State-Level Progress in Reducing the Black–White Infant Mortality Gap, United States, 1999–2013

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Objectives. To assess state-level progress on eliminating racial disparities in infant mortality.

Methods. Using linked infant birth–death files from 1999 to 2013, we calculated state-level 3-year rolling average infant mortality rates (IMRs) and Black–White IMR ratios. We also calculated percentage improvement and a projected year for achieving equality if current trend lines are sustained.

Results. We found substantial state-level variation in Black IMRs (range = 6.6–13.8) and Black–White rate ratios (1.5–2.7), and also in percentage relative improvement in IMR (range = 2.7% to 36.5% improvement) and in Black–White rate ratios (from 11.7% relative worsening to 24.0% improvement). Thirteen states achieved statistically significant reductions in Black–White IMR disparities. Eliminating the Black–White IMR gap would have saved 64 876 babies during these 15 years. Eighteen states would achieve IMR racial equality by the year 2050 if current trends are sustained.

Conclusions. States are achieving varying levels of progress in reducing Black infant mortality and Black–White IMR disparities.

Public Health Implications. Racial equality in infant survival is achievable, but will require shifting our focus to determinants of progress and strategies for success. (*Am J Public Health.* 2017;107:775–782. doi:10.2105/AJPH.2017.303689)

See also Kirby, p. 644.

Infant mortality rates (IMRs) decreased 13% in the United States from 2000 to 2013, but racial disparities persist.[1] Non-Hispanic Black and African American infants (hereafter Blacks) suffer excess adverse outcomes. In 2013, the Black IMR was 11.1 per 1000 live births (compared with 5.1 for non-Hispanic Whites), and the Black IMR has remained 2 to 3 times the non-Hispanic White IMR for decades.[2] Reducing the infant death rate in the United States overall is a national priority and leading health indicator for *Healthy People 2020*.[3]

Racial disparities in infant mortality reflect larger inequalities in population health status,[4] resulting from a broad range of factors such as social determinants, economic status, structural and relational racism, insurance coverage, and health care access, as well as positive factors such as resiliency and social support. Factors contributing to infant mortality and related racial disparities range across the continuum from "upstream determinants" to midstream and downstream factors.[5,6]

This racial disparity has been persistent, despite an explicit national goal "to eliminate health disparities" first promulgated by *Healthy People 2010*.[7] Even with significant overall declines in IMRs in the United States, negative perinatal outcomes for Black women have remained stubbornly disproportionate. Neither socioeconomic status nor maternal risk behaviors entirely explain these racial disparities.[8] In fact, the portion of the Black–White infant mortality gap that can be explained by known risk factors declined from 4.6 to 1.9 deaths per 1000 live births from 1983 to 2004, while the unexplained portion of the gap remained relatively unchanged.[9]

Much of the health disparities literature of the past 2 decades has documented these disparities, or sought to identify risk factors, while exuding a sense of inevitability regarding our failure to eliminate disparities. By contrast, there is an emerging literature of geographic variation in IMR and racial/ethnic disparities, which suggest that "disparities are not inevitable."[10] Although southern states (with a high proportion of Black population) continue to experience disproportionately high IMRs,[11] there is substantial local-area variation both in IMR and in disparities (as measured by Black–White rate differences and by Black–White IMR ratios).[12] This local-area variation demonstrates that some communities are performing better than others, and that equality of outcomes is achievable.

Black and White mortality rate trend lines for specific conditions can show very different patterns for different counties, with some showing persistent or worsening disparities, and others showing trend lines sustaining or converging on equality.[13,14] These positive outliers or exemplar communities are demonstrating progress toward racial equality in various health outcomes. Understanding the determinants and drivers of this success may help us chart new paths to health equity for communities currently stuck in a persistently high-disparity outcome trend pattern.[15]

Therefore, we undertook this study to demonstrate trend patterns in state-level racial

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disparities in Black and White infant mortality, and specifically to identify states that demonstrated converging trend lines (i.e., a pattern trending toward more optimal [improvement in Black IMR] and equitable [decreasing Black–White IMR rate-ratio] outcomes). Documenting converging trend lines with significant reductions in Black IMRs in even a small proportion of states would demonstrate that elimination of Black–White disparities in IMRs is indeed achievable.

