Reconsidering infant age at death in mortality research

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ABSTRACT

One way that the effects of the changing context in health care are evident is in the changing distribution of age at infant death. Traditional classifications of perinatal, neonatal and post-neo natal infant mortality are problematic because they mask some of the overall improvements in infant health and survival that have occurred in the latter part of the 20th century, such as improving the odds of survival to older ages for very premature infants. These changes have resulted in a transformation in the socio-demographic profiles of risk at various ages of death. Using vital registration data from Florida, I examine the racial disparity in infant mortality with a modification to the traditional classification of age at infant death in a way that acknowledges that ages at death are associated with etiologies that have been affected by the changing context of health care in the United States.

INTRODUCTION

I begin by reviewing some of the pertinent literature for this examination of age at infant death. Following this review, I then describe the data methodology employed in these analyses. Then I present the case for using a modification of the traditional age categories, by examining cause of death by age. Finally I present multivariate findings where the racial disparity in infant mortality is examined from both age categorizations before I conclude with a discussion.

BACKGROUND

During the latter part of the twentieth century, infant health and survival improved substantially due to improvements in knowledge, medical technology and therapeutic options (Markestad, Kaarrsen et al 2005; Hack and Fanaroff 1999). These improvements were accompanied by dramatic social change that was characterized by changes in the socioeconomic status of women, as well as re-organization in health care in the form of regionalization of neonatal intensive care units (Corman and Grossman 1986, Cramer 1987). These changes likely altered the nature of the relationship between maternal characteristics and infant health outcomes.

Changes in the health care and medical context have altered the way we think about the processes leading to infant mortality. The result of these reconsiderations is evident in the analyses that have been conducted throughout much of the research on infant mortality. Initially, researchers were interested in the "origin of cause" framework, but as the methods and the data

became available, demographers have increasingly become interested in cause-specific infant mortality as a way to investigate the changing health of populations.

The origin of fatal mechanisms (Bouvier and van der Tak 1976; Sappenfield 1987; Shyrock and Siegel 1976) approach was sufficient in earlier eras of demographic research on infant mortality. In short, this approach allocated the cause of death as due to causes outside the infant (exogenous mortality) or due to the biological process of pregnancy and physiological makeup of the infant (endogenous mortality). The former was considered contingent on the infant's social environment, and thus amenable to prevention efforts. The latter was considered inherent in the biology of pregnancy and fetal health of the infant and thus not amenable to prevention efforts (Eberstein and Parker 1984; Hummer 1993). This approach became untenable with massive improvements in prenatal care and screening that occurred in the latter part of the twentieth century. A latent effect of improvements in the health and survival of infants was a need to reconceptualize the process leading to infant death, and a growing recognition of the importance of maternal health for infant health and survival. The result was that the distinction between exogenous and endogenous infant mortality became less clear when some causes of death were considered (e.g necrotizing entercolitis)[1].

Cause specific analyses have contributed much to the investigation of infant mortality (Dollfus et al 1990; Song and Frisbie 2007; Sowards et al 1997). Cause specific analyses are useful because they allow for the consideration of the etiology of causes and how factors associated with certain etiologies change over time. This is an important consideration because the advances that have occurred over time have changed the nature of factors associated with risk of infant death. Frisbie et al (2004) for example, determined that in the pre-surfactant era, black infants had a survival advantage at the lowest birth weights, which was lost when surfactant therapy became widely available to preterm infants.

While it is possible to determine much from cause-specific frameworks, their use in infant mortality research is often restricted to large, national level datasets containing aggregated data from several cohorts in order to achieve statistical significance. Additionally, it can sometimes be problematic to examine cause-specific infant mortality over periods spanning

[1] Necrotizing entercolitis (NEC) is an infection that occurs in premature infants, where parts of the bowel undergo necrosis, or tissue death due to the infant's inability to metabolize food that they consume. The infection that occurs in the gastic and digestive systems is a medical condition primarily seen in premature infants.

different versions of the International Classification of Disease (which is what is used to categorize death as due to one cause or another). While there are protocols for converting etiologically similar causes across versions of the ICD (i.e. Anderson et al 2001), it is especially problematic when new causes of death emerge, such as the case of SIDS, which did not exist as an official cause before the ICD 8.

While age at death lacks some of the theoretical specificity that is possible with cause-specific frameworks, it is not without important theoretical contributions to the study of infant mortality. The etiologies of certain causes of death specify levels of risk that are associated with age. For example, deaths due to prematurity related conditions are rarely associated with infant death in infants older than 28 days, where SIDS and external causes of death (such as homicide and drowning) are generally not associated with age at death less than 7 days.

