against rural girls.

Perhaps the practice of family planning in rural China is not quite as "overriding," coercive, or successful as commonly held. However, the long-term consequences of a large and growing population of unregistered, uneducated females with unattended health problems will no doubt prove counterproductive to population objectives. □

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Infant Mortality Differences between Whites and African Americans: The Effect of Maternal Education

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ABSTRACT

Objectives. Despite decreasing infant mortality in North Carolina, the gap between African Americans and Whites persists. This study examined how racial differences in infant mortality vary by maternal education.

Methods. Data came from Linked Birth and Infant Death files for 1988 through 1993. Multiple logistic regression models adjusted for confounders.

Results. Infant mortality risk ratios comparing African Americans and Whites increased with higher levels of maternal education. Education beyond high school reduced risk of infant mortality by 20% among Whites but had little effect among African Americans.

Conclusions. Higher education magnifies racial differences in infant mortality on a multiplicative scale. Possible reasons include greater stress, fewer economic resources, and poorer quality of prenatal care among African Americans. (*Am J Public Health.* 1998;88:651–656)

Introduction

Infant mortality is on a steady decline both in the United States as a whole and in North Carolina[2–4] (see Figure 1). Nevertheless, in 1992 North Carolina had the seventh highest rate of infant mortality in the United States.[5,6] Moreover, 22 industrialized nations had lower infant mortality rates than the United States in 1988, compared with 11 in 1960.[1,7]

Disparities in infant survival across ethnic groups, educational levels, and health care settings have persisted.[1–10] The disparity in infant death rates between African Americans and Whites has hovered at about twofold since 1950 (see Figure 1).[5–9] Recent reports of national data showed an increasing gap in infant mortality between African-American and White babies with increasing maternal educational attainment.[9] However, this analysis did not control for potential confounders.

We therefore examined the joint effect of maternal race and education on infant mortality in North Carolina, adjusting for factors such as maternal age, smoking, parity, prenatal care, gestational age, and residence.

Methods

The North Carolina Linked Birth and Infant Death File, containing births in years 1988 through 1993 and all infant deaths from this cohort, was obtained. We compared mothers who reported their race as Black (hereafter designated "African Americans") with those who reported their race as White. Foreign-born mothers, who represented 3.3% of the study population, were assigned to the appropriate racial group. The 2.6% of the cohort who were neither African-American nor White were excluded, leaving 595 645 births. Infant death in the first year was the outcome.

Because African Americans have shorter gestations and lower-birthweight babies than Whites, and because these factors are strong determinants of infant mortality, many researchers adjust for length of gestation or birthweight. Given that birthweight is largely a function of gestational age at birth, the latter was used. On the other hand, preterm delivery or low birthweight could be on the causal pathway, in which case adjustment introduces bias.[11] We present results with and without adjustment for gestational age.

In our study, gestational age (derived by subtracting the date of the mother's last normal menstrual period from the delivery date) was missing for 19% (n = 113 094) of

