *all* births, there are no controls for a birth weight under 1,500 g. Such "very low" weights are an important predictor of mortality. In 2007, only 1.2 percent of White newborns and 3.3 percent of Black newborns had weights in this range; but these newborns accounted for 66 percent of neonatal mortality among White babies and 81 percent among Black babies (5). The very low birth weight diagnosis, however, is spread out across 30 individually rare ICD-9 codes (6), so that no indicator for the condition makes it to the list of the 65 most common comorbidities. This paper shows that the influential estimates of the impact of racial concordance on Black newborn mortality are substantially weakened and often become both numerically close to zero and statistically insignificant, once the analysis controls for the mortality effect of very low birth weights.

Data

Our study uses the same hospital-discharge data as in ref. 1, acquired from the Florida Agency for Health Care Administration (AHCA) (7). The data contain detailed information on all patients at Florida hospitals from 1992 through the third quarter of 2015. We select the subsample of newborns by using the admission-type variable in the data.

The hospital-discharge data identify the doctor who treated the patient and provide an identification number for each doctor. By matching these identification numbers to Florida physicians and looking up photos online, the research team in ref. 1 created a new variable indicating the race of the physician, and they made this file available to us.

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The authors declare no competing interest.

This article is a PNAS Direct Submission.

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This article contains supporting information online at https://www.pnas.org/lookup/suppl/doi:10.1073/pnas.2409264121/-/DCSupplemental.

Published September 16, 2024.

Finally, we use the subsample of births where both the doctor and patient are either White or Black. This produces a sample with 1,863,837 newborns. *SI Appendix* provides a detailed discussion of the construction of the data.

The regression model relates whether a particular newborn expired before leaving the hospital to the race of the baby and doctor, and a vector of control variables. The control variables include the quarter-year in which the birth occurred, the type of insurance billed, facility-year fixed effects, physician fixed effects, and a vector of diagnostics describing health issues potentially affecting the newborn.

The results from any study of newborn mortality will be sensitive to the health conditions included in the statistical analysis. The AHCA data report a "primary diagnosis," described with an International Classification of Disease code (ICD-9-CM) (8). The data also report the ICD-9 codes for "other diagnoses" (up to nine codes prior to 2006 and up to 30 beginning in 2006). In creating variables indicating the presence of each of these diagnoses, we set each variable equal to 1 if the relevant ICD-9 code appeared in any of the (up to 31) fields (and 0 otherwise).

The regression analysis in ref. 1 only controls for the 65 most frequent comorbidities affecting the newborn (and a variable indicating if the birth occurred outside the hospital). The "Top 65" list is compiled regardless of the outcome of the birth. Not surprisingly, the most common "comorbidity" is "Single liveborn, born in hospital, delivered without mention of cesarean section" (ICD-9 code V30.00), present for two-thirds of the sample. Our construction of the list of Top 65 comorbidities closely reproduces the original list; *SI Appendix*, Table S1 lists the health conditions represented by the most common ICD-9 codes and reports their frequency in our sample.

The Top 65 list does not contain *any* diagnoses indicating birth weights below 1,500 g. Fig. 1 illustrates the potential importance of this omission, depicting mortality rates by birth weight for White and Black newborns, and for newborns seen by White and Black doctors. Because most newborns are not diagnosed with any of the health conditions requiring a recording of their weight in the AHCA data, the most common weight classification is "no code" (comprising 91.7 percent of White and 87.4 percent of Black babies).

Fig. 1 shows that the mortality rate is remarkably high (exceeding 80 percent) for newborns in the lowest birth weight bracket and drops to near-zero levels for newborns who weigh more than 1,500 g. Another striking insight is that the strong negative relation between mortality and birth weight is nearly identical for Black and White newborns (Panel *A*) and for newborns cared for by Black or White doctors (Panel *B*).

Results

The linear probability regression model is:

$$y_{ij} = \beta_1 R_i + \beta_2 R_j + \beta_3 \left(R_i \times R_j \right) + controls + \epsilon_{ij}, \qquad [1]$$

where y_{ij} is a variable set to unity if newborn i under the care of physician j expires, and 0 otherwise; R_i is set to unity if infant i is Black, and 0 otherwise; R_j is set to unity if physician j is Black, and 0 otherwise; and the list of control variables is discussed below. The racial concordance effect is estimated by β_3, which measures the difference between the probability of mortality when a Black newborn is under the care of a Black physician and when under the care of a White physician.

