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Assessing the Impact of Paternal Involvement on Racial/Ethnic Disparities in Infant Mortality Rates

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Abstract We sought to assess the contribution of paternal involvement to racial disparities in infant mortality. Using vital records data from singleton births in Florida between 1998 and 2005, we generated odds ratios (OR), 95% confidence intervals (CI), and preventative fractions to assess the association between paternal involvement and infant mortality. Paternal involvement status was based on presence/absence of paternal first and/or last name on the birth certificate. Disparities in infant mortality were observed between and within racial/ethnic subpopulations. When compared to Hispanic (NH)-white women with involved fathers, NH-black women with involved fathers had a two-fold increased risk of infant mortality whereas infants born to black women with absent fathers had a seven-fold increased risk of infant mortality. Elevated risks of infant mortality were also observed for Hispanic infants with absent fathers (OR = 3.33. 95%CI = 2.66–4.17). About 65–75% of excess mortality could be prevented with increased paternal involvement. Paternal absence widens the black-white gap in infant mortality almost four-fold. Intervention programs to improve perinatal paternal involvement may decrease the burden of absent father-associated infant mortality.

Keywords Fathers' involvement · Paternal involvement · Infant mortality · Racial disparities

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Introduction

The infant mortality rate among non-Hispanic black infants is more than twice that of non-Hispanic white infants [1]. This disparity has persisted in spite of efforts to reduce the rates of low birth weight and preterm birth, key contributing factors to infant mortality [1, 2]. Other explanations such as access to care, quality of care, lower socioeconomic status have not fully explained differences, and interventions, although successful in reducing the overall infant mortality rate, have not eliminated racial disparities [2–4]. Further, complicating the issue is the fact that Hispanics, although of similar socioeconomic status as non-Hispanic blacks, have birth outcomes more comparable to those of whites [5, 6].

One possible explanation for the racial disparity in infant mortality might be the lack of paternal involvement in non-Hispanic black pregnancies. Black women have the highest rates of births among unmarried women (70.7%), followed by those of Hispanics (49.9%) and non-Hispanic whites (26.6%) [1]. Marital status has been used as a surrogate indicator of paternal involvement and previous

studies have shown that unmarried women are less likely to seek early prenatal care, more likely to deliver a low birth weight infant, and more likely to have unhealthy prenatal behaviors [7–10]. However, marital status is not a complete indicator of paternal involvement as gradations of involvement exist between married and unmarried (i.e.; unmarried women cohabiting with the infant's father). Yet precursors of infant mortality, such as low birth weight, exhibit the same patterns, with rates decreasing as the mother-father relationship becomes more marriage-like [11]. These associations may be particularly important as childbearing among unmarried women has increased from 28% in 1990 to 38.5% in 2006 [1].

In spite of these findings, few studies have evaluated the role of paternal involvement in infant mortality [7, 9]. Those that did noted higher infant mortality rates among those infants with absent fathers, as measured by miss-ingness of paternal information in birth vital statistics records [7, 9]. The increased mortality rates of absent fathers were also observed within each racial-ethnic sub-population [7]. Further, Tan et al. noted that the risk of neonatal and post-neonatal mortality of infants with partial paternal information missing fell between that of infants with complete paternal information and that of infants with completely missing paternal information [9]. However, the study only included twins, which may not represent the general birth population [9]. Paternal support may play an important role not only in improving maternal health behaviors, but may also reduce maternal stress by providing both emotional and financial support.

Accordingly, we undertook this study to evaluate the impact of lack of paternal involvement in the Florida birth population and to determine the degree to which inventions to improve paternal involvement during pregnancy could negate some of the adverse effects. A better understanding of the degree to which lack of paternal involvement contributes to infant mortality may lead to enhanced intervention programs aimed at improving paternal involvement during the perinatal period.

Methods

Linked birth and death certificates for all births in the state of Florida covering the period from 1998 to 2005 were used in this analysis. Only live-born singleton infants between 20 and 44 weeks of gestation were eligible for this study ($n = 1,586,805$). Records of teenage mothers (<20 years of age; $n = 187,930$) and 1,074 records of missing, divorced, widowed or unknown marital status were excluded. The final study population included 1,397,801 singleton live-born infants.