The improvements in health and survival for infants born during the period 1980-2000 altered the age distribution of infant deaths by altering the levels of risk of specific causes of death. There is reason to believe that the nature of risk associated "perinatal infant mortality" in 1980 is different than that for infants dying during the perinatal period in 2000. This is in large part due to changes in risk of specific causes of death, which would in turn change the distribution of age at death. This is evident in the increased concentration of deaths in the "early" part of the perinatal period (during the first 24 hours) in 2000 compared to 1980. Since a majority of deaths in the early perinatal period are due to maternal obstetric conditions and prematurity related conditions, both of which are strongly associated with gestational age, it would seem reasonable that improvements in prenatal care and health care that occurred in Florida during 1980-2000 may have altered the distribution of age at death for infants' mortality[2].

What remains unclear is whether there is continuity in the traditional approach to age classification that can withstand the massive change in social and medical contexts that occurred during the period 1980-2000. Improvements in access to prenatal care, advancements in medical

[2] It is possible that that this occurred by allowing women to prolong their pregnancies long enough to deliver babies that would go on to die in the early prenatal period, as opposed to experiencing fetal loss, which would not be captured in the linked birth and death files. This would result in a greater number of infants being born in 2000 with profiles of risk that in 1980 might have resulted in their being categorized as a fetal death.

technologies such as surfactant therapy (for respiratory distress syndrome), as well as more aggressive public health and awareness campaigns (such as the Back to Sleep Initiative) occurred in the latter part of the twentieth century. I am suggesting that the changes in the social and medical context have improved infant health absolutely, but have contributed simultaneously to increasing racial disparities in infant death. The overall declines in infant death were driven largely by declines in neonatal and post-neonatal deaths. This led to an overall overall shift to younger ages for most causes of death, which merits a reconsideration of the traditional age at death scheme. There is evidence that may support a modification to the conventional age of death classification. This adjustment will more adequately capture the shifts that have happened in infant and maternal health that contribute to continued racially based differences in infant mortality.

The modification under consideration is simply parsing out the deaths in the perinatal period to those that occur in the first 24 hours following birth ("early" perinatal deaths) and those occurring 1-7 days after birth ("late" perinatal deaths). Neonatal deaths (0-27 days after birth) have traditionally been those during the first 27 days of life. For our purposes here, neonatal deaths 8-27 days after birth will be considered "late" neonatal deaths, while post-neonatal deaths (28 days and older) will remain the same. Following a brief explanation of the justification for the modified age at death scheme, the racial disparity in infant mortality in Florida will be investigated to determine how social and demographic risk factors are associated with racial differences in age-specific mortality, according to the modified age scheme.

DATA

The data used to investigate the changing distribution of age at death come from the Florida Department of Health's Bureau of Vital Registration. The 1980 birth cohort was matched with subsequent infant death records to produce a linked birth/death file. Death records were matched on a variety of criteria to birth records (such as name of child, mother's name, race, maternal age, county of birth, date of birth). Since the 2000 birth cohort was available as a linked birth/death datasets directly from the Florida Department of Health, no further matching was necessary. Records with incomplete information for marital status, maternal race, prenatal care, maternal education and nativity status were excluded from the analyses, as were multiple births and those records with incomplete death data. Additionally, since the analytical interest

lies in the black-white racial disparity in infant mortality, only infant birth records where the child's race was recorded as either "white" or "African-American" were included. Asian and "other" births were excluded from the analyses. Despite its theoretical and policy importance for infant health, ethnicity was also ignored to focus only on the racial disparity in infant death in Florida. Also, because multiple gestation births are strongly associated with poor infant health outcomes (such as low birth weight, short gestation and infant death), multiple births were excluded from the analyses.

In 1980, there were 118,143 singleton births in Florida, (after excluding births on the basis of details above) of which 24.8% occurred to black women, with the remaining 75.2% to white women. Of the 1,330 infant deaths that occurred to this cohort, 62.9% were to white infants, with the remaining 37.1% being to black infants (See Table 1 below). The cohort infant mortality rate was 16.79 deaths per thousand births for blacks and 9.41 deaths per thousand for white infants.

Table 1: Race percentages of births and deaths in 1980 and 2000

	1980 % of births	1980 % of deaths	1980 IMR
African American	24.80%	37.10%	16.79/1,000 births
White	75.25	62.90%	9.41/1,000 births
	2000 % of births	**2000 % of deaths**	**2000 IMR**
African American	25.10%	42.40%	10.9/1,000 births
White	74.90%	57.60%	4.51/1,000 births

Of particular note is that while births in Florida increased by over 70,000 during the period 1980 to 2000, the proportions of black and white births remain somewhat constant, where almost three-fourths of the births were to white women. Of the 191,614 infants born to the 2000 cohort, 1,178 did not survive to their first birthdays, which produced an overall infant mortality rate of 6.14 deaths per thousand births. While white women gave birth to about three-fourths of the cohort, they accounted for about 57.6% of the cohort's infant deaths, which is less than the proportion that died in the 1980 birth cohort. The percentage of black infant deaths to this cohort increased to 42.4% (despite only accounting for about 25% of the births in 2000). The white

infant mortality rate declined markedly to about 4.51 deaths per thousand births, while the rate for blacks declined to 10.9 deaths per thousand births.

