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Infant Mortality: Explaining Black/White Disparities in Wisconsin

DeAnnah R. Byrd · Murray L. Katcher · Paul Peppard · Maureen Durkin · Patrick L. Remington

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Abstract *Objectives*: Understanding the factors contributing to black/white disparities in infant mortality rates in Wisconsin is a prerequisite to decreasing these disparities and improving birth outcomes. We examined multiple determinants of infant mortality to understand the impact of specific risk factors on the infant mortality rates of blacks and whites in Wisconsin.

Methods: We used the Wisconsin Interactive Statistics on Health database to examine infant mortality data for the 5-year time period, 1998–2002 ($N = 32{,}166$ black infant births; 272,559 white infant births). We conducted a bivariate analysis of relative risks (RR) of infant mortality (black vs. white) using specific variables available in the database. We then examined the relationship between infant mortality rate and selected risk factors using regression analyses.

Results: Unadjusted, black infants were 3.0 times more likely to die during their first year of life, compared with white infants. Adjusting for gestational age black infants were only 1.9 times more likely to die. The risk was further reduced, after adjusting for birth weight, to 1.3. However, stratifying and adjusting for 8 other multiple variables accounted for some, but not all of the disparity. Black infants who had the same risk profile as white infants still had a 2-fold excess risk of death. In addition, simultaneously controlling for 4 of the 8 risk factors (maternal age, maternal education, adequacy of prenatal care received, and region of the state) also reduced, but did not eliminate, this excess risk (RR was still 2.2 for black infants). Independent of maternal age and region of the state, adequate prenatal care and higher levels of education are significant indicators of the racial disparity between whites and blacks.

Conclusions: These results suggest that, within a given racial group, increasing access to prenatal care and increasing maternal educational attainment will improve infant mortality rates but will not eliminate the black/white disparity in infant mortality. In fact, these interventions may actually widen the disparity in infant mortality rate between blacks and whites, especially if funds and programs are applied equally throughout the population, rather than targeted to high-risk individuals, who lag significantly behind the majority population. The Wisconsin white population, which has already attained an infant mortality rate of 4.5 per 1,000 live births, will continue to have greatest benefit from these programs compared to blacks who have a rate of 19.2 in 2004; thus, the disparity is not eliminated and the gap widens probably due to differential uptake of health messages secondary to health literacy issues. Further research is needed to fully understand the additional, more difficult to measure factors that contribute significantly to infant mortality, especially among black women.

D. R. Byrd · M. L. Katcher · P. Peppard · M. Durkin · P. L. Remington
Department of Population Health Sciences, University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin, USA

D. R. Byrd · P. Peppard · P. L. Remington
University of Wisconsin Population Health Institute, University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin, USA

M. L. Katcher
Division of Public Health, Wisconsin Department of Health and Family Services, Madison, Wisconsin, USA

D. R. Byrd (✉)
DeAnnah R Byrd, MS, City of Milwaukee Health Department, 841 N. Broadway, 3rd Floor, Milwaukee, WI, 53202 USA
e-mail: drbyrd@milwaukee.gov

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Introduction

In 2003, more than 28,000 U.S. infants died before their first birthday, and the U.S. infant mortality rate (per 1,000 live births) was higher than that of 26 other industrialized nations (excluding Cuba) with population >250,000 and with infant mortality rates equal or less than the U.S. in both 2001 and 2002 [1]. Within the U.S, persistent disparities exist in infant mortality rates between whites and ethnic minorities, particularly blacks. Significant ground can be gained in overall U.S. infant mortality rates by improving the black infant mortality rate, which remains a serious public health problem, both in the United States and Wisconsin. Wisconsin's black infant mortality rate compared to other states deteriorated in national ranking from the 3rd best ranking in 1979–1981 to 3rd worst in 1999–2001 (32 out of 34 with sufficient black populations to report) [2]. Key steps have been taken by Wisconsin and other states to reduce high overall infant mortality rates; however, Wisconsin has not shown improvement in black infant mortality rates. This lack of improvement has led to the striking decrease in Wisconsin's rank relative to other states.