Married women in Florida must report the husband's name on the birth certificate; however, special circumstances, preclude inclusion of this information. Unmarried women are not required to report the father's name on the birth certificate, unless a paternity acknowledgment is obtained. Regardless of martial status, the exclusion of paternal identifiers suggests that the partner is uninvolved. Conversely, inclusion of paternal identifiers suggests a closer relationship between the mother and father of the infant. An earlier study confirmed this as it reported that the proportions of fathers who were involved during the pregnancy and the proportion of fathers with their names on the birth certificate were similar (87 and 90%, respectively) [12]. Using this methodology we categorized our study population as either father-involved or father-absent pregnancies using presence or absence of the father's first and/or last name on the birth certificate as a surrogate measure of paternal involvement during pregnancy. Father-involved pregnancies included infants whose birth certificates had the father's first and last name listed whereas father-absent pregnancies were those without paternal name listed. Therefore, father-absent pregnancies met one of the following criteria: father's first name is missing, father's last name is missing, and father's first and last name is missing.

Our main outcome of interest was infant mortality, including neonatal death (death of the newborn within the first 28 days of life), post-neonatal death (death between 28 and 364 days of life) and infant death (death occurring before 1 year of age).

Maternal characteristics (e.g., age of the mother) that could influence birth outcomes in general were considered as potential covariates and confounders. Socio-demographic characteristics of mothers with involved fathers and their counterparts with absent fathers were compared and adjusted for in multivariable analyses. These variables included: maternal age (<35 years and ≥ 35 years), educational attainment (<12 years and ≥ 12 years), marital status (married, single), reported use of tobacco during pregnancy (yes, no), adequacy of prenatal care (adequate and inadequate), parity (nulliparous, multiparous) and race/ethnicity. We categorized race/ethnicity as reported on the birth certificate into four groups: white, black, Hispanic and other (those mothers whose race/ethnicity was not listed in the birth record as white, black, or Hispanic). Adequacy of prenatal care was assessed using the R-GINDEX (revised graduated index) algorithm [13–15]. The R-GINDEX assesses the adequacy of care based on trimester prenatal care began, number of visits, and the gestational age of the infant at birth. BMI was defined as pre-pregnancy weight (grams) divided by height (centimeters) squared, as recorded on the birth certificate. BMI values were only available for births that occurred after

February 2004 since prior to that period height and pre-pregnancy weight were not recorded on the birth certificate.

Crude frequency comparisons for the presence of common obstetric complications were performed, namely, anemia, cardiac disease, diabetes mellitus, chronic hypertension, preeclampsia, eclampsia, abruptio placenta, placenta previa and renal diseases. Furthermore, since pregnancy complications were highly correlated with each other (significant pair wise correlation), to avoid the problem of multicollinearity, we constructed a composite variable defined as the occurrence of at least one of the following in the adjusted model: anemia, cardiac disease, type-1 diabetes, chronic hypertension, preeclampsia, eclampsia, abruption placenta, placenta previa, and renal disease.

We conducted univariate analysis and determined differences in proportions by means of the *chi*-square test for categorical variables and the student *t* test for continuous variables. The independent association between father involvement and risk of infant mortality was assessed by means of an unconditional multivariable logistic regression modeling after controlling for maternal characteristics and common obstetric complications. The odds ratios generated were used to approximate relative risks.

In addition to the odds ratio, we computed the preventive fraction (the level of excess feto-infant death that could be prevented if absent fathers were involved). We used the following standard formula to derive the preventive fraction: Preventive fraction (PF) = [(OR − 1)/(OR)] × 100, where PF = preventable fraction (or excess preventable mortality) and OR is the adjusted odds ratio [16]. All tests of hypothesis were two-tailed with a type 1 error rate fixed at 5%. This study was approved by the Institutional Review Board for human subjects at the University of South Florida.