METHODS

We obtained data on state-level IMRs from the US linked live birth–infant death cohort files for the periods 1999 to 2013. To protect confidentiality, we included only states where at least 10 annual infant deaths occurred per racial category (White and Black). To obtain the most accurate estimates and adjust for potential instability of rates because of small frequencies of infant deaths, we calculated 3-year rolling average IMRs and Black–White IMR rate ratios for all states with sufficient deaths in both Black and White racial groups. Thirty-five states were eligible for study inclusion, with data restricted to births and deaths for whom race was categorized as White or Black. We assigned linked births and deaths to the state of residence. We classified births by race without regard to Hispanic ethnicity. We were limited to events recorded as infant deaths in this data set, which might allow for some state-to-state and year-to-year variation according to how states coded fetal demise at the gestational margins of viability. We obtained data from the CDC WONDER online database for linked birth–infant death records through 2013, the most recent data available at the time of these analyses.

Fifteen years of annual rates from 1999 to 2013 generated 13 three-year rolling average estimates for each state (overlapping 3-year averages calculated for each year from 2000 to 2012). Using the rolling average estimates, we calculated the Black–White rate ratio as the Black IMR over the White IMR for each specific year, by state.

We also calculated each state's percentage difference in Black IMR and Black–White rate ratio from the earliest (2000) to latest (2012) data point, to estimate whether states have made progress toward optimal (Black IMR) or equitable (Black–White rate ratio) birth outcomes. We sorted states from highest to lowest according to each of these percentage differences. We also projected the "potential number of babies saved" if we had eliminated the Black–White IMR gap.[16] We made this calculation by setting the White IMR as a function of the Black births and deaths for each year and adding each adjusted death rate per year for a cumulative total per state.

To determine whether a state's Black and White IMR were converging in a way that achieved statistical significance, we conducted a linear regression for each state. The outcome variable was the log-transformed value of the rolling 3-year-average IMR. We used the log transformation to flatten the series of mortality rates, thus providing more appropriate results and improving interpretability.[17] We adjusted the model for race, year, and an interaction term (race and year). The interaction term's coefficient determined if the state was converging (negative value) or parallel (zero or positive value) and the P value ($<.05$) determined if the state's convergence was statistically significant. In addition, we made calculations for each state to estimate the year in which it would achieve IMR racial equality. We estimated this in 2 ways: (1) calculating the time point when the Black and White rolling average IMR slopes would intersect (with 95% confidence intervals) and (2) calculating the time point when the Black–White rate ratio would be equal to 1.

We tested no other explanatory variables in the multivariate models. The goal of this current study was to present the state-level Black and White IMRs in their unadjusted rates to determine if optimal and equitable reductions in IMR are occurring overall, and to reinforce the finding that disparities are not inevitable. Although risk factors vary by state, an analysis that controls for these variables may minimize the reality of racial inequality occurring in high-poverty states, for example, because poverty somehow "explains" the racial difference. Future research will explore differences in social determinants, policies, and health system characteristics that might help us further understand these causes and correlations.

RESULTS

Black and White IMR trend lines for each state are available in Figure A, available as a supplement to the online version of this article at http://www.ajph.org. State ranking of progress in reducing Black IMRs is depicted in Table 1. States are sorted from first to last by the percentage the Black IMR was reduced from 2000 to 2012. There was substantial state-level variation in Black IMR (2012 range, 6.65–13.77). Arizona, Iowa, and Massachusetts were the top-3 ranked states in terms of Black IMR improvement, each reducing its Black IMR by more than 30% in 13 years. Although there was substantial variation overall (2.7% to 36.5%), all states improved their Black IMR over the 13-year time period. It was estimated that 64 876 infant lives could have been saved over this time period if the Black–White gap in infant mortality had been eliminated. Our simple calculation of the point at which the Black and White IMR slopes would intersect estimated that 18 states would achieve IMR racial equality by the year 2050. The earliest state to achieve IMR racial equality by this method was projected to be Massachusetts by the year 2025 (2027 using the rate ratio method described in the next paragraph). There were 4 states (Iowa, New Jersey, Maryland, Delaware) for which it was determined that the lines would not intersect and that IMR racial equality would not ever be achieved at the current rate of progression.

