Published in final edited form as:
J Health Care Poor Underserved. 2009 August ; 20(3): 729–747. doi:10.1353/hpu.0.0180.

Cost of Racial Disparity in Preterm Birth: Evidence from Michigan

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Abstract

This study examined the economic costs associated with racial disparity in preterm birth and preterm fetal death in Michigan. Linked 2003 Michigan vital statistics and hospital discharge data were used for data analysis. Thirteen percent of the singleton births among non-Hispanic Blacks were before 37 completed weeks of gestation, compared to only 7.7% among non-Hispanic Whites (risk ratio = 1.66, 95% confidence interval: 1.59-1.72; p<0.0001). One thousand one hundred and eighty four non-Hispanic Black, singleton preterm births and preterm fetal deaths would have been avoided in 2003 had their preterm birth rate been the same as Michigan non-Hispanic Whites. Economic costs associated with these excess Black preterm births and preterm fetal deaths amounted to $329 million (range: $148 million - $598 million) across their lifespan over and above the costs if they were born at term, including costs associated with the initial hospitalization, productivity loss due to perinatal death, and major developmental disabilities. Hence, racial disparity in preterm birth and preterm fetal death has substantial cost implications for society. Improving pregnancy outcomes for African American women and reducing the disparity between Blacks and Whites should continue to be a focus of future research and interventions.

Keywords

Disparities; preterm birth; cost; African American; race

Despite substantial improvement in perinatal outcomes in the U.S., significant racial differences remain. Preterm birth (defined as live births before 37 completed weeks gestation) rates among Black infants have been on the rise after a decline during the 1990s, with a 1.6 fold difference between non-Hispanic Blacks and non-Hispanic Whites in 2004.[1] For every 100 live births among Blacks, approximately 18 are preterm, in contrast with 11 for Whites.[1]

Preterm birth is one of the most important indicators of quality of birth outcome and is among the leading causes of infant death.[1] It is also associated with increased risk of a host of costly adverse health and developmental outcomes, including cerebral palsy (CP), mental retardation (MR), hearing loss, vision impairment, behavioral problems, academic difficulties, and emotional problems,[2-4] as well as other disabling adult-onset diseases including cardiovascular disease, hypertension, and type II diabetes.[5-7] Therefore, infants born preterm consume more health care services than term infants, both during their initial hospitalization at birth and subsequent years after discharge.[2,8-11] Average annual medical costs for the first year of birth increase significantly as gestational age decreases — from $3,325 for infants born at 37-40

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completed weeks of gestation to $190,467 for those born before 28 weeks of gestation (2005 U.S. dollars).[2] Even at ages 5-7 years, those born at less than 28 weeks of gestation on average incur $1,119 medical care costs annually, compared with $471 for term babies (2005 U.S. dollars).[2] The annual societal economic burden associated with preterm birth in the United States was estimated to be $26 billion in 2005.[2]

In addition, perinatal deaths (defined as infant deaths under 28 days of age and fetal deaths of 20 weeks or more gestation) occur more frequently among preterm fetuses/infants than term fetuses/infants.[12] These perinatal deaths are associated with substantial productivity loss. Though infant mortality has drawn much attention, fetal mortality has been an overlooked public health issue.[12] Sixty three percent of the difference in fetal mortality between non-Hispanic blacks and non-Hispanic whites was due to higher non-Hispanic black fetal mortality at 20-27 weeks of gestation.[12]

Improving pregnancy outcomes for African American women and reducing the Black-White disparity in preterm birth have great potential for lowering societal costs. However, although cost implications for preterm births in general are well characterized, there is a paucity of data on the costs associated with the racial disparity in preterm birth rates. To address this knowledge gap, we estimated the costs associated with racial disparity in preterm birth and preterm fetal deaths in Michigan. Findings from this study will advance understanding of the financial burden of birth outcome disparity compared with other health problems, and hence facilitate cost-effective allocation of health care resources.

Methods

Data sources

Data for this study came from the linked hospital discharge and live birth certificate file, infant death records, and fetal death data for the 2003 birth cohort in the state of Michigan. The Michigan Department of Community Health performed the linkage between hospital discharge and vital statistics records using a probabilistic linkage algorithm which generated an overall matching rate of 97.1% for all live births in Michigan in 2003. Note that births occurring in other states (1.3% of live births to Michigan residents in 2003[13]) or not occurring at a hospital were not captured in the Michigan hospital discharge data. Fetal death records were extracted from the 2003 Perinatal Mortality Data file issued by the National Center for Health Statistics (NCHS) by specifying Michigan as the state of maternal residence.