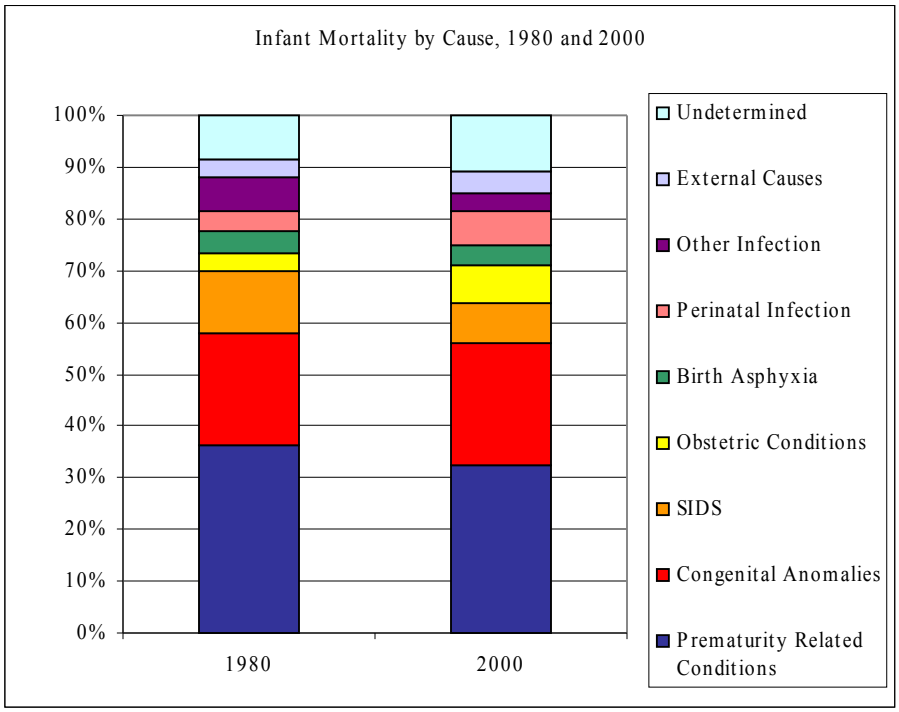
METHODS

Multinomial logistic analyses will be used to estimate racial differences in infant mortality through a series of models using a modified standard age classification, where deaths during the first 24 hours are considered "early perinatal" deaths. The deaths that are most likely to have been affected by the changes in the health care system and therapeutic care are those that occur early during the perinatal period (during the first 24 hours) and less likely to occur after 27 days old. By disaggregating infant perinatal mortality into "early" and "late" (1-7 days after birth) classifications, I aim to show that the profiles of risk of infant death have changed in the period 1980-2000.

THE CASE FOR A MODIFICATION TO AGE AT DEATH

During 1980-2000, there were dramatic changes in cause-specific infant mortality in Florida. Deaths due to "other infection" and SIDS decreased overall from 1980-2000, while those due to perinatal infection increased (see Figure 1 below). Deaths due to maternal obstetric conditions increased proportionately during the period. As expected, infants dying of SIDS deaths declined dramatically from 1980-2000. There were marginal changes in deaths due to congenital anomalies and prematurity related conditions, the former increasing slightly and the latter decreasing slightly.

Figure 1: Infant Mortality by Cause, 1980 and 2000



The age distribution for perinatal mortality shifted towards younger ages at death during the period 1980-2000. In 1980, 51.2% of infant deaths occurred in the perinatal period (aged 0-7 days) and 37.22% of all infant mortality was to infants in the post-neonatal period (see Table 2 below). By 2000, 54.35% of infant deaths occurred during the perinatal period, and 31.35% in the post-neonatal period. A substantial proportion of this shift has been driven by increases in early perinatal mortality (death during the first 24 hours following birth).

In 1980, 63.7% (n=434) of the deaths during the perinatal period were to infants less than 24 hours old. This increased dramatically in 2000, such that almost 79.3% of the deaths (n=456) during the perinatal period were to infants less than 24 hours old. The increase in "early" perinatal deaths combined with the decrease in post-neonatal deaths suggests that the age distribution of infant mortality in Florida is shifting towards younger ages.

