Widening Ethnic Disparities in Infant Mortality in Southern Brazil: Comparison of 3 Birth Cohorts

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Objectives. We analyzed trends in mortality among infants born to White and to Black or mixed-race women in 3 population-based cohorts representing all births in 1982, 1993, and 2004 in Pelotas, southern Brazil.

Methods. Births were assessed during daily visits to all maternity hospitals. Maternal skin color was classified by the interviewers as White or Black or multiracial. We used logistic regression to adjust for socioeconomic, demographic, and health services variables.

Results. The mortality rate among infants born to White mothers declined from 30.4 per 1000 live births in 1982 to 13.9 per 1000 in 2004, compared with 53.8 per 1000 to 30.4 per 1000 among those born to Black and mixed-race mothers. Differences for neonatal mortality were even more marked, with reductions of 47% and 11% for infants born to White and Black or mixed-race women, respectively. Adjusted analyses showed that ethnic group differences in neonatal and infant mortality were partly explained by differences in poverty and prenatal care.

Conclusions. Over a 22-year period, improvements in health indicators were greater for infants born to White women than for other infants. The widening racial gap requires special attention from policymakers. (*Am J Public Health.* 2008; 98:692–698. doi:10.2105/AJPH.2006.093492)

Infant mortality, an often-used indicator of population health and well-being, received less public interest in the 1990s than in previous decades,[1] because the appearance of HIV/AIDS and the growing recognition of malaria pushed it off the political agenda.[2] Over the last several years, however, the global community has given greater attention to mortality among young children. Reduction of infant and child mortality is 1 of 8 United Nations Millennium Development Goals to dramatically reduce world poverty by 2015. The fourth Millennium Development Goal focuses directly on child survival, and infant mortality rate is one of the indicators used to monitor progress toward this goal.[3]

Socioeconomic disparities, as well as race and gender inequities, have been linked to health outcomes and access to and use of health care services.[4] In developed countries, although absolute infant mortality has fallen dramatically, huge disparities still persist among selected populations.[5] Ethnic disparities in infant mortality, which are well documented in many countries, have remained unchanged or have even increased over the past decades.[6–8]

Infant mortality in Brazil has improved substantially, from 112 deaths per 1000 live births in 1960 to an estimated 25 deaths per 1000 live births in 2002.[9] Major changes in health systems occurred during these 2 decades, of which the most important was the creation of the Unified Health System (*Sistema Único de Saúde*) by the 1988 Brazilian Constitution. Access to maternal and child care was defined as a universal right in the constitution, and government health insurance became universal in 1989. Inequities in child health have been documented, however, and wide social differences still persist.[10,11] Many health disadvantages, such as high prevalence of low birthweight and preterm births, poor nutritional status, and increased risk of death during the first year of life, have been found to be more prevalent among Black infants than among White ones.[12,13]

The city of Pelotas in southern Brazil, although located in a relatively developed area of the country, has a highly inequitable income distribution. Infant mortality has remained almost stable over the last several years. During the years 1982, 1993, and 2004, birth cohort studies representing all births in the city were carried out, providing a unique opportunity for assessing ethnic group inequalities. We analyzed time trends in infant mortality between children born to White women and those born to Black or mixed-race women. We add a temporal dimension to existing analyses and explore pathways that may account for the ethnic differences in infant mortality in a middle-income setting.

METHODS

Research Setting and Study Design

Brazil is a large middle-income country with a population of 182 million and a per capita gross domestic product of approximately US$3000.[14] The city of Pelotas has a population of about 330000, and more than 99% of all birth deliveries take place in hospitals. During the period we cover, Pelotas became impoverished as a result of industrial closures and recession, but the health care system was greatly expanded.

During the years 1982, 1993, and 2004, birth cohort studies representing all births to mothers residing in the urban area of Pelotas were begun; each entailed primary data collection and used the same methodology. A detailed description of the methodology is given elsewhere.[15,16] Births were assessed during daily visits to all maternity hospitals. Soon after delivery, researchers used a pretested, structured questionnaire to interview mothers about socioeconomic variables, characteristics of pregnancy, labor, delivery, and health care use. The same variable definitions and comparable questions were used in all 3 studies. Infants were weighed naked immediately after birth. Gestational age in completed weeks was defined as the interval between the first day of the last normal menstrual period and the date of birth. Participants without information on gestational age were excluded from the analyses of preterm delivery.