State rank in terms of equitable progress in closing the Black–White IMR gap is presented in Table 2. States are sorted from first to last according to the percentage reduction in their Black–White IMR ratio for 3-year averages centered on each year from 2000 to 2012. The Black–White rate ratios from the "best" to "worst" state ranged from 1.70 (Massachusetts) to 2.37 (Kansas), respectively. We identified 2 trend patterns from the 35 states over the 15-year study period. States showed either parallel improvements in both White and Black IMR with no significant reduction in the Black–White rate ratio, or they showed improvement in Black and White IMR with a significant reduction in the Black–White rate ratio. Results of the linear regression of log-transformed rolling average IMR found that although many states were converging in closing the Black–White

TABLE 1—State Rankings by Optimal Improvement in Black Infant Mortality Rate: United States, 1999–2013

State	Black IMR (2000)[a]	Black IMR (2012)[a]	% Reduction in Black IMR From 2000 to 2012[a]	Black IMR Rolling Average 3-Year Rate, 2000–2012, Mean (95% CI)	What if We Were Equal? Number of Black Infant Lives Saved if Rates Were Equal to State's White IMR From 1999 to 2013 (Cumulative)[b]	Year State Would Achieve IMR Equality on Current Trend (95% CI)
Arizona	16.6	10.5	36.5	12.38 (11.18, 13.58)	373	2038 (2036, 2040)[c]
Iowa	16.0	10.6	33.5	11.23 (10.19, 12.27)	163	WNC
Massachusetts	9.9	6.7	32.6	8.74 (7.96, 9.51)	592	2025 (2024, 2027)[c]
New Jersey	13.5	9.6	29.2	11.31 (10.63, 11.98)	2 169	WNC
Tennessee	16.0	11.4	28.9	14.82 (13.70, 15.94)	2 114	2029 (2026, 2031)[c]
Colorado	12.7	9.3	26.9	12.97 (11.73, 14.22)	344	2028 (2026, 2031)[c]
Connecticut	13.1	9.6	26.8	12.25 (11.43, 13.07)	566	2039 (2037, 2041)[c]
Nebraska	13.0	9.5	26.6	12.55 (11.44, 13.66)	178	2036 (2034, 2039)[c]
Georgia	13.4	9.9	26.3	12.13 (11.21, 13.06)	4 493	2039 (2037, 2041)[c]
South Carolina	15.3	11.4	25.4	13.17 (12.29, 14.05)	2 147	2035 (2033, 2037)[c]
Minnesota	11.8	8.8	25.2	9.48 (8.77, 10.20)	471	2057 (2055, 2058)
Missouri	16.0	12.0	24.9	13.95 (13.11, 14.79)	1 383	2037 (2035, 2040)[c]
New York	10.9	8.2	24.7	10.03 (9.45, 10.61)	4 058	2043 (2042, 2045)[c]
Michigan	16.7	12.9	22.9	15.26 (14.40, 16.12)	3 181	2042 (2039, 2044)[c]
Nevada	11.6	9.1	22.2	11.56 (10.45, 12.68)	297	2025 (2023, 2027)[c]
Washington	10.8	8.5	21.3	8.33 (7.61, 9.05)	236	2028 (2027, 2029)[c]
Illinois	16.4	12.9	21.2	14.35 (13.63, 15.07)	4 080	2049 (2046, 2051)[c]
North Carolina	15.1	11.9	20.9	14.43 (13.66, 15.20)	3 640	2053 (2050, 2055)
Maryland	13.6	10.9	20.2	12.51 (12.03, 12.98)	2 863	WNC
California	11.5	9.4	18.9	10.63 (10.12, 11.15)	2 934	2046 (2044, 2047)[c]
Delaware	16.1	13.1	18.8	14.60 (13.83, 15.36)	365	WNC
Wisconsin	16.8	13.8	18.0	15.53 (14.50, 16.56)	1 038	2035 (2032, 2038)[c]
Pennsylvania	15.1	12.4	17.8	13.77 (13.27, 14.26)	2 765	2059 (2056, 2061)
Florida	12.7	10.6	16.6	12.16 (11.69, 12.64)	5 245	2066 (2064, 2068)
Mississippi	14.7	12.4	15.8	14.18 (13.57, 14.78)	2 026	2047 (2045, 2049)[c]
Alabama	15.2	12.9	15.4	13.72 (13.30, 14.15)	1 930	2051 (2049, 2053)
Oklahoma	14.3	12.3	13.8	13.24 (12.52, 13.95)	452	2042 (2040, 2044)[c]
Louisiana	13.7	11.9	13.5	13.22 (12.52, 13.93)	2 605	2052 (2050, 2054)
Arkansas	12.3	10.8	12.2	12.51 (11.79, 13.23)	624	2058 (2057, 2060)
Indiana	14.4	12.8	11.2	14.39 (13.75, 15.04)	1 152	2116 (2114, 2119)
Virginia	13.0	11.7	10.7	13.16 (12.75, 13.58)	2 591	2089 (2087, 2091)
Ohio	15.1	13.6	10.0	14.80 (14.37, 15.22)	2 987	2061 (2058, 2063)
Kentucky	10.4	9.8	5.7	10.82 (10.25, 11.38)	341	2065 (2064, 2066)
Texas	10.9	10.5	3.8	11.31 (10.89, 11.74)	3 942	2071 (2069, 2073)
Kansas	14.0	13.7	2.7	14.21 (13.61, 14.80)	531	2122 (2120, 2125)
Total	. . .	. . .	. . .	. . .	64 876	. . .