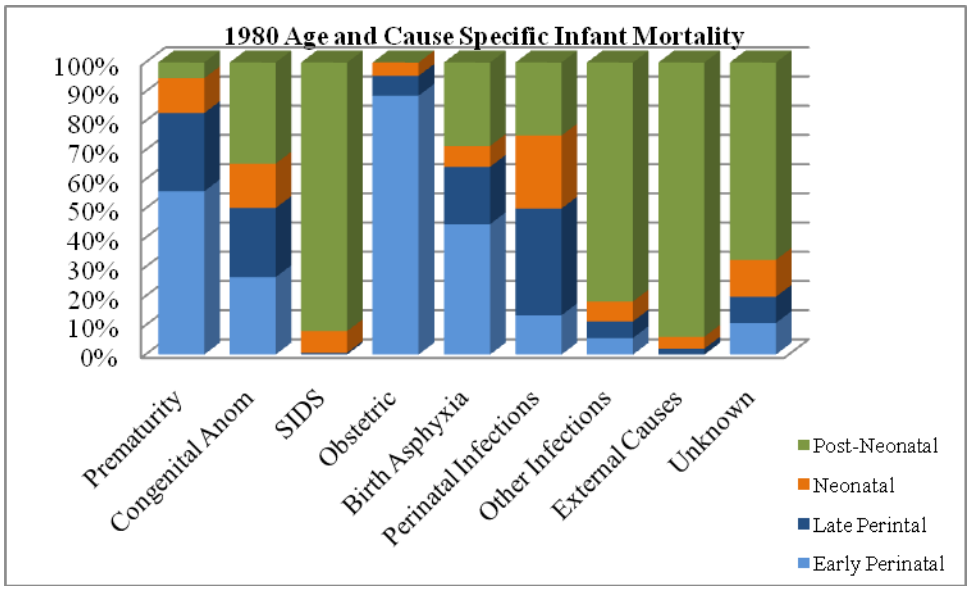
Table 2: Age at death in 1980 and 2000

1980	**n**	**% of total**	
perinatal	681	51.20%	*"early" deaths=434 or 63.7% of perinatal deaths
late neonatal	154	11.58%	
post neonatal	495	37.22%	
total deaths	1330	100.00%	

total births	118143		
2000	**n**	**% of total**	
perinatal	575	54.30%	*"early" deaths=456 or 79.3% of perinatal deaths
late neonatal	151	14.26%	
post neonatal	332	31.35%	
total deaths	1058	100.00%	
total births	191614		

Given the nature of the improvements in infant mortality that have occurred during this period, it would be reasonable to expect that "early perinatal" mortality would comprise substantially larger proportions of some causes of death than others[3]. An examination of the modified age classifications in the graphs (see Figures 2 and 3 below) illustrate that for some causes of death[4], that a large proportion of perinatal deaths occur during the first 24 hours of life. The figures presented below illustrate cause-specific infant mortality in 1980 and 2000 and the proportions of each cause that is due to early perinatal infant death.

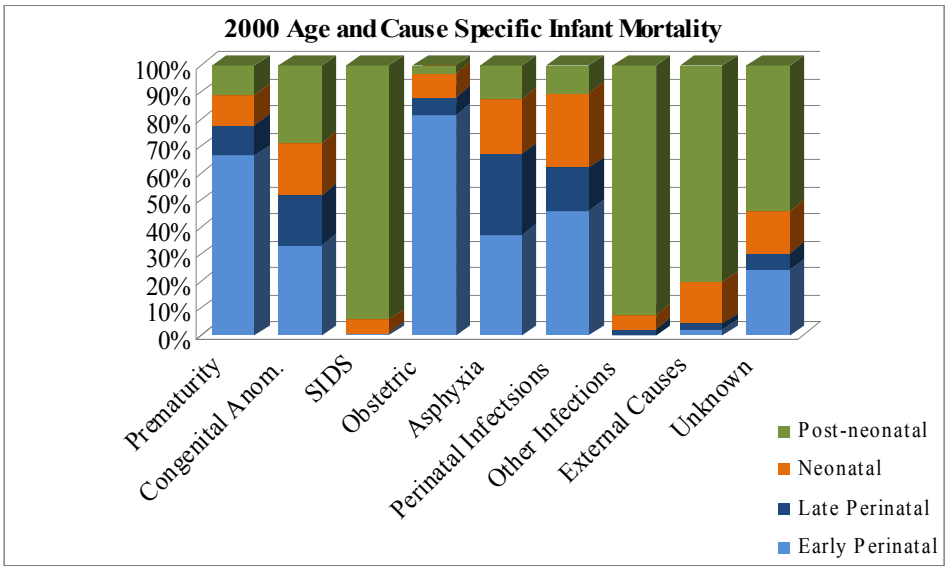
Figure 2: Cause of death by age, 1980



[3] The improvements referred to include surfactant therapy for respiratory distress syndrome (a cause of death strongly associated with preterm birth). Other improvements related to improved fetal and infant health include risk assessment, such as the use of salivary estriol and endovaginal ultrasounds, both of which determine the risk for preterm labor.