Mortality surveillance was carried out prospectively by regular visits to all hospitals, cemeteries, state vital registration services, and the city's health department. To obtain records on infants born in Pelotas who died in other parts of the state, researchers examined the state database on mortality.

Outcome and Covariates

The dependent variable for our study was infant death, defined as death in the first year (i.e., <365 days) after birth. We also examined neonatal death, which was defined as death during the first 27 days of life; early neonatal death, defined as death prior to the first 7 days of life; late neonatal death, defined as death between the first 7 and 27 days of life; and postneonatal death, defined as death between the first 28 and 364 days of life. All rates were expressed by number of deaths per 1000 live births.

We also studied other infant characteristics, such as gender, low birthweight (<2500 g), very-low birthweight (<1500 g), and preterm birth (<37 completed weeks of gestation).

Mothers' skin color, the key independent variable in our analysis, was classified according to the interviewer's observation. Maternal skin color was chosen as a proxy for ethnic background because miscegenation in Brazil is highly prevalent[17] and it is not feasible to classify women into different races or ethnic groups in large-scale studies. Skin color options given to the interviewers were White, Black, and other. Because women in the Black and "other skin color" categories had similar characteristics and infant outcomes, they were assembled into a single group and the variable was categorized into White and Black and mixed-race origin. When the 1982 cohort was aged 18 years, participants were asked to classify their own skin color, and their response was compared with the observation of the interviewer (κ=0.83).[18]

Family income in the month prior to delivery was expressed as minimum wage per month (minimum wage per month is a standardized measure of income. 1 minimum wage was worth about US$50 in 1982, US$60 in 1993, and US$80 in 2004). We classified women who were single, widowed, or divorced or who lived without a partner as single mothers. Information on prenatal care and number of consultations was taken from existing records or, if unavailable, by maternal self-report. Essential procedures carried out during prenatal care, such as measurement of uterine height, gynecological and breast examination, administration of tetanus toxoid, prescription of iron, and counseling about breastfeeding, were investigated only in 1993 and 2004, and then only by maternal self-report.

Smoking habits during pregnancy were based on maternal self-assessment. Regular smokers were those women who smoked at least 1 cigarette per day on an everyday basis in any trimester of pregnancy.

Maternal height (in centimeters) was measured by the research team and prepregnancy weight (in kilograms) was obtained from prenatal records at the woman's first antenatal visit or, in their absence, by maternal recall at the time of delivery.

Other independent variables included maternal schooling, maternal age, and type of delivery.

Data Analysis

We used the χ^2 test and Student *t* test to compare the distribution of maternal and infant characteristics by maternal skin color. When appropriate, we also performed tests for linear trends over the study period. To estimate the relationship between maternal skin color and risk of neonatal and infant mortality in the 3 birth cohort studies, we computed odds ratios and 95% confidence intervals using logistic regression analysis.

Multivariate analyses took into account the fact that maternal skin color is a distal determinant of mortality and that its effects may be mediated through a number of more proximate determinants. Our decision of which variables to include in the multivariate analysis was based on a conceptual framework describing the postulated hierarchical relationships between exposures.[19] To be included in the model, variables had to be associated with both maternal skin color and 1 of the mortality outcomes (P<.2)[20] in at least 1 of the 3 cohorts.

Four models were included for each outcome: unadjusted results (model 1), results adjusted for socioeconomic factors and maternal age (model 2), results adjusted for the model 2 variables and also for pregnancy characteristics (prenatal care and smoking; model 3), and results adjusted for the model 3 variables plus birthweight (model 4). In our analyses, only singleton live births were considered. We evaluated the correlation matrix for any evidence of multicollinearity before finalizing the models. Interaction terms between maternal skin color and year were tested but not introduced into the model, because they did not reach statistical significance.

We performed all analyses using Stata software version 9.0 (StataCorp, College Station, Tex).