Note. CI = confidence interval; IMR = infant mortality rate; WNC = would not converge.

[a]The numbers were rounded to a single decimal point to comply with editorial guidelines. The percent change was calculated based on the formula [1- (2012 rate/2000 rate)]*100 using numbers to 2 decimals.

[b]Rate calculated as Black deaths ([White IMR/1000]*Black births).

[c]Signifies racial IMR equality by the year 2050; IMRs presented as 3-year rolling averages.

TABLE 2—State Rankings by Equitable Improvement in Infant Mortality Rate Disparities (Black–White Rate Ratios): United States, 1999–2013

State	B–W Rate Ratio (2000)[a]	B–W Rate Ratio (2012)[a]	% Reduction in B–W Rate Ratio From 2000 to 2012[a]	B–W Rate Ratio, 2000–2012 Mean (95% CI)	Converging vs Parallel? (Slopes Between B–W IMR)	Year State Would Achieve IMR Equality on Current Trend
Massachusetts	2.2	1.7	24.0	2.02 (1.88, 2.17)	Converging*	2027[b]
Tennessee	2.4	1.9	22.9	2.23 (2.11, 2.35)	Converging*	2034[b]
Arizona	2.6	2.0	22.4	2.08 (1.89, 2.26)	Converging	2070
Missouri	2.7	2.2	19.4	2.27 (2.17, 2.38)	Converging*	2053
Iowa	2.9	2.4	15.5	2.23 (2.05, 2.40)	Parallel	2212
Alabama	2.2	1.9	14.3	1.97 (1.89, 2.06)	Converging*	2050[b]
Mississippi	2.1	1.8	14.0	2.06 (1.97, 2.15)	Converging*	2054
Connecticut	2.5	2.2	12.3	2.50 (2.39, 2.61)	Converging	2059
Minnesota	2.3	2.1	11.7	2.08 (1.99, 2.18)	Converging	2121
Washington	2.2	1.9	11.6	1.70 (1.59, 1.82)	Converging	2038[b]
Georgia	2.3	2.0	11.6	2.13 (2.07, 2.18)	Converging	2068
Pennsylvania	2.5	2.2	11.5	2.28 (2.23, 2.34)	Converging*	2087
Michigan	2.7	2.4	11.4	2.56 (2.50, 2.62)	Converging*	2079
Colorado	2.2	1.9	11.4	2.32 (2.13, 2.51)	Converging*	2032[b]
South Carolina	2.5	2.2	11.3	2.24 (2.15, 2.34)	Converging*	2057
New York	2.1	1.9	11.1	2.15 (2.08, 2.22)	Converging	2091
Nevada	2.1	1.9	10.1	2.18 (1.99, 2.37)	Converging*	2027[b]
California	2.3	2.1	8.7	2.22 (2.16, 2.27)	Converging*	2073
Louisiana	2.2	2.0	8.2	2.03 (1.96, 2.09)	Converging	2105
Ohio	2.3	2.1	7.0	2.30 (2.24, 2.37)	Converging*	2062
Wisconsin	2.9	2.7	6.9	2.92 (2.75, 3.09)	Converging*	2043[b]
Arkansas	1.7	1.6	5.6	1.84 (1.74, 1.93)	Converging	2126
Florida	2.3	2.2	5.4	2.25 (2.22, 2.29)	Converging	2213
Kentucky	1.6	1.5	4.8	1.68 (1.59, 1.76)	Converging	2060
Maryland	2.6	2.5	4.6	2.49 (2.37, 2.61)	Parallel	2062
North Carolina	2.3	2.2	4.1	2.39 (2.33, 2.44)	Converging	2130
Indiana	2.1	2.0	2.9	2.13 (2.03, 2.22)	Converging	2382
Oklahoma	1.9	1.9	2.7	1.86 (1.78, 1.94)	Converging	2056
Texas	2.1	2.0	2.1	2.06 (2.02, 2.10)	Converging	2084
Virginia	2.4	2.3	1.6	2.39 (2.34, 2.43)	Converging	2231
Delaware	2.3	2.3	0.8	2.27 (2.14, 2.41)	Parallel	2220
Nebraska	2.1	2.1	0.8	2.33 (2.20, 2.47)	Converging	2114
New Jersey	2.7	2.7	–0.3	2.71 (2.66, 2.77)	Parallel	2164