The analysis was restricted to non-Hispanic Black and non-Hispanic White singleton births with a reported gestational age of at least 20 weeks (referred to as Blacks and Whites, respectively, for the rest of the paper). We focused on singleton births because the incidence of preterm birth is significantly higher among multiple births and racial disparity in the rate of preterm birth is more striking in singleton than multiple births.[14,15] Both live births and fetal deaths were included. Twenty weeks gestation was used as a cut-off point for several reasons. First, fetal deaths at less than 20 weeks gestation were not consistently reported in vital statistics data. Second, the estimated gestational age appeared unreliable for births at less than 20 weeks gestation (e.g., 10 births at 10 or fewer weeks gestation were reported to have survived 28 days). Third, there were very few live births at less than 20 weeks gestation (0.05% of the singleton Black or White births in Michigan in 2003). For the purpose of this study, we defined a preterm birth as a birth occurring at less than 37 completed weeks gestation. Births at 37 or more completed weeks gestation were considered term births. Births of unknown gestational age were excluded from analysis.

Excess black preterm births

The number of excess Black preterm births was calculated as the total number of singleton, Black births in Michigan multiplied by the extent of preterm birth disparity between Blacks and Whites. The extent of disparity was estimated by using the preterm birth rate for Whites as a reference and measuring the difference in the rates between Blacks and Whites. For the purpose of this analysis, preterm birth rate was defined as the number of preterm births per 100 births (both live births and fetal deaths). The sum of the number of excess Black preterm births at each gestational age (from 20 to 36 weeks gestation) reflected the total number of excess Black preterm births that would have been averted had the racial disparity in preterm birth rates been eliminated.[*]

Cost of the excess preterm births

Initial hospitalization—Our estimate of health care costs associated with the initial hospital stay at birth included both maternal and infant cost. Diagnosis Related Groups (DRG) for the mother's delivery and newborn's initial hospitalization were extracted from the Michigan hospital discharge records for all live singleton births at 20 or more completed weeks gestation. We used the 2003 Medicare fee schedule and DRG-specific relative value units (RVU) reported in Mitchell *et al.*[16] to estimate hospital facility fees and physician professional fees associated with each hospital stay. For hospital stays that exceeded the DRG-specific day outlier threshold, we assigned a *per diem* amount for each additional day of hospitalization by dividing the full DRG payment amount by the arithmetic mean length of stay for the DRG. This outlier payment was then added to the DRG base payment. Assuming that the initial hospitalization cost for singleton births at the same gestational age did not vary by racial/ethnic group, we pooled hospital discharge data by gestational age across all racial/ethnic groups and estimated the gestational age-specific average cost of initial hospitalization per live birth (C^l) (maternal and infant costs combined). This assured a relatively large sample size when estimating gestational age-specific cost (especially for births at lower gestational ages).

Hospital discharge data associated with delivery were available for 97.1% of all singleton live births at 20 or more completed weeks gestation among Michigan residents in 2003 and 96.8% of the mothers. Based on the admission source and discharge status code on the hospital discharge record, a small proportion of the newborns (2.2%) and mothers (5.0%) were transferred from or to an acute care facility, skilled or intermediate nursing facilities, or another type of institution. For these births, attempts were made to account for the costs associated with care at both the transferring and the receiving institution by linking multiple discharge records with consecutive discharge/admission dates for the same birth. However, complete discharge records were only available for a small proportion of the deliveries that involved a transfer (25.6% of the transferred infants and 0.7% of the transferred mothers). Transferred births with incomplete hospital discharge data were excluded from our estimation of the initial hospitalization costs.

In addition, we estimated gestational age-specific fetal death rate (p^d)in Michigan in 2003 among Black singleton births at 20 or more completed weeks of gestation, and calculated the expected number of fetal deaths at each gestational age among the total excess Black preterm births. We assumed that all fetal deaths incurred no hospitalization cost on the infant side, and

[*]That is, total excess Black preterm births $(N^*) = \sum_{i=20}^{36} \left(N^b \left(R_i^b - R_i^w\right)\right)$, where N^b denoted the total number of Black singleton births at 20 or more completed weeks gestation in Michigan in 2003, i indexed gestational age in weeks, and R_i^b and R_i^w represented the gestational age-specific preterm birth rates for Blacks and Whites, respectively.

used the average maternal cost of live births with the same gestational age as a proxy for the initial hospitalization cost of fetal deaths (C^d).