RESULTS

Nonresponse rates at recruitment were below 1% in the 3 cohort studies. Although the number of women aged between 15 and 44 years increased from 53 943 in 1980 to 74 342 in 2000, the absolute number of births in the city decreased by 28%, reflecting reduced fertility (6011 births in 1982, 5304 in 1993, and 4287 in 2004). However, the proportion of births from Black and mixed-race women increased during the study period (18%, 23%, and 27%, respectively; χ^2 for trend, P<.001). The proportion of multiple births remained stable throughout the 2 decades for both White women (1.7% in 1982, 1.5% in 1993, and 2.0% in 2004; χ^2 for trend, P=.2) and Black and mixed-race women (1.9% in 1982, 1.6% in 1993, and 2.2% in 2004; χ^2 for trend, P=.3).

Maternal Characteristics

We observed the changes in maternal characteristics between 1982 and 2004 (Tables 1 and 2). Even though family income levels decreased for both groups, Black and mixed-race women had lower incomes than did White women in each study period. The proportion of single mothers almost doubled in both groups, but the proportion was higher among Black and mixed-race women. Births to adolescent mothers (aged ≤19 years) and to women aged 35 years or older increased substantially, but only among

TABLE 1—Distribution of Maternal Characteristics, by Skin Color and Year: Pelotas, Brazil, 1982, 1993, and 2004

	White				Black and Mixed-Race				
	1982	1993	2004	P	1982	1993	2004	P	P
Family income,[a] %				<.001[b]				.001[b]	<.001[c]
≤1	18.2	15.9	29.7		39.7	27.6	47.4		
1.1–3.0	47.2	42.5	46.2		48.5	44.4	42.7		
3.1–6.0	20.3	23.3	15.2		10.1	22.0	7.6		
>6	14.3	18.3	8.9		1.7	6.0	2.3		
Single mother, %	7.0	9.9	13.9	<.001[d]	14.0	20.6	23.7	<.001[d]	<.001[c]
Maternal age, y, %				<.001[b]				.09[b]	.9[c]
≤19	15.0	16.5	18.9		17.0	20.4	19.1		
20–34	75.3	72.3	67.6		71.5	68.7	67.5		
≥35	9.7	11.2	13.5		11.5	10.9	13.4		
Schooling, y, mean (SD)	6.8 (4.3)	7.1 (3.7)	8.5 (3.5)	<.001[e]	4.8 (3.2)	5.5 (3.0)	6.9 (3.1)	<.001[e]	<.001[f]
Height, m, mean (SD)	1.57 (0.06)	1.60 (0.07)	1.59 (0.06)	<.001[e]	1.56 (0.06)	1.60 (0.07)	1.59 (0.06)	<.001[e]	.3[f]
Prepregnancy weight, kg, mean (SD)	55.5 (9.5)	58.0 (10.5)	60.8 (12.1)	<.001[e]	57.0 (10.3)	58.7 (10.7)	61.5 (13.0)	<.001[e]	.1[f]
BMI, kg/m^2, mean (SD)	22.6 (3.6)	22.7 (3.8)	24.1 (4.5)	<.001[e]	23.4 (4.0)	23.0 (3.8)	24.4 (4.8)	<.001[e]	.04[f]
Total no. of births	4927	4093	3122		1081	1209	1165		

Note. BMI = prepregnancy body mass index (weight in kilograms divided by height in meters squared).
[a]Family income expressed as minimum wage per month. Minimum wage per month is a standardized measure of income. For 1982, income categories were ≤$50, $51–$150, $151–300, and >$300. For 1993, income categories were ≤$60, $61–$180, $181–$360, and >$360. For 2004, income categories were ≤$80, $81–$240, $241–$480, and >$480.
[b]χ^2 test.
[c]χ^2 test for difference between White and Black and mixed-race mothers in 2004.
[d]χ^2 test for trend over time.
[e]One-way analysis of variance.
[f]*t* test for difference between White and Black and mixed-race mothers in 2004.

White women (χ^2 for trend, $P<.001$ for both categories). White mothers had higher educational attainment than did Black and mixed-race mothers in each cohort. Height and prepregnancy weight increased in both groups throughout the 2 decades. The proportion of women who did not receive prenatal care decreased in both groups, but Black and mixed-race mothers had on average fewer antenatal consultations and later onset of prenatal care than did White mothers. Even though some procedures during prenatal care improved among both groups, Black and mixed-race women were less likely than were White women to be offered essential diagnostic procedures such as gynecological and breast examination in the 2004 study. The proportion of smokers during pregnancy decreased in both groups, but more markedly among White women. Finally, rates of caesarean delivery increased in both groups, but higher figures were seen for White women than for Black or mixed-race women among the 3 cohorts.