Illinois	2.6	2.6	–0.4	2.50 (2.44, 2.56)	Converging	2130
Kansas	2.1	2.4	–11.7	2.21 (2.14, 2.28)	Parallel	6022

Note. B–W = Black–White; CI = confidence interval; IMR = infant mortality rate. Rate ratios calculated as (Black IMR/White IMR), all conducted and presented as 3-y rolling averages.

[a]The numbers were rounded to a single decimal point to comply with editorial guidelines. The percent change was calculated based on the formula [1- (2012 rate/2000 rate)]*100 using numbers to 2 decimals.

[b]Signifies racial IMR equality by the year 2050.

*$P < .05$.

IMR gap, only 13 states had made statistically significant reductions during the study period ($P < .05$). The calculation of the point at which the Black–White rate ratio would be equal to 1 (a more conservative methodology) projected that only 7 states would achieve IMR racial equality by the year 2050. If states were to continue on their current rate ratio trend lines, Massachusetts would be the earliest to achieve IMR racial equality (by 2027 with this rate ratio method; by 2025 with the previous Black–White IMR slope intersection method).

Table 3 shows rankings of the top-16 states across 4 measures, representing current performance in the 2 optimal and equitable domains (optimal = actual Black IMR; equitable = relative disparity; i.e., Black–White rate ratio) and 15-year progress or improvement in these same 2 optimal and equitable domains. Notably, Massachusetts ranked number 1 in the nation for having the lowest Black IMR (optimal), and also ranked number 1 in making the greatest percentage progress toward equality in its Black–White rate ratio, although Kentucky and Arkansas ranked better than Massachusetts in the actual Black–White rate ratio (more equitable outcomes on an absolute basis). At the bottom end of the rankings, Kansas showed only a 2.7% improvement in Black infant mortality over the 15-year period (Black $IMR_{Kansas} = 14.0$), and actually showed a worsening of the Black–White mortality rate ratio (–11.73%, a negative improvement). The parallel trend line pattern is illustrated by states such as Illinois and New Jersey, which demonstrated improvement in Black IMR and similar improvement in White IMR, but virtually no improvement in relative disparities (Black–White IMR rate ratio gap). Georgia was the only state in the southeastern United States to achieve a top-16 ranking on all 4 measures. The importance of using both absolute and relative measures of disparities is illustrated by Arkansas, which achieved the second-best ranking on relative disparities (second-lowest Black–White rate ratio) only because White IMR was nearly as poor (high) as Black IMR.