Among the excess Black preterm births, we multiplied the expected number of live births and the expected number of fetal deaths at each gestational age by their corresponding average initial hospitalization cost. The sum of these products across gestational ages (20-36 weeks) reflected the total initial hospitalization cost of the excess Black preterm births. In a similar manner, by applying the average initial hospitalization cost of live births and fetal deaths at 37 or more completed weeks gestation, we estimated the expected costs had these excess Black preterm births been born at term. The difference represented the economic costs associated with the initial hospitalization attributable to disparity in preterm birth:

$$\left[\sum_{i=20}^{36}\left(N^b\left(R_i^b-R_i^w\right)p_i^dC_i^d+N^b\left(R_i^b-R_i^w\right)\left(1-p_i^d\right)C_i^l\right)\right]-\left[N^*p_{\geq 37}^dC_{\geq 37}^d+N^*\left(1-p_{\geq 37}^d\right)C_{\geq 37}^l\right],$$

where the subscripts denoted gestational age (in weeks).

Perinatal deaths—We determined the expected number of perinatal deaths among the excess Black preterm births by applying the gestational age-specific fetal death rate (p^d) and neonatal death rate (death within the first 28 days of life) (p^n) based on the Black 2003 singleton birth cohort in Michigan. The expected number of perinatal deaths if these pregnancies were carried to term was also estimated. The difference in these two numbers represented the incremental perinatal deaths attributable to racial disparity in preterm birth.

Grosse[17] estimated that the value of an average person's lifetime earnings and household production (C_0) amounted to \$955,895 (2000 U.S. dollars). Using this estimate, we calculated the total productivity loss associated with the incremental perinatal deaths:

$$\left[\sum_{i=20}^{36}\left(N^b\left(R_i^b-R_i^w\right)\left(p_i^d+p_i^n\right)\right)\right]C_0-N^*\left(p_{\geq 37}^d+p_{\geq 37}^n\right)C_0$$

, where the subscripts denoted weeks of gestation.

Major developmental disabilities—Prior studies suggest that the incidence of MR and CP varies significantly by the extent of preterm status.[18] We conducted an extensive literature review to determine the base-case value and plausible ranges for the incidence rate of MR and CP (p^{MR} and p^{CP}) by four gestational age groups: before 28 weeks gestation, 28-31 weeks gestation, 32-36 weeks gestation, and 37 or more weeks gestation.[2, 19-55] Most studies used the Intelligence Quotient (IQ) under 70 (or two standard deviation below the mean) or the Mental Developmental Index of Bayley Scales of Infant Development under 70 (or two standard deviation below the mean) as a definition for MR. Cerebral palsy was most commonly defined as a non-progressive abnormality of movement and posture due to a defect or lesion of the immature brain. Because prior studies generally did not report race/ethnicity-specific rates for MR or CP by gestational age, we assumed that within each gestational age category, Blacks had the same likelihood of developing the two disabilities as other racial/ethnic groups.

Among the excess Black preterm births who survived the first 28 days of life, we calculated the number of people expected to develop MR and CP based on their gestational age. We then compared this with the expected number of people developing these disabilities had they been born at term. To avoid double-counting the cost, our estimates only included the cost of MR for those who had both MR and CP (MR is the more expensive disability). Published data on the rate of coexisting disabilities ($p^{\mathrm{MR}\mid\mathrm{CP}}$) were used for this purpose.[56, 57] Honeycutt *et al.*[58] examined the costs of several developmental disabilities and estimated the average per-person lifetime costs of MR and CP (C^{MR} and C^{CP}) to be \$872,603 and \$804,287, respectively (2000 U.S. dollars). These cost estimates included the direct costs of physician visits, prescription medications, hospital inpatient stays, assistive devices, therapy and rehabilitation, long-term care, home and automobile modifications, and special education services, as well as indirect costs such as labor and household productivity losses that arise when individuals with MR or CP die prematurely or are limited in the amount or type of work they can perform.[58]

The costs associated with MR and CP among the excess Black preterm births were calculated as follows:

$$\left[\sum_{i=20}^{36}\left(N^b\left(R_i^b - R_i^w\right)\left(1 - p_i^d - p_i^n\right)p_i^{MR}\right) - N^*\left(1 - p_{\geq 37}^d - p_{\geq 37}^n\right)p_{\geq 37}^{MR}\right]C^{MR}\left[\sum_{i=20}^{36}\left(N^b\left(R_i^b - R_i^w\right)\left(1 - p_i^d - p_i^n\right)\left(p_i^{CP} - p^{MR/CP}\right)\right) - N^*\right.$$

, where the subscripts denoted weeks of gestation.