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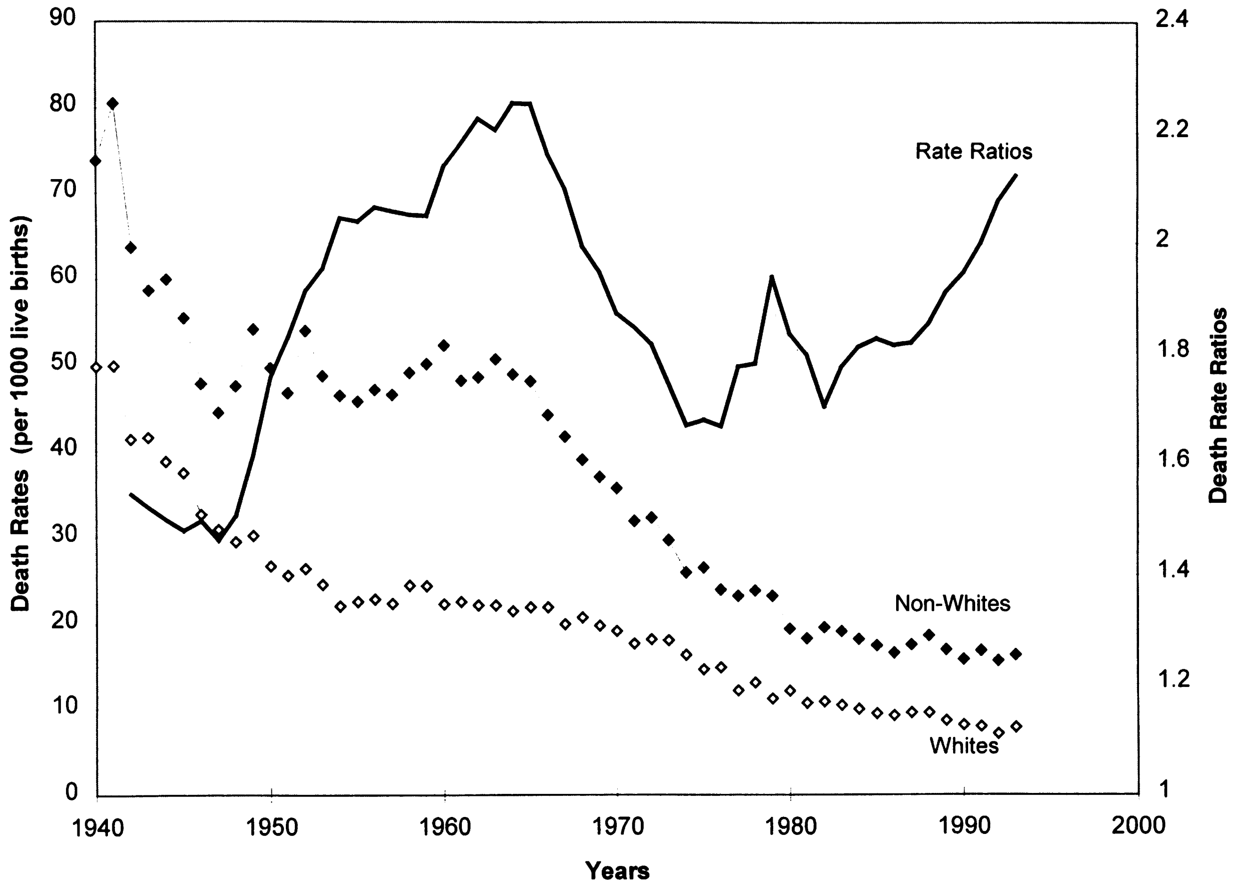

Note. Death rate ratios: smoothed curve based on 3-year moving average (period: 3-point average). 1940 through 1965 data source: *Annual Report of Public Health Statistics Section, North Carolina Vital Statistics.*[2] 1966 through 1985 data source: North Carolina Department of Human Resources, *North Carolina Vital Statistics.*[3] 1986 through 1993 data source: North Carolina Department of Environment, Health, and Natural Resources, *North Carolina Vital Statistics.*[4]

FIGURE 1—Trends for infant death rates, by race and relative risk for infant death, comparing non-Whites and Whites: North Carolina, 1940–1993.

the births. Since most of these had a plausible month and year but were missing only the day of the last menstrual period, we imputed that day, using a hot deck method[1] with stratification on maternal race, infant's sex, birthweight in 100-g intervals, death status, and gestational length in months. The procedure produced a match for all but 238 records (99.8% of observations) for which only the day was missing. Overall coverage was 96%; unusable observations had indeterminate dates for last menstrual period (missing month or year) or dates that yielded implausibly long or short gestations. The final sample included 569 960 births, 169 601 African-American and 400 359 White, with 2588 and 3031 deaths, respectively.