Preterm birth (<37 weeks) and low birth weight (<2500 *g*) are two of the major contributors to infant mortality in blacks, both nationally and in Wisconsin. From 1999 to 2001, blacks in Wisconsin had a higher proportion (18%) of preterm births compared to whites (9.8%). In Wisconsin, more than 13% of black babies weighed <2500 *g* at birth, which is more than twice the percent of low birth weight for white babies (5.8%) [3]. Evidence also shows that factors, which are difficult to quantify, such as stress [4], racism [5–7], lack of quality prenatal care [2], and maternal health experiences [8] could be contributing to the challenges in reducing infant mortality rates and low birth weight among black infants. These factors may also contribute to racial variations in the leading causes of infant deaths. For example, a case-control study of 104 very low birth weight (VLBW; <1500 *g*) black infants found a significant association between maternal lifetime reported racial discrimination and infant very low birth weight. The magnitude of this association was strongest for incidents of racial discrimination in the workplace. However, this study found no association between maternal self-reported exposure to racial discrimination during pregnancy and giving birth to VLBW infants, indicating that lifetime exposure was the contributing factor to the racial disparity in VLBW births [7].

Other factors, such as receiving early prenatal care and place of residence, also contribute to racial differences in infant mortality rates and low birth weight; however, black women who receive early prenatal care still have nearly twice the infant mortality rate of white women who receive late or no prenatal care [3]. Also, Pearl and colleagues found that, after adjusting for individual socioeconomic status (SES) and other risk factors, lower neighborhood SES characteristics were associated with lower birth weights among blacks [9]; however, this same relationship was not seen among whites or Latinas. Similar studies have also found that low-income non-Hispanic white and black woman live in qualitatively distinct neighborhoods. A study, using the data from the Pregnancy, Infection, and Nutrition Study (PIN) suggested that three constructs (physical incivilities, territoriality, and social spaces scales) are importantly associated with reproductive health outcomes, such as stress levels during pregnancy, birth weight and preterm birth. These constructs also depict unique information about these neighborhoods, not obtainable using traditional census measures [10]. Collins, et al., further report an association between specific environmental conditions and the racial disparity in post-neonatal mortality. The authors controlled for place of residence, as measured by violent crime rates, median family income, poverty prevalence, and physician supply, and found that the odds ratio (OR) for black infant mortality significantly declined from 3.0 to 1.7 (95% CI 1.5–1.9). However, black infants still had a 50% greater risk (OR = 1.5; 95% CI 1.3–1.8) of post-neonatal death compared with white infants, regardless of their residential environment, infant birth weight, or maternal sociodemographic characteristics [11].

Although previous studies have described the sociodemographic and other characteristics of infant mortality, most have not simultaneously controlled for multiple risk factors. In-depth studies such as these have not been conducted in Wisconsin, nor have they focused on which factors are contributing to the black/white disparity.

We conducted this study, examining multiple risk factors of infant mortality and racial/ethnic disparities in infant mortality rates among postpartum women in Wisconsin, to better understand (a) the extent to which specific risk factors (see Fig. 1) explain the black/white disparity in infant mortality, (b) the role of intermediate outcomes (e.g., low birth weight and short gestation) in the association between race/ethnicity and infant mortality rates, and (c) whether or not simultaneously controlling for specific factors explains the black/white disparity in infant mortality. Knowledge of the factors that may contribute to racial disparities in infant mortality is needed to guide appropriate efforts to reduce those disparities in the population.

Methods

Data

For this study, we used data from the Wisconsin Interactive Statistics on Health (WISH) database, which is maintained