Infant Characteristics

Our analyses of the trends in the characteristics of singleton live births are shown in Table 3. Information on the date of the last menstrual period was missing for 29.4% and 19.1% of Black and mixed-race and White women, respectively, in 1982. The corresponding percentages in 1993 were 14.7% and 9.9%, and in 2004, they were 13.8% and 9.2% for Black and mixed-race and White women, respectively.

Rates of preterm birth among live births in the city of Pelotas increased from 6.3% in 1982 to 11.5% in 1993 and 16.7% in 2004. Preterm birth increased among both groups, but the relative increase was larger for Black and mixed-race women (350%) than for White women (250%). No significant trends in low-birthweight and very-low-birthweight infants were observed during the study period in either group. In the 2004 cohort, higher frequencies of low birthweight and very low birthweight were seen among infants born to Black and mixed-race women than among infants born to White women.

Infant Mortality

Infant mortality among single births in the city fell by 45% during the study period, from 34.6 per 1000 live births in 1982 to 20.1 per 1000 in 1993 and 19.0 per 1000 in 2004. Infant mortality among infants born to White women showed a relative decrease of 54% (Table 3). Infant mortality among infants born to Black and mixed-race women fell by 43%, but this decrease occurred mainly between 1982 and 1993 and subsequently remained stable. In each time period, infant mortality was consistently higher among infants born to Black and mixed-race women. The proportion of deaths among infants born to Black and mixed-race women, which represented 28% of all infant deaths of the city in 1982, increased to 36% in 1993 and to 43% in 2004, representing a relative increase of 54% in the study period.

TABLE 2—Characteristics of Prenatal Care, by Maternal Skin Color and Year: Pelotas, Brazil, 1982, 1993, and 2004

	White				Black and Mixed-Race				
	1982	1993	2004	*P*	1982	1993	2004	*P*	*P*[a]
No. of prenatal consultations				<.001[b]				<.001[b]	<.001
0	4.0	3.8	1.5		10.3	8.3	3.3		
1–3	9.5	5.5	4.1		17.6	11.5	10.2		
4–6	28.8	23.3	20.3		31.6	33.4	26.4		
≥7	57.7	67.4	74.1		40.5	46.8	60.1		
Gestational age at the 1st consultation, trimester[c]				<.001[b]				<.001[b]	<.001
1st	64.5	75.5	76.6		46.5	60.5	62.7		
2nd	26.9	21.3	21.5		42.4	32.4	33.1		
3rd	8.6	3.2	1.9		11.1	7.1	4.2		
Had a gynecological examination[c]	...	79.1	78.3	.5[b]	...	74.2	71.8	.2[b]	<.001
Had a breast examination[c]	...	51.7	57.7	<.001[b]	...	42.2	51.4	<.001[b]	<.001
Uterine height was measured[c]	...	99.2	99.5	.05[b]	...	99.1	99.0	.9[b]	.05
Tetanus toxoid was administered[c]	...	57.0	76.2	<.001[b]	...	63.3	75.3	<.001[b]	.5
Received prescription for iron[c]	...	62.3	76.6	<.001[b]	...	63.8	79.0	<.001[b]	.1
Counseled about breastfeeding[c]	...	44.7	61.7	<.001[b]	...	43.5	63.7	<.001[b]	.2
Smoked during pregnancy[d]	34.8	32.5	22.6	<.001[e]	41.1	36.7	31.6	<.001[e]	<.001
Cesarean delivery	28.9	32.1	46.3	<.001[e]	21.7	25.3	42.2	<.001[e]	.02
Total no. of births	4927	4093	3122		1081	1209	1165		

[a] χ^2 test.
[b] χ^2 test for difference between White and Black and mixed-race mothers in 2004.
[c] Only for mothers who attended antenatal care.
[d] Defined as smoking at least 1 cigarette every day during the pregnancy.
[e] χ^2 test for trend over time.