[4] Sowards' 1997 modification of the Dollfus et al (1990) cause of death classification is employed here.

Figure 3: Cause of death by age, 2000



Overall, most deaths in 1980 and 2000 were due to prematurity related conditions, obstetric conditions and birth asphyxia occurred in the perintal period (with the majority being in the first 24 hours), whereas deaths from SIDS, other infections and external causes tended to occur after the perinatal period.

Of the infants born in 1980 who would die of prematurity related conditions, obstetric conditions and birth asphyxia 82.6%, 95.4% and 64.2%, respectively did so during the perinatal period. However, the majority of these deaths occurred in the first 24 hours following birth, such that for the 1980 cohort 67.6%, 69.4% and 92.8% of perintal mortality was actually "early" perinatal mortlaity.

Among infants born in 2000, the percentage of deaths due to prematurity related conditions which occurred in the perinatal period declined to 78.1%, 85.4% of which occurred in the first 24 hours after birth (see table 3 below). Of these infants who would die of obstetric conditions 88.3% did so in the perinatal period, 92.6% of which did so during the first 24 hours of life. Of the infants in the 2000 cohort that died of birth asphyxia, 67.5% did so within the perinatal period, mostly within the first 24 hours of life (55.5%).

Table 3: Cause of death and perinatal mortality

	1980		2000	
	% of total infant mortality during perinatal period	% of perinatal mortality during first 24 hours	% of total infant mortality during perinatal period	% of perinatal mortality during first 24 hours
Prematurity Conditions	82.6%	67.6%	78.1%	85.4%
Congenital Anomalies	50.1%	52.8%	52.2%	64.6%
SIDS	0.6%	0.0%	1.2%	100.0%
Obstetric Conditions	95.4%	82.8%	88.3%	92.6%
Birth Aspyxia	64.2%	69.4%	67.5%	55.5%
Perinatal Infection	50.0%	26.9%	63.3%	74.4%
Other Infection	11.4%	50.0%	2.6%	0.0%
External Causes	2.0%	0.0%	4.4%	50.0%
Undetermined	19.8%	54.5%	30.7%	80.0%

Deaths during the perinatal period increased between 1980 and 2000 for other causes of death including congenital anomalies (increased from 50.1% to 52.2%), SIDS (increased from 0.6% to 1.2%), perinatal infections (increased from 50% to 63.3%) and external causes (increased from 2.0% to 4.4%). Among these causes of death, the proportion occurring in the first 24 hours decreased only for birth asphyxia (which declined from 69.4% to 55.5%). In fact, for births in 2000, the proportion of perinatal deaths occurring during the first 24 hours following birth increased for all causes of death except for birth asphyxia.

Overall, the percentage of infants dying in the perinatal period declined for three causes of death: prematurity related conditions, obstetric conditions and other infections. For all other causes, the percentage of infants dying in the perinatal period increased. Interestingly, for all causes of death except for birth asphyxia, the percentage of perinatal deaths dying in the first 24 hours increased from 1980 to 2000.

In general, what is apparent is that for all but three causes of death (prematurity related conditions, obstetric conditions, and non-perinatal infections), the age at death has shifted to younger ages. For prematurity related conditions, obstetric conditions and "other" infections, the age at death has shifted towards older ages. What this seems to suggest is that the improvements that occurred in the medical and therapeutic treatment options for infants have altered infant mortality in two ways: by decreasing perinatal mortality overall for most causes of death, and by increasing early perinatal mortality for all but one cause of death.

MULTIVARIATE FINDINGS

The Traditional Classification of Age at Death

The multinomial logistic model using the traditional age at death categorization is presented below in Table (4). In 1980, black infants had 57% highrodds of death during the perinatal period than white infants. This was slightly larger than the racial disparity during the late neonatal period, which was 1.42, indicating that the odds of death for black infants 1-7 days after death was about 42% higher than for whites. This increases dramatically during the post-neonatal period where black infants have well over twice the risk of death as whites.

When social demographic controls are added to the model, much of the excess risk for blacks is eliminated. The disparity for late neonatal mortality reduces to insignificance. During the perinatal period, the disparity reduces such that black infants have only 29% greater odds of dying during that period compared to whites. The excess risk for blacks remains substantial in the post-neonatal period, such that they are about twice as likely to die at that age as whites. The addition of gestational age in the full Model for 1980 eliminates racial disparity in infant death at the youngest ages (perinatal and late neonatal mortality). The racial differences in post-neonatal mortality are attenuated even more, reducing to 67% greater odds of death for blacks than for whites.