Sensitivity analysis—We identified plausible ranges for: (1) the average cost of initial hospitalization using the 95% confidence intervals of the gestational age-specific cost estimates, (2) the probability of developing MR and CP at a different gestational age and the likelihood of having co-existing disabilities based on data reported in the literature, and (3) the per-person lifetime cost of developmental disability and the value of lifetime productivity for a healthy person by using ±50% of the base value as the lower and upper bound. One-way sensitivity analysis was conducted to examine the overall costs of racial disparity in preterm birth in Michigan by varying the value of these key parameters across their plausible ranges.

Data analyses were conducted using SAS version 9.1 (SAS Institute Inc., Cary, NC) and Microsoft Excel. All cost data were adjusted to 2007 U.S. dollars using the Consumer Price Index for all urban consumers.[59]

Results

In 2003 in Michigan, there were 87,520 and 23,212 singleton non-Hispanic Whites and Blacks, respectively, born alive at 20 or more completed weeks gestation. In addition, 361 White and 171 Black singleton fetal deaths (at 20 or more weeks gestation) occurred during the year. Overall, 12.8% of the singleton births among Blacks were before 37 completed weeks of gestation, compared to only 7.7% among Whites (risk ratio (RR) = 1.66, 95% confidence interval (CI): 1.59-1.72; p<0.0001) (Table 1). The RR estimate is similar to that of the U.S. population.[60] Moreover, among fetuses that survived to 20 weeks gestation, the risk of fetal death at birth was also higher in Blacks than in Whites (RR = 1.78, 95% CI: 1.48-2.13, P<0.0001). Of those infants born alive, the neonatal death rate was significantly higher among Blacks than Whites as well (RR = 2.37, 95% CI: 1.99-2.83, P<0.0001).

Estimates of the average initial hospitalization cost by gestational age are reported in Table 2. Data on the base-case value and plausible ranges for the incidence rate of MR and CP by gestational age groups and the rate of co-existing MR and CP are presented in Table 3. The costs incurred by the excess Black preterm births over and above the costs if they had been born at term were regarded as the costs associated with the racial disparity in preterm births.

Overall, 1,184 Black preterm births would have been avoided in Michigan had the preterm birth rates among Blacks been the same as Whites (Table 4). According to the gestational age-specific fetal death rate and neonatal mortality rate among Michigan Blacks (Appendix A), 88 of these excess preterm births were expected to result in fetal deaths and 110 would die within 28 days of birth. This compares to one expected fetal death and one expected neonatal death if the 1,184 births were born at term.

The expected cost of initial hospitalization, productivity loss due to perinatal deaths, and lifetime direct and indirect cost of developmental disabilities among these excess Black preterm births totaled $352 million (Table 5). In contrast, if the racial disparity in preterm birth could be eliminated and the 1,184 Black births were born at term, the overall societal cost would be

$22.9 million, indicating a net cost of $329 million associated with the Black-White disparity. The most significant portion of the cost was productivity loss caused by perinatal deaths ($225 million), accounting for 68.4% of the total cost of disparity (Figure 1). Cost associated with MR and CP ($75.0 million) and initial hospitalization ($28.8 million) contributed 22.8% and 8.8% of the total cost, respectively. Sensitivity analysis suggested that the total cost of racial disparity in preterm birth in Michigan could range from $148 million to $598 million.

Discussion

Although overall birth outcomes in the U.S. have improved considerably over the past several decades, racially and ethnically linked disparities in birth outcome remain one of the most persistent and challenging public health problems.[2,61] African American women continue to experience a much higher rate of preterm and low birth weight births across all economic levels.[62] Consistent with these prior reports, our data showed that the gestational age-specific rates of preterm birth were higher among Blacks than Whites in Michigan in 2003. This racial disparity resulted in 1,184 additional preterm births in Michigan in 2003 and could cost the society $329 million over the life span of the 2003 Michigan singleton birth cohort. To the best of our knowledge, this is the first study directly quantifying the cost of racial disparity in preterm birth using U.S. data.