The set of control variables used in Eq. **1** include some combination of the following sets of fixed effects: type of health insurance; indicators for each of the Top 65 comorbidities; time fixed effects, hospital fixed effects, and physician fixed effects. Table 1 presents the results. We follow the approach of introducing the control variables sequentially, so that the various rows of the table precisely reproduce the order in which the variables are introduced in ref. 1. We also adopt the convention of multiplying the dependent variable by 100 so that the coefficients can be interpreted as percentage-point changes.

Column 1 reports the published estimates of the coefficient β_3 in Eq. **1**. Row 1 gives the unadjusted concordance effect. The mortality rate for Black babies is −0.49 percentage points lower if they have a Black attending physician. This large effect drops to −0.13 points (and statistically significant) in a fully specified model that includes all other control variables. Because newborn mortality is a relatively rare event among Black babies, with a mean of 0.8 percent, a reduction of 0.13 percentage points implies that racial concordance reduces the probability of mortality among Black newborns by about one-sixth.

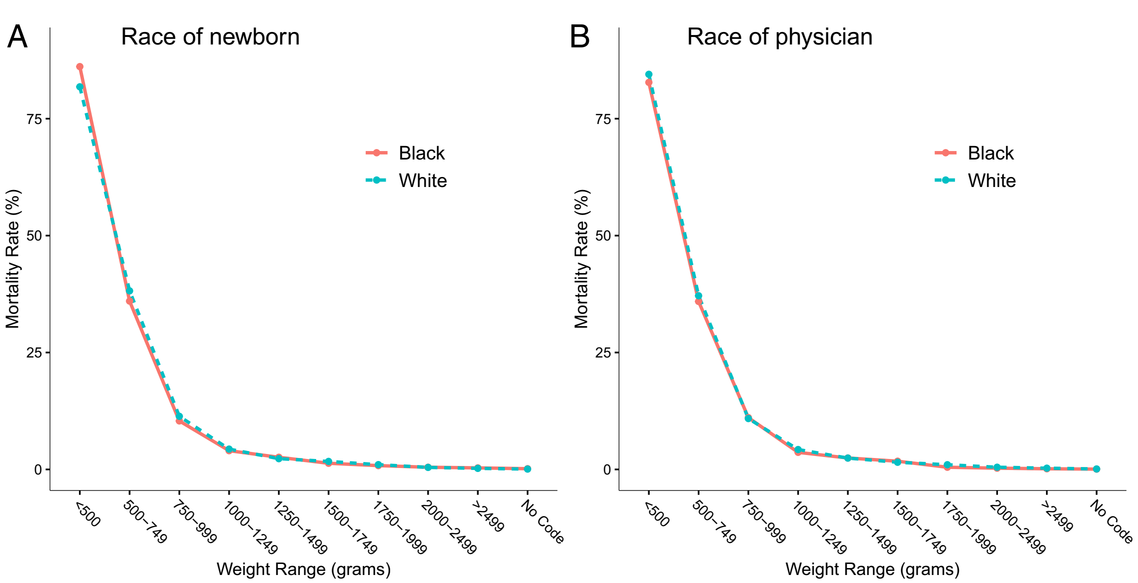

Fig. 1. Mortality rate of newborns by birth weight. (*A*) By race of newborn. (*B*) By race of physician.

Table 1. Racial concordance effect for Black newborns, adjusting for alternative sets of comorbidities

Fixed effects included:	Set of comorbidities included in the model: 1: Top 65 (Original study)	2: Top 65 (Replication)	3: None	4: Single indicator for very low birth weight	5: Vector of 30 very-low-birth-weight fixed effects
1. No Controls	−0.494*** (0.085) R^2 = 0.001	−0.486*** (0.084) R^2 = 0.001	(No change)	(No change)	(No change)
2. + Insurance and Comorbidities	−0.358*** (0.067) R^2 = 0.045	−0.350*** (0.066) R^2 = 0.050	−0.471*** (0.083) R^2 = 0.002	−0.121*** (0.040) R^2 = 0.124	−0.109*** (0.032) R^2 = 0.346
3. + Year-Quarter	−0.331*** (0.063) R^2 = 0.046	−0.331*** (0.065) R^2 = 0.050	−0.486*** (0.086) R^2 = 0.002	−0.130*** (0.041) R^2 = 0.124	−0.117*** (0.033) R^2 = 0.346
4. + Hospital	−0.257*** (0.061) R^2 = 0.050	−0.250*** (0.062) R^2 = 0.054	−0.376*** (0.079) R^2 = 0.008	−0.064 (0.040) R^2 = 0.126	−0.053 (0.031) R^2 = 0.348
5. + Hospital-Year	−0.236*** (0.058) R^2 = 0.058	−0.241*** (0.059) R^2 = 0.062	−0.342*** (0.073) R^2 = 0.016	−0.045 (0.039) R^2 = 0.132	−0.037 (0.032) R^2 = 0.351
6. + Physician	−0.129** (0.052) R^2 = 0.144	−0.136*** (0.052) R^2 = 0.164	−0.131*** (0.052) R^2 = 0.130	−0.033 (0.039) R^2 = 0.209	−0.014 (0.034) R^2 = 0.386