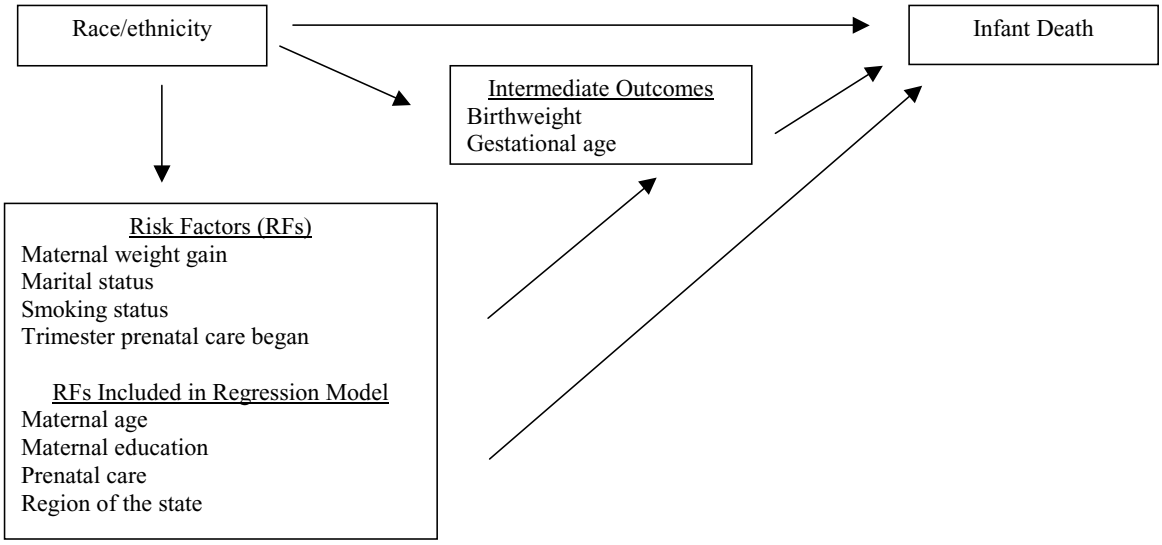

Fig. 1 Theoretical framework: black/white disparity in infant mortality, wisconsin 1998–2002

by the Wisconsin Department of Health and Family Services, Division of Public Health (DPH), Bureau of the Health Information and Policy (BHIP). WISH is a public-use database (http://www.dhfs.state.wi.us/wish/) that provides information about all Wisconsin infant births and deaths from 1989–2002 ($N = 968{,}757$ births; 7,265 deaths). Using matched birth and infant death certificates from WISH, we selected all infant births to non-Hispanic women who were black ($N = 32{,}166$) and white ($N = 272{,}559$), for the years of 1998–2002. We examined the following birth-certificate variables available in the WISH database, to determine their effect on infant mortality during this 5-year period: gestational age, birth weight, maternal age, maternal education, marital status, weight gained during pregnancy, smoking status, adequacy of prenatal care, trimester prenatal care was first received, single or multiple births, and region of the state. We further examined cause of death reported on the death certificate.

Dependent variable

Infant Mortality Rate, as calculated by WISH, was defined as the number of infant deaths per 1,000 live births within a calendar year. The BHIP Vital Records Section, routinely matches infant deaths to birth records. Linking the records adds the information from the birth record to that in the death record, so that infant deaths can be analyzed by such factors as prenatal care, birth weight, prematurity, and other maternal characteristics. Only in-state resident deaths were used in the linking process, which is reported on the death certificate. All linked birth-death records are sent to the National Center for Health Statistics for quality checks and control review. In Wisconsin, the linked records are used for statistical purposes, such as providing information for the WISH database.

Independent variables

All information obtained was that reported on the birth and/or death certificate. In this paper, the term "black" refers to non-Hispanic black and the term "white" refers to non-Hispanic white. We examined 2 intermediate outcomes, gestational age and birth weight. We calculated gestational age using the computed difference between the date of last normal menses and the date of the infant's birth. If the date of last normal menses was missing, or the computed difference was less than 16 weeks or more than 45 weeks, then the gestational age was substituted with a clinical estimate, reported by the attending physician. Birth weight is the newborn's weight reported in grams.

We examined the following maternal demographic factors to understand their influence on the association between race and infant death: maternal age (age at which the mother gave birth); maternal education (reported level of education the mother completed); and marital status (reported as being married or single). We also examined risk factors during pregnancy: weight gained during pregnancy (total amount of weight gained in pounds between conception and delivery); smoking status (based on mother's report of smoking during pregnancy, which is reported as a yes/no indicator and does not measure the amount or duration of tobacco used during pregnancy); adequacy of prenatal care (WISH adapted Kotelchuck's adequacy of prenatal care utilization index into two categories of prenatal care, adequate and inadequate). Adequate prenatal care was determined by comparing the number of prenatal visits to the expected number for gestational age, based on the Kotelchuck index, which uses the

month of entry into prenatal care, the number of prenatal visits, and the gestational age of the infant to measure the utilization of prenatal care [12]. We also looked at trimester prenatal care began and the DPH region of the state in which the mother lived.