Our findings add to the literature on the economic burden of preterm birth. Using data from two hospitals in Alabama in 1989-1992, St. John *et al*.[63] estimated that the average medical care cost during the initial hospitalization at birth to be $145,892 per live births born at 24 weeks gestation who survived to hospital discharge (1992 U.S. dollars). This compared to $2,362 for an infant born at 36 weeks (1992 U.S. dollars). Based on data from California singleton live births in 1996, Gilbert *et al*.[64] estimated that the neonatal hospital cost ranged from $3,600 for a 36-week newborn to $210,200 for a delivery at 25 weeks (combined maternal and neonatal cost, not including physician fees, 1996 U.S. dollars). Similarly, Schmitt *et al*.[65] used more recent data from California and found that infants born at less than 33 completed weeks gestation had a mean hospital cost of $66,813, while those born at 33-36 weeks had a mean hospital cost of $7,081 (2000 U.S. dollars). Phibbs and Schmitt[66] further demonstrated that a two-week increase in gestational age among newborns below 33 weeks gestation could result in a median saving of $28,870-$64,021 per birth (2003 U.S. dollars). Our data suggested an average initial hospitalization cost of $103,980 for a 26-week newborn and $6,368 for a term infant.

More importantly, our results provided direct evidence for the cost of racial disparity in preterm birth. In conducting the study, we took into consideration the long-term costs of preterm births, such as the costs related to developmental disabilities and productivity loss due to perinatal deaths. Thus, our data provide a comprehensive picture of the societal burden associated with the disparity in preterm birth between African Americans and Whites.[67] The overall costs of the racial disparity in preterm birth are likely even higher because our analysis only included disparity in singleton gestations. However, because the degree of disparity is less extreme in multiples than in singletons[14,15] and since multiples only accounted for 3.3% of all live births in the U.S. in 2003,[68] we expect the impact on the overall cost of preterm birth disparity to be small.

Our findings highlight the economic importance of improving pregnancy outcomes for African American women and reducing the disparity in preterm birth rates. If this gap can be eliminated, Michigan alone could save $28.8 million (range: $23.6 million - $33.9 million) each year on the initial hospitalization costs of newborns. Moreover, given our estimated lifetime cost of productivity loss and developmental disabilities ($225 million + $75.0 million) and the reported life expectancy at birth in year 2003 for Blacks (i.e., 72.6 years),[69] there is an additional average annual cost of $4.13 million (range: $1.72 million - $7.78 million) associated with productivity loss and developmental disabilities for the 2003 Michigan birth cohort alone. The total annual cost savings across multiple birth cohorts that are alive in any given year for the entire country could be substantial. These estimates can be used to inform comparisons of the cost of racial disparity in preterm birth with other health care problems and hence help set priority areas for future research and public health efforts. They can also facilitate more efficient allocation of health care resources by informing cost effectiveness analyses of future interventions targeted at reducing disparities in preterm births.

Previous research has identified numerous sociodemographic and behavioral risk factors for poor pregnancy outcome, such as marital status (unmarried or cohabiting), young or advanced maternal age, low socioeconomic status, late initiation or inadequate use of prenatal care, and unintended pregnancy.[2, 70-72] Data consistently show higher rates of births to unmarried mothers, births to mothers with less than 16 years of education, and births to women younger than 20 years of age among African Americans compared with Whites; and African American women are also less likely to receive adequate prenatal care.[73] However, even after adjusting for measured socioeconomic differences, African American women experience higher rates of preterm birth than White women.[2] Despite extensive research efforts, little is known about how preterm birth can be prevented, and there is still limited understanding regarding the etiology of the causes of racial disparity in preterm births.[2, 74] The gap in perinatal outcomes between African American and White women must be examined in greater depth to identify causative factors and develop sustainable solutions. Such research holds great potential for substantial economic benefits.