The racial disparity in 2000 is larger at all three ages of death, which may provide evidence for an increasing racial disparity in infant death. The addition of sociodemographic controls in Model 2 reduces the racial disparity dramatically in the late neonatal and post-neonatal periods, and to a lesser extent for deaths in the perinatal period. With these controls, the excess risk for black infant death during the perinatal period is 2.35, meaning that even after controlling for social and demographic risk factors; black infants have over twice the risk of infant death in this period as whites do. The black excess mortality in the late neonatal period reduces to about 50%, where white infants have about half the risk of death during this period as black infants. Black infants have about 1.68 times the risk of death as whites in post-neonatal period.

Table 4: Multinomial logistic regressions, traditional age classification

1980 Florida Birth Cohort		Model 1			Model 2			Model 3	
Variable	Perinatal	Late Neonatal	Post Neonatal	Perinatal	Late Neonatal	Post Neonatal	Perinatal	Late Neonatal	Post Neonatal
Racial Group									
(White)									
Black	1.57 ***	1.42 *	2.28 ***	1.29 **	1.25	1.96 ***	1.06	0.99	1.67 ***
Socioeconomic Status									
Maternal Education				0.94 ***	0.99	0.94 **	0.94 ***	1.00	0.95 *
Age									
Maternal age				0.99	0.97	0.99	1.01 *	0.98	0.99
Maternal Nativity Status									
(US born)									
Foreign born				0.99	0.90	0.83	1.04	0.91	0.83
Maternal Marital Status									
(Married)									
Not Married				1.25 *	1.09	1.15	0.74 *	0.79	1.01
Prenatal Care									
(Adequate)									
Inadequate				1.52 ***	1.57 **	1.24 *	1.14	1.36	1.19
Intermediate				1.02	1.38	1.07	1.24 *	1.62 *	1.20
Adequate Plus				1.79 ***	1.99 **	1.56 ***	0.56 ***	0.96	1.06
Parity									
Parity				0.98	1.01	1.01	0.90 *	1.00	1.01
Length of Gestation									
Gestational age in weeks							0.75 ***	0.79 ***	0.85 ***
2000 Florida Birth Cohort		Model 1			Model 2			Model 3	
Variable	Perinatal	Late Neonatal	Post Neonatal	Perinatal	Late Neonatal	Post Neonatal	Perinatal	Late Neonatal	Post Neonatal
Racial Group									
(White)									
Black	2.59 ***	1.73 ***	2.31 ***	2.35 ***	1.48 *	1.68 ***	1.11	1.00	1.34 **
Socioeconomic Status									
Maternal Education				0.92 ***	0.88 ***	0.91 ***	0.97	0.89 ***	0.92 **
Age									
Maternal age				1.01 *	1.00	0.96 ***	1.00	1.00	0.96 ***
Maternal Nativity Status									
(US born)									
Foreign born				0.96	1.03	0.52 ***	0.91	1.04	0.53 ***
Maternal Marital Status									
(Married)									
Not Married				1.30 *	1.17	1.18	0.92	1.00	1.11
Prenatal Care									
(Adequate)									
Inadequate				1.82 ***	1.14	1.31 *	1.12	0.93	1.15
Intermediate				0.83	0.90	0.89	0.95	1.12	1.03
Adequate Plus				3.27 ***	2.03 ***	1.99 ***	1.11	0.94	1.19
Parity									
Parity				0.88 **	1.09	1.26 ***	0.72 ***	1.11	1.26 ***
Length of Gestation									
Gestational age in weeks								0.72 ***	0.77 ***

Note: Variables in parentheses are reference groups
*Note: Levels of Significance: *p≤.05; **p≤.01; ***p≤.001*
Note: Some births were excluded from analyses: these were multiple births and those missing information on infant and maternal characteristics.
Source: Florida Department of Health Bureau of Vital Statistics

The addition of gestational age in the full model (Model 3) for the traditional age classification eliminates much of the remaining racial differences in infant death in the perinatal and late neonatal period for the 2000 birth cohort. The racial differences in perinatal and late neonatal mortality virtually disappear. Additionally, the remaining racial difference in post-neonatal mortality reduces further, such that black infants have about 34% greater odds of death at that age than white infants do.

The Modified Classification of the Age at Death

In 1980, the racial disparity in infant death was greatest in the early perinatal and post-neonatal periods. In the reduced model, black infants have 62% greater odds of infant death than white infants (see Table 5 below). The excess risk for black infants is similar for deaths in the late perinatal period and late neonatal period (relative risk ratios 1.48 and 1.42, respectively).