Results

Of the 1,397,801 singleton live births that were available for analysis, 1,276,820 (91.3%) mothers were in the father-involved group whereas 120,981 (8.7%) mothers were in the father-absent group. Selected demographic characteristics of mothers in the two groups are presented in Table 1. Mothers who were in the father-absent group were younger, more educated, more likely to be black, nulliparous and had a higher percentage of risk factors such as smoking and inadequate prenatal care than mothers in the father-involved group.

Obstetric complications such as anemia, chronic hypertension, eclampsia and placental abruption were more prevalent to mothers in the father-absent group while mothers in the father-involved group were more likely to

Table 1 Distribution of selected maternal socio-demographic and maternal characteristics between father-involved and father-absent groups (Florida 1998–2005)

	Father-absent %	Father-involved %	P-value
Advanced maternal age (≥35 years old)	10.09	16.39	<0.01
Education (≥12 years)	32.38	13.62	<0.01
Mother married (Yes)	10.86	72.26	<0.01
Smoker	15.21	7.65	<0.01
Adequate prenatal care[a]	35.32	56.28	<0.01
Race			
White	44.44	70.6	<0.01
Black	44.61	17.21	
Hispanic	6.23	6.12	
Other	4.72	6.08	
Multiparous	25.77	29.83	<0.01
Anemia	3.36	2.42	<0.01
Cardiac disease	0.28	0.38	<0.01
Diabetes	2.17	2.92	<0.01
Preeclampsia	3.47	3.57	0.12
Chronic hypertension	0.89	0.76	<0.01
Renal disease	0.17	0.15	0.12
Eclampsia	0.47	0.31	<0.01
Abruption	0.54	0.39	<0.01
Placenta previa	0.34	0.36	0.39

[a] Adequacy of Prenatal care was determined using the revised graduated index algorithm

have cardiac disease and diabetes (Table 1). There was no difference in the levels of preeclampsia, renal disease and placenta previa between the two groups.

Infants of mothers who were in the father-absent group were born slightly earlier than those in the father-involved group [Mean gestational age (±SD) = 38.32 weeks (±2.70 weeks) versus 38.64 weeks (±1.97) respectively; $P < 0.01$]. The mean birth weight of the infants differed by paternal involvement status. Infants of mothers in the father-absent group weighed on average 165 g less than those of mothers in the father-involved group [Mean (±SD) = 3,169.0 g (±639.3) versus 3,333.7 g (±559.7) respectively, ($P < 0.01$)].

Overall, there were 7,709 infant deaths (rate = 5.5 per 1,000). Of these, 4,872 were neonatal deaths (rate = 3.5 per 1,000) and the remaining 2,837 were post-neonatal deaths (rate = 2.0 per 1,000). The adjusted odds ratios and their associated 95% confidence intervals for the association between father-involvement and infant mortality outcomes are summarized in Table 2. Infants in the father-absent group had an elevated risk infant mortality. Neonatal death had the highest risk (OR = 4.00, 95% CI = 3.71, 4.32) followed by infant death (OR = 3.41,

Table 2 Adjusted odds ratio and preventive fraction of infant mortality among mothers in the father-absent group (referent group = mothers in the father-involved group)

	Adjusted estimates	Preventive fraction				
	Overall OR (95% CL)	Overall	White	Black	Hispanics	Other
Neonatal death	4.00 (3.71–4.32)	75.00	74.38	73.57	74.50	75.07
Post neonatal death	2.74 (2.49–3.01)	63.50	65.48	68.26	56.53	68.34
Infant death	3.41 (3.22–3.62)	70.67	71.06	71.82	69.97	73.13

Adj. OR = Adjusted odds ratio; CI = Confidence estimates; Overall includes all races

Preventive fraction was computed thus: [(OR−1)/(OR)] × 100, where OR = Adjusted odds ratio. Proportions represent reductions in infant death at 100

Adjusted estimates were generated after controlling for the effects of maternal age, parity, race, smoking, education, marital status, adequacy of prenatal care, a composite variable which include at least one of the following: anemia, cardiac disease, type-1 diabetes, chronic hypertension, preeclampsia, eclampsia, abruption placenta, placenta previa, and renal disease

95% CI = 3.22, 3.62). Table 2 also presents the proportion of excess mortality that could be prevented should fathers who were absent become involved, perhaps through intervention efforts. This preventable proportion ranges from 56 to 75%, with post-neonatal death having the lowest magnitude of prevention and neonatal death the highest.