Neonatal mortality among infants born to White women decreased by 47% throughout the study period, whereas among infants born to Black and mixed-race mothers, it decreased by 11%. By 2004, neonatal mortality among infants born to Black and mixed-race women was twice as high as for Whites.

Postneonatal mortality decreased among both groups between 1982 and 1993, showing no change thereafter. The rate among infants born to Black and mixed-race women was almost twice as high as the rate among infants born to White mothers at every time period.

In Table 4, multivariate analyses in the 3 cohorts explore potential pathways through which maternal skin color may be affecting infant survival. Maternal anthropometric variables and infants' gender were not included in the multivariate analyses because they failed to be associated with neonatal and infant mortality.

In 1982, children born to Black and mixed-race mothers had a rate of neonatal mortality similar to that of children born to White mothers in the crude analyses (model 1); by 1993, the odds ratio had increased to 1.84 and remained at a similar level in 2004 (1.98). In model 2, the lack of association in 1982 persisted, and in the 2 later cohorts, the odds ratios were reduced and lost statistical significance. In 1993 and 2004, further substantial reduction was observed when there was adjustment for antenatal care and smoking during pregnancy (model 3). These findings suggest that in the 2 later cohorts, much of the excess risk among Black and mixed-race children can be explained by poverty and inadequate antenatal care. In model 4, further adjustment was made for birthweight, which led to the disappearance of the excess risk for the infants of Black and mixed-race women in the 2 earlier cohorts. In 2004, the risk for infants born to Black and mixed-race mothers remained 60% higher than for infants born to White mothers, but this was not statistically significant.

Table 4 also shows that in the crude analyses (model 1), children born to Black and mixed-race mothers in all 3 cohorts had higher mortality than did those born to White mothers. After sociodemographic variables were included, the odds ratios were reduced in the 3 cohorts. Further reductions were observed when adjustment was made for antenatal care and smoking during pregnancy (model 3) in 1982 and 1993 and, to a lesser extent, for birthweight (model 4) in 2004. In the 3 cohorts, had the distribution of birthweight and other mediating variables been the same among both groups, children born to Black and mixed-race women would have continued to have higher (although not statistically significant) mortality.

DISCUSSION

We have provided an account of trends in maternal and infant characteristics over a period of 22 years in the city of Pelotas, southern Brazil. We found important racial disparities in

TABLE 3—Characteristics of Singleton Live Births and Infant Mortality (per 1000 Singleton Live Births), by Maternal Skin Color: Pelotas, Brazil, 1982, 1993, and 2004

	White				Black and Mixed-Race				
	1982	1993	2004	P^a	1982	1993	2004	P^a	P^b
Boys, %	51.1	49.5	52.2	.5	52.2	48.3	51.5	.8	.7
Birthweight < 2500 g, %	7.8	8.6	8.5	.2	10.3	10.7	10.4	.9	.05
Birthweight < 1500 g, %	0.9	0.5	1.1	.9	1.2	1.2	1.9	.2	.04
Gestational age,[c] weeks, %				<.001[d]				<.001[d]	<.001
< 34	1.0	2.5	3.9		1.0	4.5	5.7		
34–36	4.8	7.2	10.5		4.8	12.2	14.1		
≥ 37	94.2	90.3	85.6		94.3	83.3	80.2		
Mortality per 1000[e]									
Infant	30.4	16.8	14.9	<.001	53.8	31.6	30.4	.005	.001
Neonatal	18.2	11.3	9.6	.001	21.2	20.5	18.8	.7	.02
Early neonatal	15.3	9.3	6.6	<.001	14.4	16.2	14.3	.9	.02
Late neonatal	2.9	2.0	3.0	.9	6.7	4.3	4.5	.5	.5
Postneonatal	12.2	5.5	5.3	<.001	32.7	11.1	11.6	<.001	.03
Total no. of births	4773	3996	3030		1040	1170	1117		

[a]χ^2 test for trend over time.
[b]χ^2 test for difference between White and Black and mixed-race mothers in 2004.
[c]Gestational age was defined as the interval between the first day of the last normal menstrual period and the date of birth (in complete weeks). Participants without information on gestational age were excluded from the analyses of preterm delivery.
[d]χ^2 test.
[e]Infant death was defined as death in the first year (i.e., < 365 days) after birth. Neonatal death was death during the first 27 days of life. Early- and late-neonatal death was death prior to the first 7 days and death between the first 7 and 27 days of life, respectively. Postneonatal death was death between the first 28 and 364 days of life.

the studied population—not only persistent socioeconomic and health care inequalities but also growing racial inequities in survival.