Findings from this study should be interpreted with several limitations in mind. First, availability of epidemiologic and cost data restricted our analysis to only two developmental disabilities (i.e., MR and CP). Future studies should account for other morbidities, such as chronic lung diseases, hearing loss, blindness, and behavioral/learning disorders, all of which are more common in premature infants, as more data become available. Second, we assumed that the likelihood of having coexisting MR and CP was the same across all gestational age. Research on infants with different birth weights suggests that they experience different rates of developing coexisting disabilities.[75, 76] It is likely that the rate of coexisting disabilities varies with gestational age as well.

Third, our estimates did not account for caregivers' costs such as productivity loss of the parents who often spend a significant amount of time taking care of premature infants or children with disabilities. Non-economic costs, such as missed education opportunities and the emotional distress and suffering of the parents and their infants, also need to be considered in future studies. Fourth, except for those related to MR and CP, we did not include the higher medical costs of subsequent hospitalizations and outpatient care required by former premature infants[77] or the non-medical costs of prematurity such as transportation and housing during hospitalizations. Fifth, there has been controversy regarding the value of a person's life and empirical studies have reported different estimates.[78] We used an estimate of $955,895 as the value of an average person's lifetime earnings and household production.[17] Although we performed a sensitivity analysis using ±50% of this base value as the lower and upper bound, it is likely that the value of a particular individual's life is higher or lower than the bounds. Moreover, costs associated with the likelihood that a second child was born in "replacement" of the deceased infant were not considered. Finally, as noted in the Methods section, transferred newborns and mothers with incomplete hospital discharge data were excluded when we estimated the average initial hospitalization cost per birth. These births were likely the more severe cases with more health care utilization.

Despite these limitations, this study takes an important first step toward understanding the economic benefits of reducing birth outcome disparities in the U.S. Eliminating the racial disparity in preterm birth in the 2003 Michigan singleton birth cohort alone could have saved $329 million (range: $148 million - $598 million). Improving pregnancy outcomes for African American women and reducing the racial disparity has great potential to reduce economic costs.

Acknowledgment

This study was supported by the National Institutes of Health Roadmap Initiative grant number 1 P20 RR020682-01. The authors thank Thu Le, PhD, Michigan Department of Community Health, who performed the linkage between hospital discharge and vital records, live births and infant deaths data.

Appendix

Appendix

Appendix A

Distribution of births by gestational age and race, and gestational age-specific fetal death rate and neonatal death rate, 2003 M ichigan singleton births (≥20 completed weeks gestation)

Gestational age (in weeks)	Distribution of births by gestational age			Fetal death rate among Blacks,[a] by gestational age	Neonatal death rate among Blacks,[a] by gestational age
	Blacks[a]	Whites[b]	Difference (disparity)		
20	0.11%	0.05%	0.06%	50.00%	50.00%
21	0.20%	0.08%	0.12%	34.04%	63.83%
22	0.26%	0.09%	0.17%	41.67%	48.33%
23	0.23%	0.08%	0.15%	25.93%	51.85%
24	0.25%	0.08%	0.17%	15.25%	28.81%
25	0.30%	0.08%	0.22%	12.86%	20.00%
26	0.27%	0.08%	0.20%	17.19%	9.38%
27	0.29%	0.10%	0.19%	4.48%	14.93%
28	0.30%	0.12%	0.18%	7.14%	5.71%
29	0.36%	0.13%	0.24%	12.94%	2.35%
30	0.39%	0.17%	0.23%	6.52%	2.17%
31	0.49%	0.22%	0.27%	5.22%	4.35%
32	0.67%	0.27%	0.40%	0.64%	2.55%
33	0.74%	0.44%	0.30%	1.74%	1.74%
34	1.59%	0.92%	0.66%	1.35%	0.81%
35	2.24%	1.49%	0.75%	0.76%	0.95%
36	4.10%	3.34%	0.75%	0.73%	0.42%
≥37	87.21%	92.27%	-5.07%	0.11%	0.10%
Total	100%	100%	0%	-	-

[a]Non-Hispanic Blacks.

[b]Non-Hispanic Whites.