We further examined the underlying causes of death, comparing black and white infants. Causes of infant death, obtained from linked birth and death certificates, were coded according to the International Classification of Diseases, 9th and 10th editions (ICD-9 and ICD-10). The ICD-9 and ICD-10 codes have similar mortality content, but different comparability for a number of causes of death. Revisions are made periodically to the ICD to incorporate changes from the medical field, which substantially affect the ranking of some leading causes of death and produce some breaks in the comparability of cause-of-death statistics [13, 14]. We examined the following causes of infant death: disorders related to short gestation (prematurity) and low birth weight, congenital anomalies, sudden infant death syndrome (SIDS), unintentional injuries (excluding medical/surgical complications), and homicide. We also examined the neonatal deaths (occurring in the first 27 days of life) and post-neonatal deaths (occurring on day of life 28 through 364) per 1000 live births [15, 16].

Analytic approach

We used a bivariate analysis to examine the epidemiology of infant mortality in Wisconsin. Specifically, we considered the impact of maternal race/ethnicity on birth outcomes. We estimated the relative risk of infant mortality for black women compared to that for white women for the causes of infant death. To control for potential confounding factors, we calculated the standard mortality ratios (SMR) for specific variables available in the WISH database. We excluded records for multiple births, women who were >44 years of age, and women who had no education listed. We then analyzed the somewhat smaller subset of singleton births of 30,905 black infants and 263,621 white infants, examining death rates for whites and blacks, stratifying by all of the other independent variables. We analyzed each stratum within a variable and then calculated the observed and expected number of deaths. We divided the observed and expected number of deaths to obtain the SMR. Using white infant mortality rate as the reference group, we calculated the excess infant deaths among black women for each variable. We further calculated the standard error (SE) and confidence intervals (CI). Using the following formula: $CI = SMR \pm (1.96 \times SE)$, we estimated the 95% CI of the SMR [17].

Logistic regression analysis was used to compute odds ratios (OR) and 95% confidence intervals to estimate the relationship between maternal and other risk factors, maternal race/ethnicity, and risk of infant mortality. We constructed queries to obtain information about live births and infant mortality rates according to specific risk factors. The queried results contained counts of women sharing the same risk factors. For example, we downloaded a table that contained only black women with less than a high school education, age less than 20 years, who received inadequate prenatal care, and lived in the southeastern region of the state. We extracted individual women who shared these select risk factors, thereby forming one aggregate group of women. The aggregated data were entered into an excel spreadsheet and converted to a SAS data file, for further analysis. The model included maternal race; maternal education (less than high school graduation, high school graduation, and more than high school graduation); and maternal age (<20 years, 20–24 years, and 25–44 years), categorized by examining natural breaks in the data. Other factors exist within, or even across, these age categories; for example, women at highest risk for adverse birth outcomes are those ≤17 and >34 years [studies have shown that women in these age groups are at an increased risk of delivering a low birth weight and premature infant [18, 19]]; region of the state [southeastern region (including Milwaukee) vs. other regions]; and adequacy of prenatal care (received inadequate or adequate care). Finally, we examined interactions in our model to determine whether the association between race and infant mortality would be the same for different levels of each variable. Although we examined these interactions in the bivariate analyses above, regression analysis looked at this relationship while controlling for the other variables in the model. Statistical Analysis Software (SAS), version 8.2 (SAS Institute Inc., Cary, NC) was used for all statistical analyses.

Results

The relative risks for causes of infant deaths, and the period in which the death occurred (neonatal or post-neonatal), are presented in Table 1. The leading cause of black infant deaths is short gestation (prematurity) and low birth weight, with a 5.2-fold greater risk of dying from these two conditions compared to whites (95% CI 4.4, 6.0). The second leading cause of black infant deaths is SIDS. Again, we see black infants have a 5.0-fold greater risk of dying from SIDS compared to white infants (95% CI 3.9, 6.0). Prematurity, low birth weight, and SIDS cause more black infant deaths compared to all other causes of deaths combined. Although not a major cause of infant death, homicide is 6.2-times more likely to be the cause of death for a black infant than for a white infant (95% CI 3.0, 9.5).