Additionally, we categorized infants by race and involvement status into eight groups: white women in the father-involved (referent group), white women in the father-absent group, black women in the father-involved group, black women in the father-absent group, Hispanic women in the father-involved group, Hispanics in the father-absent group, other women in the father-involved group, and other in the father-absent group. White women in the father-involved group constituted the majority of women in the study population ($n = 901,404$; rate = 64.5%), followed by blacks ($n = 219,699$; rate = 15.7%), Hispanics ($n = 78,095$; rate = 5.6%), and other ($n = 77,622$; rate = 5.5%). In contrast, most absent fathers were black ($n = 53,970$; rate = 3.9%), followed by white ($n = 53,767$; rate = 3.9%), Hispanic ($n = 7,537$; rate = 0.5%) and other ($n = 5,707$; rate = 0.4%). Crude rates of infant mortality by racial-ethnic subgroups are presented in Fig. 1.

Subgroup analysis of the association between father involvement and infant mortality outcomes indicated that within each racial-ethnic group, absent fathers had a higher risk of feto-infant mortalities than their counterparts with involved fathers (Table 3). Among mothers with absent fathers, regardless of race/ethnicity, the greatest mortality risk among their infants was neonatal death. Infants born to black mothers with absent fathers experienced the highest risk of infant mortality. The risk among black mothers with absent fathers was most pronounced for neonatal death (OR = 8.06, 95% CI = 7.28–8.93). For all mortality outcomes, the risk estimates for Hispanic infants with involved fathers were not significantly different from that of the referent group (white infants with involved father) (Table 3).

Discussion

The present study suggests that lack of paternal involvement is an important potentially modifiable risk factor for infant mortality. The neonatal mortality rate of infants born to women with absent fathers is nearly four times that of their counterparts with involved fathers. Further, this difference persists after adjusting for a host of socio-demographic and obstetric variables. Disparities in infant mortality exist not only between racial ethnic subpopulations, but also within each racial-ethnic group. When compared to white women with involved fathers, black women with involved fathers have a two-fold increased risk of infant mortality whereas infants born to black women with absent fathers are seven times more likely to die during infancy. Further, our findings confirm studies that suggest that Hispanic women have birth outcomes that are similar to those of white women in spite of risk profiles that are similar to those of black women [11, 17, 18]. Hispanic women with absent fathers have an elevated risk of neonatal, but not post-neonatal mortality.

Paternal involvement may promote healthy pregnancy behaviors thereby decreasing the likelihood of an adverse pregnancy outcome. In our study, like previous studies, women with absent fathers have a higher prevalence of maternal obstetric complications are less likely to get adequate prenatal care, and more likely to smoke [7–9]. It is possible that financial and emotional support decreases stress and promotes healthy behaviors, thereby improving the infant's survival. Stress and smoking have all been associated with adverse pregnancy outcomes [19–22]. Unfortunately, our study did not have indicators or measures of stress, nor did it include maternal reports of stress, financial worries or other family support. Since it is possible that support from other family members during the perinatal period may have compensated for the lack of paternal involvement, we excluded teen pregnancies from the study population. Even with this exclusion, lack of