Notes: *P < 0.1; **P < 0.05; ***P < 0.01. The dependent variable of the linear probability model is defined as 100 when the newborn expired and 0 otherwise, so the coefficients can be interpreted as percentage-point changes. SE reported in parentheses are clustered at the physician level. The regressions reported in column 1 are drawn from ref. 1 (Table 1, row 3) and have 1,812,979 observations; all other regressions have 1,863,837 observations.

Column 2 re-estimates the regressions using our sample. The replication comes very close to duplicating the original effects. The unadjusted racial concordance effect is −0.49 percentage points, and the estimate from the fully specified model still falls to about −0.13 percentage points.

We estimate several alternative models, employing different assumptions about the set of comorbidities included in the regression. Column 3 re-estimates the regression models but *leaves out* the Top 65 comorbidity indicators (and the out-of-hospital birth indicator). This column produces an estimate of the racial concordance effect that ignores all underlying differences in health conditions among newborns. Remarkably, the relevant coefficient in the fully specified model barely changes, suggesting that the included comorbidities in the Top 65 list may not do a good job of controlling for the potential impact of racial differences in health conditions that influence newborn mortality.

There is, however, a very simple way of illustrating how a *single* health condition left out of the Top 65 comorbidities accentuates the empirical finding of racial concordance. We created a variable indicating whether the newborn's birth weight is below 1,500 g[*]. Column 4 shows that regardless of the list of control variables included in the regression, replacing the entire vector of comorbidities with this single variable greatly reduces the magnitude of the racial concordance effect while improving model fit. In fact, the effect is statistically insignificant in the fully specified model (with a coefficient of −0.033 and a SE of 0.039). Column 5 replaces the single very-low-birth-weight indicator with a vector of the 30 different ICD-9 codes that describe the nature of the condition in detail. Not surprisingly, the inclusion of more granular information on the incidence of very low birth weights substantially increases the R-squared of the regression (to 0.39). It is worth emphasizing that the estimated racial concordance effect is statistically insignificant in all models reported in both Columns 4 and 5 that include hospital or doctor fixed effects.

In short, the finding of racial concordance in newborn mortality is very sensitive to subjective decisions about which comorbidities to include as control variables. To assess the robustness of the evidence, *SI Appendix*, Table S2 presents other regression models that expand the list of comorbidities beyond the Top 65. We estimated a model that includes a fixed effect for *all* potential diagnostics reported in the AHCA data, which total 4,050 in our sample (i.e., up to 31 different diagnoses for each newborn, and hundreds of potential ICD-9 code for each diagnosis). As with the simpler models reported in Table 1, the inclusion of the entire set of potential comorbidities reduces the magnitude of the estimated concordance effect and yields statistically insignificant effects in the fully specified model. An even more general model allows for the possibility of a newborn having multiple comorbidities at once. Specifically, the regression model includes a fixed effect for each possible combination of the 4,050 comorbidities. This model too estimates a racial concordance effect that is numerically close to zero and statistically insignificant.

These expanded specifications, however, have some drawbacks. Some of the diagnoses could reflect issues caused by poor postnatal care—e.g., an infection caught at the hospital or "diaper or napkin rash" (ICD-9 code 691.0, a condition that makes the Top 65 list). These postnatal conditions may be endogenous to the "treatment"—i.e., being cared for by a White or Black physician after birth—and we may not want to control for conditions that arise in the postnatal period because of heterogeneity in physician services. Our finding that the concordance effect in the fully specified model becomes insignificant once the regression also controls for the incidence of very low birth weight is impervious to this criticism, as the weight was precisely recorded at the time of birth.