Table 2 presents the standardized mortality ratios for the intermediate outcomes and select risk factors. Unadjusted, black infants were 3.0 times more likely to die during their first year of life, compared with white infants, with an excess

Table 1 Variation in black infant mortality rate (IMR) vs. white IMR (per 1,000 live births), by causes of infant death and period of infant death, Wisconsin 1998–2002

Causes of Death	White IMR (n)	Black IMR (n)	RR (95% CI)
Short gestationand Low birth weight	0.9 (244)	4.7 (150)	5.2 (4.4, 6.0)
Congenital anomalies	1.3 (354)	2.2 (71)	1.7 (1.3, 2.1)
Sudden Infant Death Syndrome (SIDS)	0.6 (154)	2.8 (91)	5.0 (3.9, 6.0)
Accidents	0.3 (67)	0.8 (24)	3.0 (1.8, 4.2)
Homicide	0.1 (20)	0.4 (14)	6.2 (3.0, 9.5)
Total (excluding all other causes)	3.1 (839)	10.9 (350)	3.5 (3.2, 3.9)
Period of Infant Death			
Neonatal	3.8 (1,030)	11.4 (366)	3.0 (2.7, 3.3)
Post-neonatal	1.9 (506)	5.9 (191)	3.2 (2.7, 3.6)

of 304 black infant deaths during the 5-year period of this study. Controlling for gestational age, black infants were 90% more likely to die than white infants (95% CI 1.7, 2.1). After we adjusted for birth weight, black infants were still 30% more likely to die compared to white infants (95% CI 1.2, 1.4). Stratifying and adjusting for multiple variables such as maternal age, maternal education, marital status, amount of weight gained during pregnancy, smoking status, adequacy of prenatal care, trimester that prenatal care began, and region of the state, accounted for some, but not all, of the disparity. Black infants who had the same risk profile as white infants for all of these variables still had a 2-fold excess risk of death.

After analyzing the independent contributions of the above variables (e.g., maternal age, maternal education, marital status, amount of weight gained during pregnancy, smoking status, adequacy of prenatal care, trimester that prenatal care began, region of the state, gestational age and birth weight), we then looked at the independent effects of 4 of these variables (maternal age, maternal education, adequacy of prenatal care, and region of the state). We mutually adjusted each variable for maternal and other characteristics. We found that being an infant of a black mother is a strong predictor of infant mortality, apart from maternal age, maternal educational attainment, region of the state, and adequacy of prenatal care. The risk of death to infants of black mothers in Wisconsin is 2.2-times (OR = 2.2; 95% CI 2.0, 2.5) greater than that of infants of white mothers.

We further found interaction between certain model variables (e.g., maternal education and adequacy of prenatal care) and black race. Education and black race significantly interacted with one another when we adjusted for them in the model. The level of disparity depends upon the mother's education level. Surprisingly, black women that were college educated (i.e., more than high school education) had a 3-fold (95% CI 2.4, 3.8) greater risk of an infant death compared with college-educated white women. However, black women with less than a high school education were only 1.4 times more likely to experience an infant death compared with white women with less than a high school education (95% CI 1.1, 1.8). Thus, the difference in infant mortality rates between whites and blacks increases as the mother's level of education increases.

We also found racial differences for women who received different levels of prenatal care. Black women who received adequate prenatal care were 3.1 times more likely to have an infant death compared to white women who received adequate prenatal care (95% CI 2.7, 3.7). In contrast, black women who received inadequate prenatal care were 1.6 times more likely to experience an infant death when compared to

Table 2 Adjusted variables contributing to black/white disparity in infant mortality, wisconsin 1998–2002

Variables Adjusted	Risk Ratio (SMRs) -Black vs. White (95% CI)	Excess deaths	% of white Excess deaths
None (Race)	3.0	304	
Maternal Age	2.4(2.1,2.6)	41	13%
Maternal Education	2.1(1.9,2.3)	63	21%
Marital Status	2.0(1.8,2.2)	78	26%
Weight gained during pregnancy	2.5(2.3,2.8)	29	10%
Smoking status	2.9(2.7,3.2)	3	1%
Adequacy of prenatal care	2.7(2.5,3.0)	39	13%
Trimester prenatal care was initiated	2.6(2.4,2.9)	22	7%
Region of the State	3.3(3.0,3.6)	–13	–4%
Intermediate Outcomes			
Gestational age	1.9(1.7,2.1)	91	30%
Birth weight	1.3(1.2,1.4)	196	64%

white women receiving inadequate prenatal care (95% CI 1.3, 2.0). Thus, the differences in the degree of racial disparity of infant mortality rate were greatest for women who received adequate prenatal care. Independent of maternal age and region of the state, adequate prenatal care and higher levels of education significantly explain more of the racial disparity between whites and blacks.