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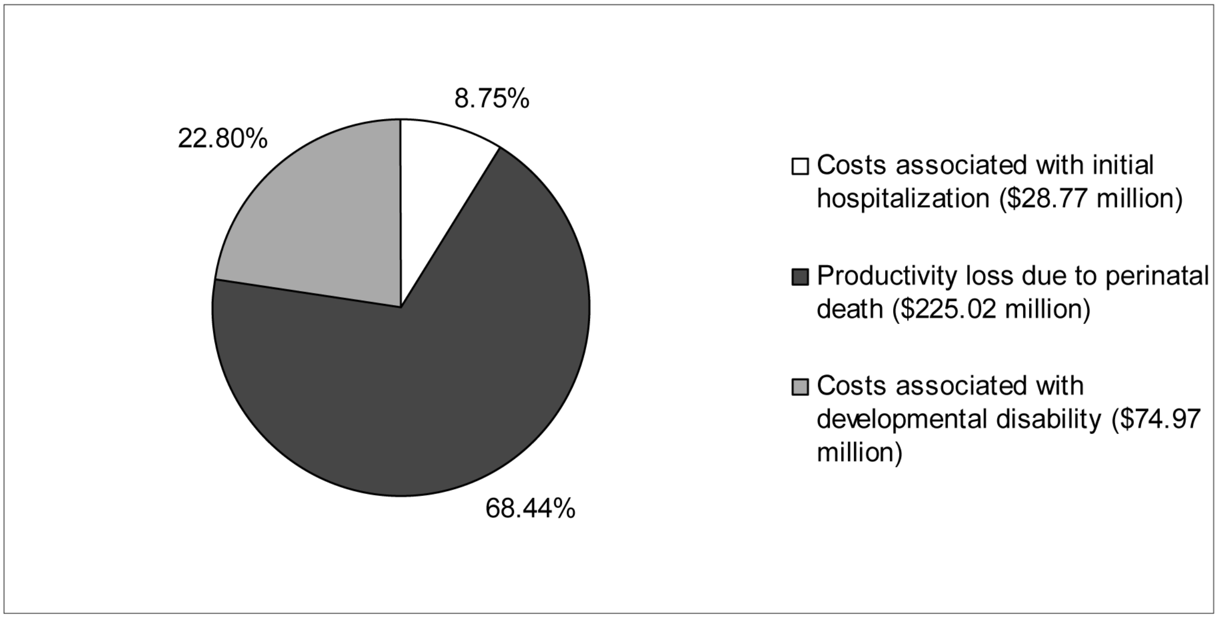

Figure 1.
Costs of racial disparity in preterm birth between non-Hispanic Blacks and Whites among 2003 Michigan singleton birth cohort

Table 1

The proportion of births born before 37 completed weeks of gestation, and the rate of fetal death and neonatal death among 2003 Michigan singlet on births (≥20 completed weeks gestation)

	Overall Sample	Black[a]	White[b]	Risk Ratio (95% CI)	P value
Total Births (N)	111,264	23,383	87,881		
Gestation age at birth, n (%)				1.66 (1.59-1.72)	<0.0001
< 37 weeks	9,780 (8.79%)	2,991 (12.79%)	6,789 (7.73%)		
≥ 37 weeks	101,484 (91.21%)	20,392 (87.21%)	81,092 (92.27%)		
Fetal deaths, n (%)				1.78 (1.48-2.13)	<0.0001
Fetal deaths	532 (0.48%)	171 (0.73%)	361 (0.41%)		
Live births	110,732 (99.52%)	23,212 (99.27%)	87,520 (99.59%)		
Neonatal deaths, n (%)[c]				2.37 (1.99-2.83)	<0.0001
Neonatal deaths	515 (0.47%)	199 (0.86%)	316 (0.36%)		
Survivors at 28 days	110,217 (99.5 3%)	23,013 (99.14%)	87,204 (99.64%)		

Percentages may not add to exactly 100 due to rounding. CI = confidence interval

[a]Non-Hispanic Blacks.

[b]Non-Hispanic Whites.

[c]Among live births only.

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Table 2

Gestational age specific estimates of the initial hospitalization cost, 2003 Michigan singleton births (≥20 completed weeks gestation, regardless of race/ethnicity)