The addition of socio-demographic controls in Model 2 reduces the excess risk for black infants at all ages of death. In Model 2, the racial difference between black and white infants is reduced to non-significance for deaths in the late-perinatal and neonatal period. The inclusion of socio-demographic controls in this model causes the remaining racial disparity in early perinatal death and post-neonatal death to reduce, but the race differences remain significant. In this model, black infants have 37% greater odds of death in the perinatal period, and 96% greater odds of death in the post-neonatal period than white infants.

The addition of gestational age in Model 3 reduces the disparity further, such that the racial differences in early and late perinatal death, as well as late neonatal death disappear altogether. Interestingly, the excess mortality risk for black infants during the post-neonatal period is reduced somewhat by the addition of gestational age to the model. The result is that the racial difference in post-neonatal mortality between black and white infants decreases to 1.67, suggesting that after the addition of controls for social and demographic risk factors, that black infants have about 67% greater odds of death at age 28 days and older.

Table 5: Multinomial logistic regressions, modified age classification

1980 Florida Birth Cohort	Model 1				Model 2				Model 3			
Variable	Early Perinatal	Late Perinatal	Late Neonatal	Post Neonatal	Early Perinatal	Late Perinatal	Late Neonatal	Post Neonatal	Early Perinatal	Late Perinatal	Late Neonatal	Post Neonatal
Racial Group												
(White)												
Black	1.62 ***	1.48 **	1.42 *	2.28 ***	1.37 **	1.16	1.25	1.96 ***	1.15	0.94	0.99	1.67 ***
Socioeconomic Status												
Maternal Education					0.94 **	0.93 **	0.99	0.94 **	0.93 **	0.94	1.00	0.95 *
Age												
Maternal age					1.00	0.98	0.97	0.99	1.03 **	1.00	0.98	0.99
Maternal Nativity Status												
(US born)												
Foreign born					0.83	1.27	0.90	0.83	0.89	1.30	0.91	0.83
Maternal Marital Status												
(Married)												
Not Married					1.24	1.28	1.09	1.15	0.66 **	0.89	0.79	1.01
Prenatal Care												
(Adequate)												
Inadequate					0.48 ***	1.58 **	1.57 **	1.24 *	1.04	1.31	1.36	1.19
Intermediate					0.99	1.07	1.38	1.07	1.21	1.28	1.62 *	1.20
Adequate Plus					2.01 ***	1.41	1.99 **	1.56 ***	0.53 ***	0.60 *	0.96	1.06
Parity												
Parity					0.97	1.00	1.01	1.01	0.86 **	0.96	1.00	1.01
Length of Gestation												
Gestational age in weeks									0.74 ***	0.78 ***	0.79 ***	0.85 ***
2000 Florida Birth Cohort	Model 1				Model 2				Model 3			
Variable	Early Perinatal	Late Perinatal	Late Neonatal	Post Neonatal	Early Perinatal	Late Perinatal	Late Neonatal	Post Neonatal	Early Perinatal	Late Perinatal	Late Neonatal	Post Neonatal
Racial Group												
(White)												
Black	2.83 ***	1.84 ***	1.73 ***	2.31 ***	2.58 ***	1.69 **	1.48 *	1.68 ***	1.15	1.00	1.00	1.34 **
Socioeconomic Status												
Maternal Education					0.93 **	0.90 **	0.88 ***	0.91 ***	0.99	0.92	0.89 ***	0.92 **
Age												
Maternal age					1.02 *	1.00	1.00	0.96 ***	1.00	0.99	1.00	0.96 ***
Maternal Nativity Status												
(US born)												
Foreign born					0.94	1.02	1.03	0.52 ***	0.86	1.00	1.04	0.53 ***
Maternal Marital Status												
(Married)												
Not Married					1.41 **	1.00	1.17	1.18	0.98	0.80	1.00	1.11
Prenatal Care												
(Adequate)												
Inadequate					1.81 ***	1.86 **	1.14	1.31 *	1.03	1.41	0.93	1.15
Intermediate					0.81	0.87	0.90	0.89	1.21	1.18	1.12	1.03
Adequate Plus					3.40 ***	2.85 ***	2.03 ***	1.99 ***	0.81	1.14	0.94	1.19
Parity												
Parity					0.84 ***	0.99	1.09	1.26 ***	0.97	1.04	1.11	1.26 ***
Length of Gestation												
Gestational age in weeks									0.61 ***	0.69 ***	0.72 ***	0.77 ***

Note: Variables in parentheses are reference groups
*Note: Levels of Significance: *p≤.05; **p≤.01; ***p≤.001*
Note: Some births were excluded from analyses: these were multiple births and those missing information on infant and maternal characteristics.
Source: Florida Department of Health Bureau of Vital Statistics

In 2000, the racial disparity between black and white infants is largest in the early perinatal period, where black infants have almost three times the risk of death as white infants. The racial difference in post-neonatal deaths is somewhat smaller, where black infants have 2.3 times the odds of death as whites. The elevated risk of late perinatal and late neonatal death for black infants is substantial; they have 84% and 73% higher odds of death, respectively.