Discussion

Evidently, the exclusion of the very-low-birth-weight indicator from the list of controls in Eq. **1** leads to a very different estimate of the racial concordance effect. The difference can be

[*]This variable takes the value of 1 if a newborn has a diagnostic with an ICD-9 code in the following ranges: 764.01-.05 ("'light-for-dates' without mention of fetal malnutrition"), 764.11-.15 ("'light-for-dates' with signs of fetal malnutrition"), 764.21-.25 ("fetal malnutrition without mention of 'light for dates'"), 764.91-.95 ("fetal growth retardation, unspecified"), 765.01-.05 ("extreme immaturity"), and 765.11-.15 ("other preterm infants"). Each of these 30 ICD-9 codes indicates a birth weight that is below 1,500 g.

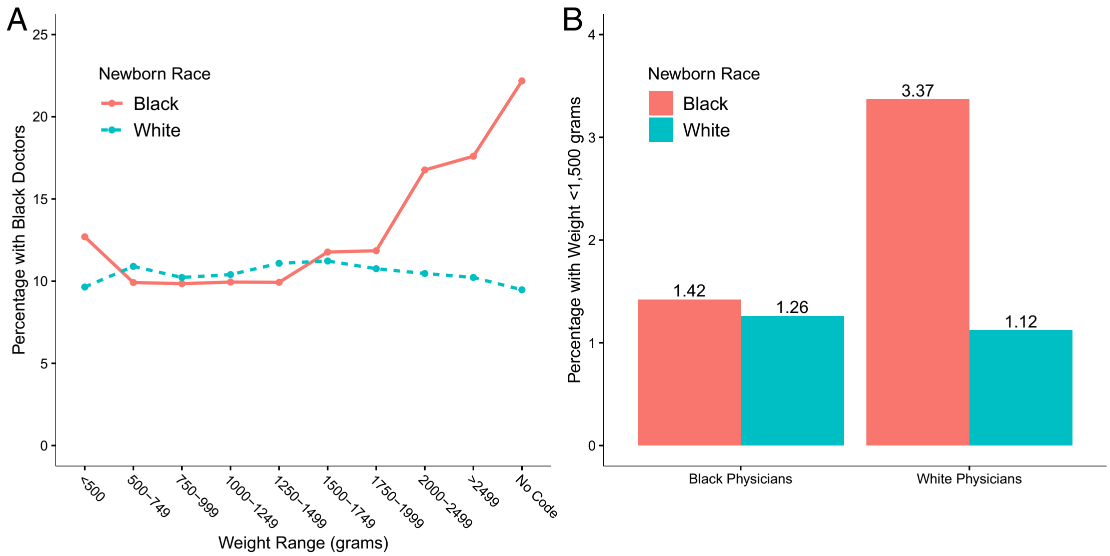

Fig. 2. (*A*) Fraction of newborns with Black physicians at each point of the birth weight distribution, by race of newborn. (*B*) Fraction of newborns with very low birth weight (under 1,500 g), by race of newborn and race of physician. Overall, 1.13 percent of White newborns and 2.96 percent of Black newborns have a very low birth weight.

understood in terms of the classic statistical model of omitted variable bias. In the racial concordance context, this bias can be easily derived if we estimate the regressions separately in the samples of Black and White doctors. Consider the simplest case when the regression does not have any control variables other than the very-low-birth-weight indicator. Let the "true" model describing the determinants of newborn mortality be given by:

$$\text{Black Doctors:}\ \ y_i = \alpha_B R_i + \delta_B T_i + \epsilon_i, \qquad [2]$$

$$\text{White Doctors:}\ \ y_i = \alpha_W R_i + \delta_W T_i + \epsilon_i, \qquad [3]$$

where T_i equals 1 if newborn i weighs less than 1,500 g (and 0 otherwise). The racial concordance effect in this specification is given by $\left(\alpha_B - \alpha_W\right)$.