Discussion

In this large cohort of black and white infants, we found considerable differences in infant mortality, including underlying causes of death. Infants of black mothers had higher infant mortality rates for prematurity/low birth weight and SIDS than infants of white mothers. We attempted to explain these higher mortality rates among black infants by controlling for selected established risk factors that are recorded on the birth certificate. In general, controlling for risk factors individually explained only a small proportion of the excess risk. Controlling for major risk factors (maternal age, maternal education, adequacy of prenatal care, and region of the state), reduced the risk from 3.1 to 2.2, accounting for less than half of the excess deaths.

Surprisingly, we failed to find differences in infant mortality rates among black women in different regions of the state. We originally hypothesized that black infants in the southeast region (including Milwaukee) would be at a higher risk for death than black infants in other regions of the state. We found that, regardless of what region of the state a black woman lives, she has 3-fold greater risk of having an infant death compared to a white woman. However, the majority of the black infant deaths occurred in southeastern Wisconsin. This finding corresponds to the 2003 Milwaukee Infant Mortality Disparity Fact Sheet, which found that 78 deaths occurred among black infants living in Milwaukee compared to only 8 deaths for black infants living in other regions of the state [20]. This finding is not surprising, since Milwaukee has the highest concentration of black people in Wisconsin. Additional data are needed to understand the major contributors to the black/white disparity in infant mortality rates in other regions of the state, since these contributors have been well examined in Milwaukee.

Our findings are subject to several limitations. Our analysis of Wisconsin may not be representative of other states or of the entire nation, especially in light of the worsening relative rank of Wisconsin's black infant mortality among states during the past 20 years. Wisconsin's black infant mortality rate has remained essentially unchanged, while other states' have improved during this period. This stagnancy may relate in part to the deterioration in the Milwaukee central-city zip codes, where many of these infant deaths occur. Jobs are scarce, average income and education levels are low, housing has deteriorated, with low owner occupancy, and social capital and social support are also lacking; however, isolated pockets of resiliency do exist.

Also, we focused on only 2 racial groups in this study, and our findings may not be applicable to other racial/ethnic groups. Other racial groups were excluded in this analysis because of the small number of live births within these groups in Wisconsin. We would not have had enough power to detect a statistically significant difference among these racial/ethnic subgroups; therefore, they were not included.

Underreporting and misreporting of maternal risk factors on the birth certificate could also affect our results. For example, the amount of tobacco use during pregnancy may be underreported. Studies have found that birth certificates are not valid sources of information on tobacco and alcohol use. For example, comparing birth certificates to medical records, researchers have reported lower sensitivity and less reliability for tobacco and alcohol use variables [21, 22]. Other variables, such as race, may have been misreported. The race of the infant is reported by that of the mother, which may be inaccurate, since the infant's race may not always be the same as that of the mother's. For instance, biracial children who are classified by maternal race only may be erroneously recorded, since the infant's race could differ from that of the mother. However, if this information is underreported and/or misreported on the birth certificate, then our results conservatively estimate the true effect of these variables on infant death.

Misclassification of underlying cause of death on the death certificate may have further affected our results. For example, the variation in ICD-9 and ICD-10 codes may have affected the classification of certain causes of death. Nevertheless, our findings are consistent with those in other studies regarding racial/ethnic differences as the leading causes of infant deaths [15, 23]. Several studies have found differences in environment [24], SES [3, 8], stress [4, 25], racism [4, 26], access to health care [27], and equity of care issues [28], and these factors may also contribute to variations in the racial differences in the leading causes of infant deaths.