Gestational age (in weeks)	Average initial hospitalization cost per live birth[a] (mean, 95% confidence interval)	Average initial hospitalization cost per fetal death[b] (mean, 95% confidence interval)
20	$11,397 ($10,446-$12,348)	$3,650 ($3,330-$3,971)
21	$11,703 ($10,607-$12,799)	$3,890 ($3,545-$4,235)
22	$25,367 ($13,894-$36,839)	$4,279 ($3,868-$4,691)
23	$48,908 ($33,033-$64,783)	$6,976 ($4,955-$8,997)
24	$99,477 ($73,957-$124,997)	$6,807 ($5,407-$8,208)
25	$82,296 ($68,939-$95,652)	$6,268 ($5,207-$7,329)
26	$103,980 ($81,621-$126,340)	$6,773 ($4,925-$8,621)
27	$72,212 ($63,185-$81,239)	$7,015 ($5,925-$8,104)
28	$56,933 ($50,903-$62,964)	$6,891 ($5,875-$7,907)
29	$45,598 ($39,185-$52,011)	$6,624 ($5,452-$7,796)
30	$34,642 ($29,407-$39,877)	$6,882 ($5,763-$8,001)
31	$29,679 ($25,817-$33,542)	$6,354 ($5,472-$7,235)
32	$24,623 ($22,484-$26,762)	$7,677 ($6,599-$8,756)
33	$21,887 ($20,111-$23,662)	$5,590 ($4,987-$6,191)
34	$18,617 ($17,733-$19,501)	$5,197 ($4,766-$5,627)
35	$15,864 ($15,293-$16,435)	$4,592 ($4,406-$4,779)
36	$12,305 ($11,952-$12,659)	$4,264 ($4,181-$4,347)
≥37	$6,368 ($6,328-$6,409)	$3,877 ($3,869-$3,884)

Costs reported in inflation adjusted 2007 U.S. dollars.

[a]Including costs associated with the hospitalization for both the m other and the newborn.

[b]Including costs associated with the hospitalization for the mother only.

Table 3

Probability of developmental disabilities, by gestational age

Developmental Disability	Base Value	Range	References
Mental retardation (MR)			
≤27 weeks	15.0%	6.0-37.2%	2, 21, 22, 27, 31, 35, 36, 39–42, 45, 46, 48–50, 52, 53
28-31 weeks	9.0%	2.5-22.8%	2, 26, 32, 37, 48
32-36 weeks	5.0%	1.0-8.1%	2, 24, 37
≥37 weeks	1.0%	0.0-3.0%	2, 17, 19, 28, 36, 44
Cerebral palsy (CP)			
≤27 weeks	14.0%	5.0-26.4%	2, 18, 20–23, 27, 29–31, 33–36, 38–43, 45–53
28-31 weeks	7.0%	1.7-11.6%	2, 18, 25, 26, 29, 32, 33, 37, 38, 47, 48
32-36 weeks	0.7%	0.3-4.4%	2, 18, 24, 29, 33, 37, 38
≥37 weeks	0.0%	0%-0.23%	2, 17, 19, 22, 28, 29, 33, 36
Proportion of persons with CP who have co-existing MR	64.0%	60-70%	54, 55

Table 4

Number of excess preterm births among non-Hispanic, singleton Black births (≥20 completed weeks gestation) in Michigan in 2003

Gestational age (in weeks)	Number of excess Black preterm births	Expected number of fetal deaths	Expected number of neonatal deaths	Expected number of survivors[a]
20	13	7	6	0
21	29	10	19	0
22	40	17	19	4
23	36	9	19	8
24	41	6	12	23
25	52	7	10	35
26	46	8	4	34
27	44	2	7	35
28	41	3	2	36
29	56	7	1	48
30	53	3	1	49
31	63	3	3	57
32	94	1	2	91
33	69	1	1	67
34	155	2	1	152
35	176	1	2	173
36	176	1	1	174
Total	1,184	88	110	986
Expected birth outcomes if the excess Black preterm births were born at term		1	1	1,182

[a]Newborns who would survive the first 28 days of life.

Table 5

Costs associated with the racial disparity in preterm birth between non-Hispanic Blacks and non-Hispanic Whites in the 2003 Michigan singleton birth cohort

	Expected lifetime cost of the 1,184 excess Black preterm births	Expected lifetime cost if the 1,184 births were born at term	Cost of racial disparity in preterm birth	Sensitivity analysis on the cost of racial disparity in preterm birth
Initial hospitalization at birth	$36,322,800	$7,552,544	$28,770,256	$23,638,788 - $33,901,737
Productivity loss due to perinatal death	$227,892,229	$2,873,589	$225,018,640	$112,509,320 - $337,527,960
Developmental disabilities	$87,412,764	$12,440,062	$74,972,702	$12,093,290 - $227,000,571
Total	$351,627,793	$22,866,195	$328,761,598	$148,241,398 - $598,430,267

Costs reported in inflation adjusted 2007 U.S. dollars.