Suppose we estimate each of these equations but *exclude* the very-low-birth-weight indicator from the regressions. The expected value of the estimated ordinary least squares (OLS) coefficient measuring the link between mortality and the race of the newborn is

$$E\left(\widehat{\alpha}_j\right) = \alpha_j + \delta_j \rho_j, \qquad [4]$$

where ρ_j is the coefficient from an ancillary regression estimated in the sample of race-j doctors that relates whether the newborn has a very low birth weight to the newborn's race. The parameter ρ_j then measures the Black–White difference in the probability of being very-low-weight among newborns attended by race-j doctors. The expected value of the OLS coefficient $\widehat{\alpha}_j$ relating mortality to the newborn's race correctly estimates the true impact α_j if very low birth weights do *not* determine mortality (i.e., $\delta_j = 0$) or if Black and White babies attended by race-j physicians have the same probability of a very low birth weight (i.e., $\rho_j = 0$). Otherwise, the second term in Eq. **4** gives the bias contaminating the OLS coefficient.

The racial concordance effect produced by estimating the incorrectly specified model in the samples of Black and White physicians is

$$E\left(\widehat{\alpha}_B - \widehat{\alpha}_W\right) = \left(\alpha_B - \alpha_W\right) + \left[\delta_B \rho_B - \delta_W \rho_W\right]. \qquad [5]$$

The bracketed term in Eq. **5** gives the omitted variable bias on the estimated concordance effect. It depends on the differential impact of very low birth weight on mortality between Black and White doctors (δ_B and δ_W) and on how the relative probability of Black newborns having a very low weight differs between the two types of doctors (ρ_B and ρ_W).

Fig. 1 shows that the impact of low birth weight on child mortality is nearly identical for babies attended by either Black or White doctors (i.e., $\delta_B \approx \delta_W$)[†]. Eq. **5** then simplifies to:

$$E\left(\widehat{\alpha}_B - \widehat{\alpha}_W\right) \approx \left(\alpha_B - \alpha_W\right) + \delta\left[\rho_B - \rho_W\right]. \qquad [6]$$

The parameter δ is positive, as very low birth weight is associated with higher mortality. Hence, the sign of the bias on the concordance effect depends on the sign of $(\rho_B - \rho_W)$. In other words, is the relative probability of a Black baby having a very low birth weight higher for newborns attended by Black doctors or by White doctors?

Fig. 2*A* shows that White doctors are disproportionately more likely to care for Black newborns with very low birth weights. In particular, the figure shows the fraction of White or Black newborns cared for by Black doctors in each category of the birth weight distribution. Roughly 10 percent of White newborns are cared for by Black doctors regardless of their weight, but the fraction of Black newborns cared for by Black doctors is relatively lower for those weighing below 1,500 g.

Fig. 2*B* shows that the different birth-weight distributions of newborns under the care of Black and White doctors imply that 3.4 percent of Black newborns attended by White doctors have a very low birth weight, as compared to only 1.4 percent of Black newborns attended by Black doctors. The higher relative frequency of very-low-birth-weight Black newborns cared for by White doctors implies $\rho_W > \rho_B$[‡]. Eq. **6** then suggests that the exclusion of

[†]If we estimate the models in Eqs. **2** and **3**, the coefficient δ_B is 18.216 (with a SE of 1.499) and δ_W is 17.988 (0.698). The hypothesis that $\delta_B = \delta_W$ cannot be rejected ($P = 0.44$).

[‡]If we estimate the ancillary regressions suggested by the omitted variable bias formula, the coefficient ρ_B is 0.002 (0.002) and ρ_W is 0.023 (0.003). The difference between the two coefficients is statistically significant ($P < 0.001$).

the birth weight variable from the regression imparts a negative bias on the estimated racial concordance effect[§].

In other words, the newborns attended by White and Black physicians are not random samples. Black newborns with a very low birth weight are disproportionately more likely to be attended by White doctors than by Black doctors. Those newborns are also more likely to have a low chance of survival. The exclusion of the very-low-birth-weight variable from the regressions then suggests that, on average, Black babies attended by White doctors will have poorer outcomes than Black babies attended by Black doctors. But this effect may have little to do with racial concordance. It can instead arise because Black newborns attended by White doctors are more likely to have a vulnerability closely linked to mortality.

In conclusion, the analysis in the Greenwood et al. study (1) suggested that higher mortality rates among Black newborns can be partly explained by the racial match between doctors and patients. If Black babies are indeed less likely to die when cared for by Black physicians, the adoption of policies that increase the number of Black doctors and that place more Black children in the care of racially concordant physicians could greatly reduce the very high rates of mortality among Black newborns.