Adjustment for race-specific percentiles of gestational age was carried out as described elsewhere.[13] This approach provides a public health basis for assessing equity in health by comparing African Americans born at, for example, the 5th percentile of gestational age among African-American neonates with Whites born at the 5th percentile of gestational age among White neonates, regardless of the actual length of gestational age. To fit the nonlinear curve for infant mortality, linear splines with a knot at the 6.5th percentile were applied to gestational age.[14–16]

Education was categorized as indicator variables: fewer than 12, 12, and more than 12 years. Maternal age described a roughly J-shaped curve in relation to infant death. Therefore we applied a linear spline transformation with 2 knots, at 17 and 30 years. Nulliparous women as well as those with 3 or more previous live births were compared with mothers of parity 1 or 2. Kotelchuk's 4-level indices for both initiation and utilization of prenatal care were used: inadequate, intermediate, adequate, and adequate plus.[17] For prenatal care initiation, these categories corresponded to beginning care at month 7 or later, month 5 or 6, month 3 or 4, and month 1 or 2, respectively. For prenatal care utilization, these categories corresponded to use of less than 50%, 50% to 79%, 80% to 109%, and 110% or more of recommended prenatal services, respectively. Comparisons were made between rural and urban residence at birth, between smokers and nonsmokers, and between unmarried and married mothers. Because of the low quality of self-reports of drinking during pregnancy and the bias that ensues from adjustment for a confounder that has been measured with error, this variable was not used.[18]

Stratification and bivariate analyses were used to identify important predictors of infant death. Multiple logistic regression models adjusted for potential confounders. Analyses were conducted on the whole population and on each racial group separately. Marital status, prenatal care initiation, and nulliparity were neither independent predictors nor confounders nor effect modifiers of the main associations of interest and were excluded from final models.

Results

Findings on the imputed data set were similar to those on the smaller data set of complete observations only. Therefore we present the former.

The study population is described in Table 1. Twice as many African-American infants as Whites died before their first birthday. African-American mothers were younger, less educated, less likely to smoke, of higher parity, and more likely to be unmarried than Whites. They also initiated prenatal care later and delivered earlier, on average, than Whites.

African Americans were at higher risk for infant mortality at every level of education (Table 2), and the disparity on a multiplicative scale increased as educational achievement increased. Adjustment for covariates did not noticeably change the relative risk estimates.

In both races, achieving 12 years of education reduced risk by more than 10% (Table 3). Further education reduced risk only in Whites (by 20%) but conferred no advantage in African Americans. An increased risk with maternal age was stronger in Whites; so was high parity. African-American babies born in rural settings had lower infant death rates. Adjustment for maternal risk factors, congenital anomalies, and complications of labor and/or delivery, which were unevenly distributed across racial and educational groups, did not change the relative risk for race-by-education groups (data not shown).

TABLE 1–Risk Factors for Infant Mortality among African Americans and Whites: North Carolina Birth and Infant Death Linked File, 1988 through 1993

	African Americans[a] (n = 169 601)	Whites[a] (n = 400 359)
No. deaths per 1000 live births	15.3	7.6
Demographic variables		
Maternal age, y, mean ± SD	24.0 ± 5.7	26.3 ± 5.6
Education, %		
<12y	28.6	19.2
12y	46.4	37.3
>12y	24.9	43.3
Missing	0.1	0.1
Parity, %		
0	40.2	46.7
1–2	48.5	48.1
3+	11.2	5.1
Missing	0.1	0.1
Marital status, %		
Unmarried[b]	64.3	14.4
Married	35.7	85.6
Residence, %		
Rural[c]	66.8	82.3
Urban	33.2	17.7
Medical and lifestyle factors		
Smoking, %		
Yes	15.8	21.2
No	83.5	77.9
Missing	0.7	0.9
PNC utilization, %[d]		
<50	6.2	1.8
50–79	12.7	8.7
80–109	35.3	46.0
≥110	45.1	43.2
Missing	0.7	0.3
PNC initiation, %		
Month 7+	8.6	2.7
Month 5–6	15.0	5.6
Month 3–4	34.1	24.9
Month 1–2	41.6	66.6
Missing	0.7	0.3
Gestational age, d, mean ± SD	270.7 ± 25.6	277.8 ± 18.2
Gestational age, wk, mean ± SD	38.3 ± 3.5	39.2 ± 2.5
Birthweight, g, mean ± SD	3115.1 ± 646.4	3395.8 ± 595.5