The addition of sociodemographic controls in Model 2 reduces the racial differentials, but does not eliminate them at any age. The greatest reduction in the racial disparity occurred in the post-neonatal period. However, even with these controls the largest racial difference in infant mortality occurred in the early perinatal period, where black infants have over two and half times

greater risk of death than white infants. The inclusion of gestational age in the full model ameliorates racial differences between blacks and whites in the early perinatal, late perinatal and late neonatal periods. Gestational age also reduces black excess mortality in the post-neonatal period, but does not cause it to disappear.

The effect of gestational age on the racial differences in infant mortality by age is stronger in 2000 than it is in 1980. Further, the effects of social demographic indicators included in these analyses are stronger in 1980 than they are in 2000. Additionally, the greatest differences in the racial disparity in infant mortality shifted from the oldest ages in 1980 to the youngest ages in 2000. What this seems to suggest is a declining importance in socio-demographic risk factors and an increasing importance of the pregnancy process for infant mortality in as much as it influences the risk of preterm birth.

The modified age standard allows for a more detailed examination of age at infant death. In disaggregating deaths at the youngest ages from those that at older ages, it is possible to see improvements in infant death which were not apparent with the standard age classification. What these improvements attest to, is that the programs and measures that have been undertaken to improve the social and demographic risk factors associated with racial differences in infant death have worked, because over time, they have become less important for infant health and survival. These social and demographic risk factors have been replaced by factors that influence the medical and physiological aspects of the pregnancy process.

DISCUSSION

The racial disparity in the 1980 birth cohort was largest for the oldest age group, where the causes of infant deaths have historically been considered “external”, or outside the influence of the pregnancy process. In 2000, the racial disparity between black and white infants was largest during the first 24 hours following birth (in the early perinatal period). The addition of social and demographic variables ameliorates much of the racial differences in infant death in 1980, but fails to do so in 2000. Further the reductions in the racial disparity that occur when gestational age is added to the model in 1980 are much less than the reductions that occur with its addition in 2000. The remaining significant racial difference (in post-neonatal mortality) is larger in 1980 than it was in 2000.

What this seems to highlight is the declining importance of social and demographic variables for infant mortality in Florida. This may also underscore the importance of conditions related to the pregnancy process. Additionally, the declining proportion of deaths outside the perinatal period has meant that deaths in the perinatal period are increasing proportionately and that the overall risk of death in the perinatal period has increased from 1980 to 2000. For the analyses presented here, this is an important distinction. Since the deaths during the perinatal period are those most strongly related to pregnancy related conditions, the increasing racial disparity in that period may provide evidence for the increasing importance of the pregnancy process for differential infant health for black and white infants in Florida.

One of the most intriguing findings reported here, is that with the addition of social and demographic controls in Model 2 of the Modified Classification, causes the racial disparity to decrease at all ages in 1980 (and even disappear in late perinatal and late neonatal mortality) but does not in 2000, where the racial disparity remains substantial and significant. What this may suggest is increasing heterogeneity in the risk factors associated with infant death. The findings presented here seem to suggest the influence of socio-demographic controls was stronger on racial differences in infant mortality in 1980 than it was in 2000. Additionally, these findings may also support that the influence of factors associated with pregnancy became more important for racial differences in 2000 than they were in 1980.

This seems plausible, given the increasing importance of gestational age in 2000, compared to 1980. Initially, this might seem to underscore the importance of helping women carry their pregnancies to full term, but some research has suggested that the route to continued improvements in infant health outcomes lie with preconception health. Improving the health of women before they become pregnant holds the promise to improve infant health outcomes by assisting women in carrying their pregnancies to term (Atrash 2006).

While the demonstrated shift in age at death to younger ages (towards ages that are more strongly associated with gestational age), is considered evidence for the growing importance of gestational age and the pregnancy process in infant health, it is possible this shift is simply the result of an evolving medical context and that continued racial differences are simply the result of differential improvements for blacks and whites. This alternative explanation may be incomplete, because it does not address preconception health. In fact, this idea of "differential" improvement assumes that black and white women have comparable levels of health prior to conception and that continued racial differences are the result of slower improvement among blacks than among whites. Disaggregating "early" deaths in perinatal mortality has illustrated that factors affecting the pregnancy process are growing in importance compared to those that are associated with older age infant mortality. Therefore, factors that influence the pregnancy process (such as preconception health) will continue to be important as deaths at the oldest ages continue to fall rapidly.

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