TABLE 3—Top 16 Rankings on Optimal and Equitable Outcomes (2011–2013) and on Progress Toward Optimal and Equitable Outcomes (1999–2013): United States

Absolute Outcome (Closest to Optimal): Top 16 for Lowest Black IMR (Absolute Outcome)	% Progress Toward Optimal: Top 16 for % Improvement in Outcome (% Decrease in Black IMR)	% Progress Toward Equitable: Top 16 for % Improvement in Equality (% Decrease in B–W Rate Ratio)	Relative Disparities (Closest to Equitable): Top 16 for Lowest B–W IMR Rate Ratio (Best in Relative Outcome)
1. Massachusetts	1. Arizona	1. Massachusetts	1. Kentucky
2. New York	2. Iowa	2. Tennessee	2. Arkansas
3. Washington	3. Massachusetts	3. Arizona	3. Massachusetts
4. Minnesota	4. New Jersey	4. Missouri	4. Mississippi
5. Nevada	5. Tennessee	5. Iowa	5. Tennessee
6. Colorado	6. Colorado	6. Alabama	6. Nevada
7. California	7. Connecticut	7. Mississippi	7. Oklahoma
8. Nebraska	8. Nebraska	8. Connecticut	8. New York
9. New Jersey	9. Georgia	9. Minnesota	9. Washington
10. Connecticut	10. South Carolina	10. Washington	10. Alabama
11. Kentucky	11. Minnesota	11. Georgia	11. Colorado
12. Georgia	12. Missouri	12. Pennsylvania	12. Louisiana
13. Texas	13. New York	13. Michigan	13. Indiana
14. Arizona	14. Michigan	14. Colorado	14. Georgia
15. Iowa	15. Nevada	15. South Carolina	15. Texas
16. Florida	16. Washington	16. New York	16. Arizona

Note. B–W = Black–White; IMR = infant mortality rate.

DISCUSSION

This study demonstrates 3 key findings. First, states are making significant progress in reducing Black infant mortality, but less progress in eliminating Black–White disparities. Second, there is considerable statewide variation in progress both toward optimal outcomes (Black IMR) and equitable outcomes (Black–White rate ratio). Third, analysis of Black–White IMR rate ratios suggests that 7 states have achieved trend lines that, if sustained, could lead to racial equality of IMR outcomes by 2050 (1 state as early as 2025 or 2027, depending on projection method).

Study data also quantify the magnitude of the tragedy of racial disparities in IMR—64 876 babies died between 1999 and 2013 in the 35 states because the IMR for Blacks was not the same as that for Whites. If we eliminated the Black–White gap in infant mortality, we could save 12 babies every day. The converging Black–White IMR trend lines of some states suggest that we could achieve equality of outcomes within the foreseeable future.

The leading causes of Black infant mortality in the United States during the neonatal period are complications related to prematurity or low birth weight, congenital abnormalities, and maternal complications of pregnancy, and leading causes of postneonatal mortality are congenital abnormalities, sudden infant death syndrome, and accidental injuries.[18] More broadly, there are upstream and downstream causes affecting the disparity in Black–White IMR, such as racial and socioeconomic stress (allostatic load), maternal behaviors, access to quality health care, adequate nutrition, social capital, and maternal health (before, during, and after pregnancy). Differential exposure to protective and risk factors over the course of a woman's life influence these leading causes of infant death.