At each time period, Black and mixed-race women were more likely to be smokers and single, to have lower family income, and to have lower educational attainment than were White mothers. These findings have been described by other authors and in different settings.[11,21–25]

Inequalities were observed in terms of prenatal care throughout the 2 decades. Despite an increased number of consultations and earlier initiation of antenatal care, Black and mixed-race women consistently had fewer antenatal consultations than did White women. The resources women need to obtain care—even where consultations are free of charge, as occurs in the Unified Health System—and differences in beliefs about medical care are known to create racial disparities in service use.[26] Other authors have shown that the use and timing of prenatal care is influenced by women's knowledge of its importance and perceptions about the quality of health care available.[27] The analyses of tasks that should have been performed for all women during prenatal care showed that Black and mixed-race women underwent fewer gynecological and breast examinations than did White women. Self-reported information provided by the mothers suggests that White women received better care than did Black and mixed-race women; however, medical records were not available to validate these data. Poorer quality of antenatal care provided to Black and mixed-race women and discrimination in obtaining family planning or contraceptive services have also been described in the United States.[28,29]

Although our findings have to be interpreted with caution because of missing

TABLE 4—Multivariate Analyses of Risk of Infant and Neonatal Death Among Offspring of Black and Mixed-Race Women Compared With Those Among White Women: Pelotas, Brazil, 1982, 1993, and 2004

	Neonatal Death[a]			Infant Death[a]		
Model	1982, OR (95% CI)	1993, OR (95% CI)	2004, OR (95% CI)	1982, OR (95% CI)	1993, OR (95% CI)	2004, OR (95% CI)
Model 1 (maternal skin color)	1.16 (0.73, 1.87)	1.84* (1.12, 3.03)	1.98* (1.13, 3.49)	1.82*** (1.32; 2.49)	1.92** (1.27; 2.88)	2.08** (1.33; 3.27)
Model 2 (model 1 + family income, marital status, education, and age)	0.99 (0.61, 1.62)	1.59 (0.95, 2.66)	1.60 (0.88, 2.91)	1.34(0.96, 1.86)	1.58* (1.04, 2.41)	1.62 (1.01, 2.60)
Model 3 (model 2 + onset of prenatal care, no. of consultations, and cigarette smoking during pregnancy)[b]	1.18 (0.44, 3.18)	1.30 (0.73, 2.31)	1.47 (0.73, 2.93)	0.97(0.50, 1.90)	1.25 (0.78, 2.00)	1.65 (0.96, 2.83)
Model 4 (model 3 + birthweight)	0.92 (0.53, 1.60)	0.98 (0.49, 1.96)	1.60 (0.73,3.48)	1.23 (0.85, 1.76)	1.28 (0.79, 2.09)	1.54 (0.87, 2.73)

Note. OR = odds ratio; CI = confidence interval.
[a]Infant death was defined as death in the first year (i.e., < 365 days) after birth. Neonatal death was death during the first 27 days of life.
[b]Defined as smoking at least 1 cigarette every day during the pregnancy.
*P < .05; **P < .01; ***P < .001.

information on gestational age, mainly in 1982, there were marked increases in rates of preterm deliveries and caesarean deliveries in the city between 1982 and 2004, a finding that was reported in a previous publication.[30] In our study, as well as in another Brazilian study covering the period from 1978 and 1979 to 1994,[31] the marked increase in preterm births has been attributed, at least in part, to medical interventions such as caesarean deliveries and induction of labor at gestational ages under 37 weeks. The significant increase in the number of newborns with a gestational age of 34 to 36 weeks, most of whom weighed more than 2500 g, could explain why the increase in preterm birth was not accompanied by an increase in low-birthweight or very-low-birthweight births.