There were also limited variables in the WISH database; thus, we were only able to analyze certain risk factors. Some of the variables in WISH were taken from birth certificates, which may also affect our results. For example, prenatal care was taken from the birth certificate and birth certificate variables are not always valid or reliable. Northam et al., concluded that birth certificate data were not a reliable source of information for prenatal care. They noted that, although the medical record and the birth certificate may agree on the number of prenatal visits, both sources might erroneously underestimate or overestimate the actual number [21]. Other studies have shown that birth certificates do not contain accurate and complete fields for certain variables. For example, birth weight is recorded more completely and accurately than

is gestational age. Researchers have found that the reported gestational age contains numerical errors or falls outside of the biologically plausible range [29]. Other researchers have found differences in the use of clinical estimates vs. last menstrual period (LMP) based gestational age estimates. For example, Mustafa et al., found significant disagreement between menstrual and clinical estimates of gestational age in preterm and post-term births. They further highlight that approximately 20% of live-birth certificates in the United States have missing or incomplete data for LMP, and a greater proportion of these are from birth certificates of children born to women of low SES or women who received late prenatal care [30]. Thus, the reliability of birth certificates to calculate gestational age is questionable.

Furthermore, more missing birth certificate data occur among high-risk groups such as younger and unwed women, mothers with lower SES, and disadvantaged racial/ethnic groups [21, 29]. Thus, birth certificates are limited in their ability to accurately reflect the impact of some variables on high-risk sub-populations. With that being said, birth and infant death certificates do not contain information about other factors such as the quality of prenatal care, barriers women face in accessing health care, and community or environmental factors, any of which may affect the risk of an infant death.

Finally, our results do not address causality, but rather our theoretical framework (see Fig. 1) implies that the association between race/ethnicity and infant death is mediated through multiple risk factors. Race, in and of itself, does not cause worse birth outcomes in African Americans. However, other less easily measured factors are likely contributors; these are not addressed in this study.

Our regression analyses also yielded somewhat unexpected results. We found that the relationship between race and infant death depends on the level of maternal education and the adequacy of prenatal care received. College-educated black women who received adequate PNC, had a 3-fold greater risk of an infant death compared to white women with the same level of education and adequate prenatal care. Our results are consistent with what other studies have found regarding racial differences in infant mortality and education. Several studies have found that college-educated black women have higher infant mortality rates when compared with white women with no high-school education. Higher education levels have also been associated with decreased pregnancy-related mortality among white women, but not among black women [5]. In the case of adequate prenatal care, WISH uses what is reported on the birth certificate, which does not take into account the quality of care received. "Adequate" prenatal care is defined only by the number of visits and initiation of care, and not by other measures of quality, access, or content. It may be that the differences in quality and access, factors not incorporated in our analyses, contribute to the black/white gap in infant mortality.

In summary, we suggest other unmeasured factors contribute to the racial/ethnic disparities in birth outcomes. We contend that, even if black infants had the same risk profile as white infants, disparities would still persist. We found that by mutually adjusting for select risk factors, black infants still had more than 2-fold greater risk of dying, suggesting that other factors are contributing to this relationship.

Other reports, such as the Wisconsin Minority Health Report, have found that black infants have a 3-fold greater risk of death compared to white infants [31]. However, this report does not provide a complete assessment of the infant mortality rates in Wisconsin. Our results suggest that simultaneously addressing maternal and other risk factors will explain more of this relationship. In addition, our results show that the black/white gap in infant mortality continues. Future research should focus on other factors, which are difficult to quantify, such as racism, life-course stressors, and differential quality in the care received, that likely contribute to the persistent higher rates of low birth weight and infant mortality among blacks.

We hope that this paper will help point to the need for comprehensive public health programs that focus on the woman's lifespan. These types of multidisciplinary and multidimensional programs may counteract the stress of racism and poverty that continue to contribute to adverse birth outcomes among black women. Our results show that implementing single-focus programs may partially reduce the black/white disparity in infant mortality rates, but not completely. Our results further show that the black/white disparity increases as one improves services such as prenatal care and educational programs for the entire population, suggesting that white women are benefiting most from programs aimed at improving birth outcomes. These findings may reflect a lack of culturally-sensitive messages and culturally-competent delivery. Even greater formal education is unlikely to overcome a life course of high stress due to poverty and racism [4]. Program development may benefit from cultural *representation* in designing and conducting programs, and measuring and monitoring progress towards reducing the black/white disparity, rather than just improving the health outcomes of the entire population. Certainly, variations in health literacy among individuals play a part in the differential impact of public health programs [32].

It is our hope that research moves beyond simply considering overall outcomes of programs that may be evidence based to examining factors that affect subgroups of woman throughout their life-course. Our greatest improvements in public health will be determined by our success in eliminating racial and ethnic disparities in birth outcomes. The health of future generations of mothers and babies depend on the action we take today, not tomorrow.

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