In addition, certain structural, systemic, and historical factors in our society, such as segregation, limited educational opportunities, structural racism, and intergenerational poverty, influence the health of women and infants, their families, and their communities. Poverty can have lasting effects and result in epigenetic changes that begin in utero and carry across generations.[17,19]

The multidimensional etiology of disparities suggests the need for multilevel interventions. At a minimum, public health and perinatal care could be more tightly integrated.[20] Going further, the key to reducing IMR could lie at the intersection of adequate health services and improvement of social conditions for pregnant women, or it may require a broader approach to promoting resiliency and positive social determinants, with the focus on community health improvement across all age and racial/ethnic strata.[21] A more holistic, biopsychosocial, and ecological life course approach is suggested by Lu et al.'s "12-point plan," which emphasizes improving health care for Black women, strengthening Black families and communities, and addressing social and economic inequities.[22]

Several states now demonstrate a real trend toward a more equitable outcome in Black–White IMR disparities, just as Levine et al. have demonstrated that certain US counties have completely eliminated racial disparities in mortality for Black men from all-cause mortality.[23] It remains to be demonstrated whether states that are lagging could learn transferrable strategies from these states, ranging from specific perinatal intervention programs or to broader social policies that enhance economic and psychosocial health. The distinction between optimal Black outcomes versus equitable Black–White outcomes may guide some states to design different strategies (e.g., race-focused vs universal) depending on each state's unique trend pattern.

To the extent that communities have overcome poor maternal and child health outcomes, perhaps they have found mechanisms (deliberately or serendipitously) to positively leverage protective factors and minimize risk factors, especially for women at adverse risk because of race or socioeconomic disadvantage. The persistent disparity in Black infant mortality is therefore historical and biopsychosocial in etiology, but is not insurmountable or inevitable.[24]

Interventions at the health care system level include targeting the reduction of cesarean births (including elective cesarean deliveries and preterm deliveries), implementing protocols to decrease preterm delivery, sudden infant death syndrome prevention programs, and increased breastfeeding. At the community level, interventions have focused on social, emotional, and nutritional support for pregnant women, or even during preconception. A review by the Health Resources and Services Administration found 17 evidence-based programs that address individual patients in the context of their home, family, and community. Examples included nurse–family partnerships, parents as teachers, and home visiting programs for women with high-risk pregnancies.[25] Home visitation has demonstrated significant improvement in prenatal care, gestational age, and birth weight,[2] as well as long-term effects such as reductions in subsequent pregnancies, maternal criminal behavior, maternal drug and alcohol abuse, welfare utilization, and incidence of child abuse and neglect.[26]

Engaging in ongoing surveillance of racial disparities in IMR would allow for a continuous feedback loop to intensify rapid-cycle improvement processes in these interventions. Exploring geographical variation at a more local level may also help identify best practices from exemplar or positive outlier communities whose Black–White IMRs are both decreasing and converging.[27,28] Community-level investigation (both quantitative and qualitative) may reveal resilience factors in individuals and communities that have overcome historical and socioecological factors[29] at the root of racial disparities in infant mortality. Investigation may also identify specific interventions targeting infant mortality, and multilevel, interdisciplinary efforts that have a collective impact on the health of women, infants, and their communities. If known risk factors accounted for less than 40% of variation in the Black–White IMR gap in 2004, then it may be that drivers of health equity are not simply the inverse of risk factors and "determinants" of disparities, but rather new paths that are being blazed by communities demonstrating success and progress toward equity.

Public health investigators have previously used a positive deviance framework to identify local health departments achieving better than expected maternal and child health outcomes.[30] For example, high-performing jurisdictions in 3 states (Florida, Washington, and New York) did not simply spend more, but were found to have depended more on community-level partnerships. Using this approach, we could potentially eliminate the disparity in Black infant mortality through active investigation (including active listening) about what is working well in communities trending toward equity, generating rapid-cycle feedback loops of local measures benchmarked against best-practice exemplars, and building coalitions to work together across disciplines and domains toward a common goal.