Note. PNC = prenatal care.
[a]All factors significantly ($P < .05$) associated with maternal race.
[b]Unmarried category includes single, unwed, separated, widowed.
[c]Rural is defined as nonincorporated areas or municipalities with 50 000 or fewer inhabitants.
[d]Utilization is defined as percentage of recommended services received.

Discussion

Our study revealed, first, that relative risk for infant mortality among African Americans compared with Whites increases as mothers' educational achievement increases, and second, that postsecondary education does not appear to reduce infant deaths in African Americans, although it does in Whites.

Two prominent studies examined race differences in infant mortality among college graduates.[19,20] First live-born infants of African-American graduates from four Atlanta, Ga, colleges had death rates 1.5 times higher than their White counterparts, after adjustment for many confounders.[19] We computed the 95% confidence interval to be 0.8, 2.5. Using national data for 1983 to 1985, Schoendorf et al. reported similar findings,[20] but the elevated risk for African Americans disappeared when infants weighing less than 2500 g were excluded. When we excluded low-birthweight babies, the racial gap for infant mortality in North Carolina was attenuated but did not disappear, and the gradient with education remained. These other studies, because they were restricted to college graduates, could not examine the interaction of education and race.

Using national data, Singh and Yu found that disparities in infant mortality between African Americans and Whites increased with education, and they also demonstrated that education-specific gaps have increased over time.[9] Our analyses confirm that this crude finding remains after adjustment for sociodemographic and lifestyle factors and in both the neonatal and postneonatal periods.[21]

TABLE 2—Adjusted Odds Ratios (ORs) for Infant Death, Comparing African Americans and Whites across Educational Levels: North Carolina Birth and Infant Death Linked File, 1988 through 1993

	Adjusted OR (95% CI)		
Education, y	Reduced model[a]	Model 1[b]	Model 2[c]
<12	1.5 (1.4, 1.7)[d]	1.4 (1.3, 1.6)	1.8 (1.6, 2.0)
12	1.9 (1.8, 2.1)	1.8 (1.7, 2.0)	2.0 (1.9, 2.2)
>12	2.5 (2.3, 2.8)	2.2 (2.0, 2.5)	2.5 (2.3, 2.8)

Note. CI = confidence interval.
[a]The reduced model is a multiple logistic regression that includes maternal race, maternal education, and the interaction term race by education.
[b]Model 1 is the same as the reduced model and also adjusts for maternal age, smoking, high parity, Kotelchuk prenatal care utilization indices, and rural residence.
[c]Model 2 is the same as model 1 with additional adjustment for percentiles of gestational age at birth.
[d]*P* values for homogeneity across levels of education were <.0001 in all models.

Strengths of our study include the large sample size, permitting statistically powerful analysis of effect modification, and the percentile-based standardization, which does not require assumptions about the distribution of gestational age yet provides a public health basis for comparing subgroups with markedly different gestational age distributions.[13] Although the data were cross-sectional, maternal factors and behaviors were encountered before delivery and in most cases recorded before the deaths, providing appropriate temporality regarding cause vs effect. North Carolina birth data were recently shown to be of high quality.[22]

Many authors adjust for birthweight rather than gestational age because the former is recorded more completely and accurately. With imputation, we attained 96% usable observations, thereby improving precision. Adjustment for birthweight yielded the same results as adjustment for gestational age.[13]

Because maternal schooling is such a strong determinant of infant health, one might expect the racial gap in infant mortality to decline as more African Americans attain higher education. That findings from 3 studies now contradict such expectations raises serious concerns; a 2.5-fold difference in mortality among babies all of whose mothers received education beyond high school requires some explanation. Identification of the factors that cause higher education to appear ineffective in reducing infant mortality for African-American babies is essential for designing appropriate interventions that can narrow the ethnic gap.