Fig. 1 Crude estimates of infant mortality outcomes by father involvement status. *Filled square* = Father-involved group, *Square* = Father-absent group. *P*-values for all comparison was less than 0.01
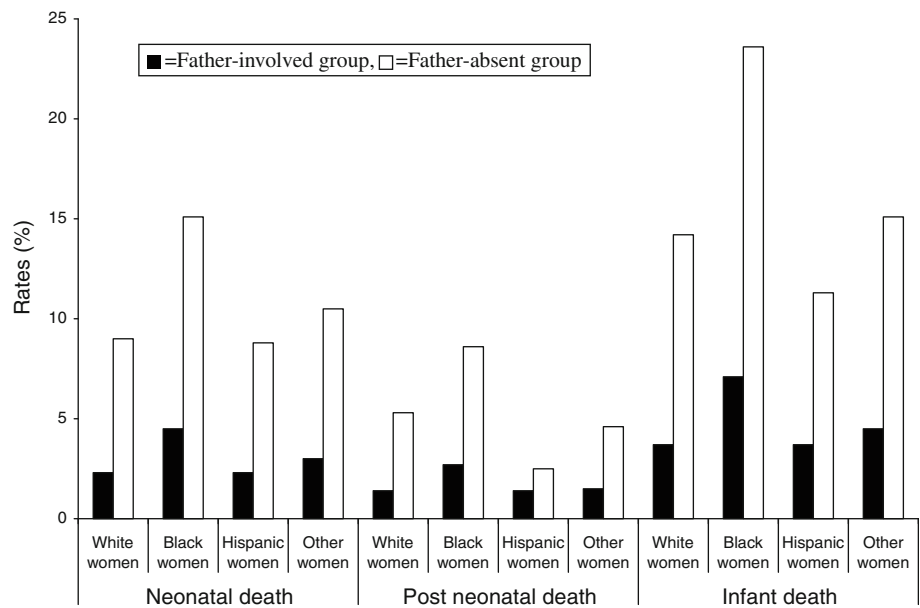

Table 3 Adjusted odds ratios and 95% confidence intervals for the association between father involvement and infant mortality outcomes

	Whites Father-absent	Blacks Father-involved	Blacks Father-absent	Hispanics Father-involved	Hispanics Father-absent	Others Father-involved	Others Father-absent
Neonatal death	4.40 (3.87–5.00)	2.17 (1.99–2.36)	8.06 (7.28–8.93)	1.06 (0.97–1.17)	4.54 (3.90–5.30)	1.43 (1.24–1.64)	5.85 (4.49–7.63)
Post-neonatal death	2.99 (2.56–3.49)	1.79 (1.60–1.99)	5.01 (4.40–5.70)	0.83 (0.73–0.94)	1.76 (1.38–2.24)	1.12 (0.92–1.35)	2.70 (1.81–4.01)
Infant death	3.78 (3.42–4.17)	2.02 (1.89–2.16)	6.74 (6.22–7.31)	0.97 (0.90–1.05)	3.26 (2.87–3.71)	1.31 (1.17–1.46)	4.40 (3.53–5.49)

Referent group = White mothers in the father-involved group

Adjusted estimates were generated after controlling for the effects of maternal age, parity, race, smoking, education, marital status, adequacy of prenatal care, a composite variable which include at least one of the following: anemia, cardiac disease, type-1 diabetes, chronic hypertension, preeclampsia, eclampsia, abruption placenta, placenta previa, and renal disease

paternal involvement seems to be an important risk factor for infant mortality. Nonetheless, it must be noted as a limitation that we were unable to directly assess the type, quality, or quantity of paternal involvement. However, our measure of paternal involvement is believed to be fairly accurate as previous authors noted a correlation between presence of paternal information on the birth record and paternal prenatal involvement [12]. In addition, our analyses controlled for marital status which allowed us to examine the role of paternal involvement independently. Marital status was correlated with paternal involvement, but it is important to note that marital status is not wholly indicative of paternal involvement. About 23% of unmarried women were missing father's name on the birth certificate, only 1.4% of married mothers were missing father's name. Therefore, it is reasonable to assume that some married fathers are not involved while some unmarried fathers are involved during pregnancy.

Our study also had several strengths, including its large population-based design which includes a diverse population. Florida ranks fourth in the number of live births in the United States and only Texas and California surpass Florida in the number of Hispanic births [23]. Further this study highlights the contributions of a modifiable risk factor to the infant mortality rates and most importantly, our study suggests that significant proportion of infant mortality could be prevented if fathers were to become more involved. This finding may be particularly important as an increasing proportion of infants, particularly among non-Hispanic black women, are born outside of marriage [1]. More studies evaluating the effectiveness of programs designed at promoting paternal involvement during the perinatal period are needed.

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