At the state level, public health departments and their partners have explored various strategies to reduce infant mortality among disadvantaged populations. The Infant Mortality Collaborative Improvement and Innovation Network developed active partnerships involving individual states plus the Association of State and Territorial Health Officials, the Health Resources and Services Administration, the March of Dimes, and the National Institute for Children's Health Quality. The Infant Mortality Collaborative Improvement and Innovation Network initiatives in each state adopted different strategies within a common framework.[31] For example, public health and Medicaid agencies in South Carolina partnered to increase use of long-acting, reversible contraception, recognizing that unintended pregnancy (79% for Medicaid pregnancies) was a major contributor to high IMRs among lower-income groups. Georgia concentrated efforts on reducing early elective delivery rates and on home visitation programs and "Baby Friendly" initiatives to increase breastfeeding. Other southern states successfully reduced smoking rates during pregnancy, and also lowered elective cesarean delivery rates.

Each of these strategies has merit, but completely eliminating the gap in Black–White infant mortality will almost certainly require a multidimensional approach, including root cause interventions at the upstream level of health and social policy, structural racism, and economic justice, as well as interventions targeting the midstream level of socioecological community context, and downstream factors such as health care and health behaviors.[32] Efforts should be not only multidimensional and intersectoral, but also coordinated and cohesive if they are to achieve collective impact. Kania and Kramer have articulated 3 preconditions (influential leaders, sense of urgency, and adequate resources) to achieve collective impact at the

community level, as well as 5 necessary conditions (common agenda, shared measurement, mutually reinforcing activities, continuous communication, and staff support).[33]

Limitations

The use of state-level comparisons of vital statistics data introduces limitations to this study. The geographic unit of analysis is not granular enough to capture within-state local-area variation. We also looked at the broadest Black–White racial categories, rather than analyzing subgroups by Hispanic ethnicity or immigration status or national origins. Using geospatial methods to cluster similar local areas within states may address sample size issues and improve the validity of future local-area analyses.[13]

Measuring trend lines in low-frequency events such as infant mortality is fraught with challenges, including both random and nonrandom sources of variation. For example, fetal deaths at the gestational margin of viability may be counted as infant deaths in some states but not others, or even be counted differently in the same state from one year to another.[34] Even at this macro-geographical level, some states do not have sufficiently high numbers of Black births or Black infant deaths to surpass confidentiality thresholds and to create stable rates. Our projections of potential dates by which some states will achieve equality are also crude projections with substantial levels of uncertainty and all the limitations inherent in extrapolating past trends to future outcomes. Even so, the state-to-state variation and the potential for Black–White trend lines to converge on equality is evident.

Our data also do not explain each state's progress or lack of progress in eliminating racial disparities in IMR. Further studies are needed to explore these geographical trends at a more granular level, utilizing both quantitative and qualitative approaches that may unearth more specific strategies for working together.

Public Health Implications

Varying levels of progress are being achieved across many states in reducing Black infant mortality and in closing the Black–White gap in IMRs. The fact that progress (and indeed equality) is achievable suggests that our nation can hold itself accountable and establish measurable time-limited benchmarks of progress toward racial equality of health outcomes. Researchers and communities can look to high-performing states or cities for paths toward perinatal health equity and models of collective impact to eliminate Black infant mortality. Focusing on resiliency, resources, and strategies of positive outliers may provide a more strategic view of the way forward, rather than continuing to emphasize the lack of progress and suboptimal outcomes. AJPH

CONTRIBUTORS

J. S. Brown Speights contributed team leadership, writing of the initial draft, and article preparation and review. S. S. Goldfarb contributed data collection and analyses, methods, results, tables, and article preparation and review. B. A. Wells contributed article preparation and review. L. Beitsch contributed content expertise and article preparation and review. R. S. Levine contributed conceptualizing this line of research inquiry, giving advice, feedback, and revisions of drafts of the article. G. Rust contributed formulation of the research question, and article preparation and review.

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HUMAN PARTICIPANT PROTECTION

This study was exempt from institutional review board approval because it was obtained from a publicly available data set with aggregated rates and no personal identifiers.

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