[§]We derived the omitted variable bias formula in a model where the only control variable is the very-low-birth-weight indicator. Equations analogous to Eqs. **4** and **5** can be derived when the regressions include other control variables. The variables in Eqs. **2** and **3** are then interpreted as residuals of (y_i, R_i, T_i) from regressions that include all the other control variables. In regressions that include the set of controls in the fully specified model, the coefficient δ_B is 15.028 (1.135) and δ_W is 15.621 (0.576). The hypothesis that the two coefficients are equal cannot be rejected ($P = 0.32$). If we estimate the ancillary regressions of a very-low-birth-weight outcome on whether the newborn is Black, the coefficient ρ_B is 0.006 (0.001) and ρ_W is 0.012 (0.002). The difference between the two coefficients is statistically significant ($P = 0.004$).

Our study shows how an important research design decision can yield an empirical finding of racial concordance in newborn mortality. Specifically, the influential research in ref. 1 did not control for the impact of very low birth weights (i.e., under 1,500 g) on newborn mortality. Although these types of births are rare, they occur more frequently in the Black population, and they account for a very high fraction of mortality. It turns out that a disproportionately large number of Black newborns with very low birth weights are attended by White physicians. We show that once we control for the impact of very low birth weights on mortality, the estimate of the racial concordance effect is substantially weakened and becomes statistically insignificant in models that account for other factors that determine newborn mortality.

Data, Materials, and Software Availability. The hospital admissions data are available through a limited use agreement with the Florida Agency for Healthcare Administration. The research team in ref. 1 gave us access to the physician race data file.

ACKNOWLEDGMENTS. We are particularly grateful to Charles Fain Lehman for his valuable assistance in the coding and preparation of the hospital admission data and to Brad Greenwood for guiding us through the work done in the original study. We are also grateful to two anonymous reviewers for their constructive suggestions and to Daniel Hamermesh and Theodore Joyce for valuable discussions. Our data agreement with the Florida AHCA requires we state that the "Agency specifically disclaims responsibility for any analysis, interpretations, or conclusions that may be created as a result of the limited dataset."

1. B. N. Greenwood, R. R. Hardeman, L. Huang, A. Sojourner, Physician–patient racial concordance and disparities in birthing mortality for newborns. *Proc. Natl. Acad. Sci. U.S.A.* **117**, 21194–21200 (2020), 10.1073/pnas.1913405117.
2. R. Pichetta, "Black newborns more likely to die when looked after by white doctors," *CNN*, 20 August 2020. https://www.cnn.com/2020/08/18/health/black-babies-mortality-rate-doctors-study-wellness-scli-intl/index.html. Accessed 31 July 2024.
3. T. Russell, "Mortality rate for black babies is cut dramatically when black doctors care for them after birth, Researchers say," *Washington Post*, 13 January 2021. https://www.washingtonpost.com/health/black-baby-death-rate-cut-by-black-doctors/2021/01/08/e9f0f850-238a-11eb-952e-0c475972cfc0_story.html. Accessed 31 July 2024.
4. Students for fair admissions Inc., v. President and fellows of Harvard College (2023), 600 U.S. (2023), p. 23. http://www.supremecourt.gov/opinions/22pdf/20-1199_hgdj.pdf. Accessed 31 July 2024.
5. T. J. Mathews, M. F. MacDorman, Infant mortality statistics from the 2007 period linked birth/infant death data set. *Natl. Vital Stat. Rep.* **59**, 1–30 (2011), https://www.cdc.gov/nchs/data/nvsr/nvsr59/nvsr59_06.pdf. Accessed 31 July 2024.
6. Appendix A ICD-9-CM Code Tables, Specifications manual for joint commission national quality measures (v2013A1), The Joint Commission. https://manual.jointcommission.org/releases/TJC2013A/AppendixATJC.html#Table_Number_11_12_Birth_Weight. Accessed 31 July 2024.
7. Florida Agency for Health Care Administration, Hospital Inpatient Data File,1992 through Q3 2005. https://quality.healthfinder.fl.gov/Researchers/Order-Data/. Accessed 31 July 2024.
8. Centers for Medicaid & Medicare Services Files, ICD-9-CM Diagnosis and procedure codes: Abbreviated and full code titles. https://www.cms.gov/medicare/coding-billing/icd-10-codes/icd-9-cm-diagnosis-procedure-codes-abbreviated-and-full-code-titles. Accessed 31 July 2024.