TABLE 3—Adjusted Odds Ratios (ORs) for Infant Death in Relation to Education and Other Covariates for African Americans and Whites Separately: North Carolina Birth and Infant Death Linked File, 1988 through 1993

	Whites[a]		African Americans[a]	
	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)
Education, y				
<12	1.0	1.0	1.0	1.0
12	0.8 (0.7, 0.9)	0.9 (0.8, 1.0)	0.9 (0.8, 1.0)	0.9 (0.8, 1.0)
>12	0.7 (0.6, 0.8)	0.8 (0.7, 0.9)	0.9 (0.7, 1.0)	0.9 (0.8, 1.0)
Age, per-year increment[b]				
<17 y	1.0 (0.8, 1.1)	1.15 (0.99, 1.34)	0.9 (0.9, 1.0)	1.04 (0.95, 1.33)
17–29 y	1.0 (1.0, 1.0)	0.97 (0.96, 0.98)	1.0 (1.0, 1.0)	1.01 (0.99, 1.02)
≥30 y	1.1 (1.0. 1.1)	1.03 (1.01, 1.05)	1.0 (1.0, 1.0)	1.01 (0.98, 1.04)
Smoking, yes/no	1.4 (1.3, 1.5)	1.2 (1.1, 1.3)	1.3 (1.1, 1.4)	1.1 (1.0, 1.2)
Parity, ≥3 vs lower	1.3 (1.1, 1.5)	1.2 (1.0, 1.4)	1.0 (0.9, 1.1)	0.9 (0.8, 1.1)
Proportion of recommended prenatal care received				
<50%	3.2 (2.6, 3.8)	1.4 (1.2, 1.8)	3.1 (2.7, 3.5)	1.4 (1.2, 1.6)
50%–79%	1.2 (1.0, 1.4)	1.2 (1.0, 1.4)	1.2 (1.1, 1.4)	1.3 (1.1, 1.5)
80%–109%	1.0	1.0	1.0	1.0
≥110%	2.3 (2.1, 2.5)	1.1 (1.0, 1.2)	1.7 (1.5, 1.9)	1.0 (0.9, 1.2)
Residence, rural vs urban	1.1 (1.0, 1.2)	1.0 (0.9, 1.2)	0.9 (0.8, 1.0)	0.9 (0.8, 1.0)
Percentile of gestational age, per-percentile increment[b]				
<6.5th	...	0.55 (0.54, 0.56)	...	0.52 (0.51, 0.53)
≥6.5th	...	0.99 (0.99, 1.00)	...	0.99 (0.99, 0.99)

Note. CI = confidence interval. Models 1 and 2 are defined in Table 2 note.
[a]Race-restricted analyses, each variable adjusted for the others.
[b]The odds ratio represents the incremental or decremental change in odds of infant death associated with a 1-unit increase within the range shown.

Education is a robust[8] indicator of individual socioeconomic status.[23,24] Education may not provide the same social or economic benefit to African-American mothers as to Whites. Income increases with education, but more so for Whites.[23,25] Also, economic resources beyond income, strongly related to mortality,[26] are undoubtly greater, on average, for Whites than for African Americans.[27]

Education also acts as a surrogate for knowledge. Programs for supplementing nutrition and knowledge about maternal and child health in less-educated and underserved pregnant women, such as WIC (Special Supplemental Nutrition Program for Women, Infants, and Children), are effective in reducing low-birthweight rates,[28,29] with more impact among African Americans than among Whites.[29] Possibly these programs reduced the risk ratios for race in the 2 lower-education groups.