In the 2004 cohort study, Black and mixed-race mothers had higher proportions of preterm and low-birthweight infants than did White mothers, which is in accordance with studies from developed countries.[32] Racial disparities in rates of preterm birth have persisted for decades, although the precise reasons are not yet clear. A number of explanations have been proposed,[33] but stress and infection are currently regarded as the most important factors. Black women are more likely to experience more stressful life events and a number of infections, including bacterial vaginosis and sexually transmitted infections, than are White women. Several pathways linking maternal psychological stress and infections to premature births have been proposed; these include neuroendocrine, immune-inflammatory, and vascular processes.[33]

Significant improvements in neonatal and infant mortality occurred only among infants born to White women. Reductions in neonatal mortality have been almost entirely because of improvements in early neonatal mortality and in birthweight-specific survival, because there has been virtually no improvement in birthweight distribution.

During the early 1990s, neonatal intensive care units were substantially expanded and neonatal care was improved, and the fact that White mothers had better access to this care may explain why in the 1993 cohort mortality was lower for infants born to White mothers than for those born to Black and mixed-race mothers. As discussed elsewhere, new interventions tend to be adopted primarily by the better-off, and this may lead to a widening of inequality gaps.[10] Nevertheless, in 2004, when technology was supposed to be up to date in every neonatal intensive care unit, early neonatal mortality among Black and mixed-race women continued to be higher than among White women. Although access is, in theory, universal, beds in neonatal intensive care units in the government insurance sector are often not available.

In the 1993 and 2004 cohorts, a substantial part of the ethnic gap in neonatal and infant mortality was because of sociodemographic conditions and differences in antenatal care (Table 4). The inability to explain much of the difference in neonatal and infant mortality levels among ethnic groups in 2004 suggests that other unmeasured factors such as differential access to neonatal services or provision of specific interventions to newborns, or perhaps other social variables and intergenerational differences, will need to be studied in the future.

Limitations

Some methodological difficulties of the study need to be mentioned. First, ethnicity is difficult to measure in epidemiological studies.[34] Because interviewers' criterion for the classification of the mothers' skin color implies subjective perception, the possibility of misclassification cannot be ruled out. Second, even though follow-up rates were high and missing data for most variables accounted for less than 5% of the observations, up to 20% of the mothers in 1982 were unable to recall the date of their last menstrual period and information on gestational age was missing. Because mothers in the 1982 cohort who did not recall their last menstrual period had greater risk of delivering a low-birthweight infant (and likely greater risk of preterm delivery), it is possible that the increase in preterm births observed between 1982 and 1993 could have been smaller had information on gestational age been complete in the 3 cohorts. Finally, our data are all from a single city. Our results, however, are in line with those of other studies showing that Black infants have substantially higher mortality than do infants of other ethnic groups in Brazil.[13]

Conclusions

Growing disparities in infant mortality throughout the 2 decades of this study have mirrored the persistence of large social and economic inequalities and have shown that improvements in the provision of health care in Brazil were not sufficient to eliminate ethnic group inequities. The findings from the 1993 and 2004 cohorts showed that part of the excess risk for Black and mixed-race infants could be explained by poverty and less adequate antenatal care, indicating that other unmeasured factors such as quality of neonatal care need to be studied. Policymakers and health care professionals designing infant survival programs should pay special attention to the needs of Black and mixed-race women and their infants by developing ethnic-specific approaches to reducing infant mortality and eliminating disparities. Our results strongly support placing the notion of ethnicity at the forefront of theories and analyses of child mortality in Latin America. ■

About the Authors

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Contributors

A. Matijasevich originated the research question, conducted the analyses, and wrote the first draft of the article. C.G. Victora originated the research question, supervised the analysis and interpretation of the findings, as well as the writing of the article. A.J.D. Barros, I.S. Santos, and F.C. Barros contributed to the interpretation of the analyses and assisted with the editing of the article. P.L. Marco entered data and contributed to the data analyses. E.P. Albernaz contributed to data collection and the training of the field personnel.

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Human Participant Protection

The study protocol was approved by the Medical Ethics Committee of the Federal University of Pelotas, which is affiliated with the Brazilian Federal Medical Council. In the 1982 and 1993 cohort studies, verbal consent to participate in the study was obtained from mothers. In 2004, cohort study women were asked to sign an informed consent form after being informed of study objectives.

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