Stress may also play a role.[30-32] If African Americans with some college education spend more time interacting with Whites in their daily lives, they may be subject to individual racism to a greater extent. Segregation index is related to infant mortality in African Americans.[24] Some African Americans with higher education may experience a degree of disjunction from the lives of their family members and hence have less social support.[33,34] Persons of any ethnic group who change social class from that of their parents may feel less at ease in their social milieu than those who grew up in similar surroundings. The percentage of African-American women with college degrees rose 40% from 1980 to 1994 (from 8.1% to 13%).[25] These factors (more racism, more solitude, less social support, loss of familiar culture, resulting stress) could partly explain the decreased risk of infant death for African Americans in rural areas that we observed, the increased risk of having low-birthweight babies for educated African Americans living in wealthy communities,[35,36] and the lack of benefit from higher education that we observed in African Americans.

Finally, racial differences in health status, physical as well as mental, could be greater at higher educational levels. Although adjustment for maternal risk factors did not alter our results (data not shown), it is still possible that racial disparities in the degree of access to care as well as the quality of care actually received may be more pronounced at moderate and higher levels of education, whereas those with the least education may lack adequate health care regardless of race.[37]

Conclusions

After adjustment for numerous confounding factors, we found that African-American infants had a higher risk of death than their White counterparts at every level of maternal education. On a relative scale the racial gap increases with more years of schooling (although it decreases on an absolute scale), owing to a diminishing return in benefit from higher education among African Americans. These results call for studies to elucidate the forces behind the smaller benefit from education for African-American mothers than for White mothers and to determine the relative roles of economic resources, programs for the poor, health status, stress, and quality of health care. □

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Rates and Independent Correlates of Pap Smear Testing among Korean-American Women

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ABSTRACT

Objectives. This study reports population estimates of Pap smear testing among Korean-American women and evaluates correlates of testing.

Methods. Korean Americans in 2 California counties were surveyed by telephone. Frequencies were age-adjusted to the 1990 census to produce population estimates of testing. Logistic regression models were used to evaluate independent correlates of testing.

Results. Only 50% of the Korean-American women surveyed had a Pap test in the previous 2 years. The strongest independent correlate was having had a regular check-up in the previous 2 years (odds ratio 7.2, 95% confidence interval 4.2, 12.1).

Conclusions. Rates of Pap testing among Korean-American women are well below national objectives. Collaboration and community-sensitive research are essential to collect data and design programs to improve the health of ethnic minority communities. (*Am J Public Health.* 1998;88:656–660)

Introduction

Asian Americans are the fastest growing minority in the United States and comprise many diverse ethnic groups.[1] Korean Americans are the fifth largest such group (12%), and their numbers increased by 125% from 1980 to 1990.[1]

Available data suggest that cervical cancer is an important cause of morbidity among Korean-American women. In California, where almost one third of Korean Americans reside,[2] cervical cancer was the fourth most commonly diagnosed invasive cancer among Korean-American women (average annual age-adjusted incidence 14.7 per 100 000, 9.9 per 100 000 for all races/ethnicities).[3]

National and state surveys suggest that Asian-American ethnicity is associated with a lack of Pap smear testing.[4,5] National objectives for cervical cancer screening[6] have not been met for Chinese-American[7,8] and Vietnamese-American women.[8–10] No published data are available for Korean-American women.

Correlates of cervical cancer testing for Asian Americans may differ from those for women of other races/ethnicities because of unique cultural, linguistic, and financial factors.[11] Since these factors vary between groups, it is important to examine their effect on testing for each group.

"Health is Strength," the Korean Breast and Cervical Cancer Screening Intervention Project, is a collaboration between Asian Health Services and the Center for Family and Community Health at the University of California, Berkeley. Its goals are to improve breast and cervical cancer testing among Korean-American women through community intervention and to empower the community to take charge of its health. The design is quasi-experimental, with baseline and follow-up surveys in intervention and control counties. We present baseline cervical cancer testing estimates and correlates of behavior.

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