# Low Birthweight and Infant Mortality in Puerto Rico


## ABSTRACT

*Objectives.* The purpose of this study was to quantify the relative contributions of maternal age, education, marital status, hospital of birth, and use of prenatal care to the high incidence of low birthweight and infant mortality in Puerto Rico.

*Methods.* An analysis was conducted of 257 537 live births that occurred from 1986 through 1989 among Puerto Rico residents and the 3373 corresponding infant deaths. Binomial multiple regression models were used to calculate the adjusted population attributable risks for each variable.

*Results.* Our estimates indicate that approximately 6 of every 10 infant deaths on the island are potentially preventable if low birthweight were eradicated, regardless of other associated factors. Eliminating risks associated with sociodemographic and socioeconomic factors (including hospital of birth) would potentially decrease the incidence of low birthweight in Puerto Rico by one third. Specifically, the elimination of risks associated with the socioeconomic disadvantage of women delivering in public hospitals alone would potentially decrease Puerto Rico's low birthweight incidence by 28%, regardless of other factors considered in our study.

*Conclusions.* Efforts to prevent low birthweight and infant mortality in Puerto Rico should focus on reducing the gap between the private and public sectors. (*Am J Public Health.* 1993;83:1572–1576)



*José E. Becerra, MD, MPH, Hani K. Atrash, MD, MPH, Nilsa Pérez, MS, and José A. Saliceti, PhD*


## Introduction

Puerto Ricans in both the continental United States and Puerto Rico have the highest incidence of low birthweight and infant mortality of all Hispanic groups in the United States.[1] In 1990, the low-birthweight rate in Puerto Rico was 9.1%, compared with 7.0% for the United States as a whole.[2,3] In the same year, the infant mortality rate in Puerto Rico was 13.4 per 1000 live births, compared with the overall US rate of 9.1.[2,4]

In previous studies, investigators have implicated increased birthweight-specific neonatal mortality risks,[1,5] smoking,[6] and inadequate prenatal care[7] as contributors to adverse pregnancy outcomes in Puerto Rico; however, no previous study has quantified the relative contributions of sociodemographic and socioeconomic factors to the high incidence of low birthweight and infant mortality on the island.

This study had two objectives: to assess the relative contributions of maternal age, marital status, maternal education, hospital of birth, and use of prenatal care to the incidence of low birthweight in Puerto Rico, and to assess the relative independent contributions of those same factors to the incidence of infant mortality after accounting for the effect of birthweight. The ultimate goal of the study was to provide public health policymakers in Puerto Rico with accurate information that can guide the design and implementation of prevention strategies to reduce the high incidence of low birthweight and infant mortality.

## Methods

From 1986 through 1989, 258 354 live births occurred among Puerto Rico residents.[2] Infant death certificates from 1986 through 1990 were matched to their corresponding birth certificates. Fewer than 2% of these certificates remained unmatched, thus, valid data for the variables under study were available for 257 537 live births and the 3373 corresponding infant deaths.

We defined infant death as the death of a newborn before the end of the first year of life; infant birthweight as low birthweight (< 2500 g) or normal birthweight (≥ 2500 g); maternal age as less than 20 years or 20 years or more; marital status as unmarried (including consensual unions) or married; maternal education as less than 12 or 12 or more years of formal education; hospital of birth as public or private; and prenatal care as none or some prenatal care documented in the birth certificate.

We used the generalized linear model technique to fit a binomial multiple regression model to the data.[8] After considering all possible combinations of main effects of the variables under study, we selected and compared four hierarchical models. Two of these models (models 1a and 1b) included the combined effect of all exposure variables on birthweight. Model 1a included only the main effects, and model


José E. Becerra and Hani K. Atrash are with the Pregnancy and Infant Health Branch, Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, Ga. Nilsa Pérez and José A. Saliceti are with the Office of Health Statistics, Commonwealth of Puerto Rico Department of Health, San Juan, Puerto Rico.

Requests for reprints should be sent to José E. Becerra, MD, MPH, Commonwealth Perinatal Epidemiologist, Puerto Rico Department of Health, PO Box 70184, San Juan, Puerto Rico 00936.



This paper was accepted March 10, 1993.

1b added all statistically significant ($P < .05$) second-order interactions. The log-likelihood ratios[9] were 51.6 ($df = 26$, $P < .01$) for model 1a and 32.9 ($df = 23$, $P = .08$) for model 1b. The other two models (models 2a and 2b) added birthweight to the exposure variables and considered infant death as the outcome. Model 2a included only the main effects, and model 2b added all statistically significant ($P < .05$) second-order interactions. The log-likelihood ratios were 105.8 ($df = 57$, $P < .01$) for model 2a and 57.6 ($df = 52$, $P = .27$) for model 2b.

Finally, we estimated the population attributable risk for each variable after adjusting for all other variables included in model 1b and model 2b.[10] The population attributable risk is the proportion of a health outcome potentially prevented if the risk associated with a given factor is eradicated from the population after the data have been adjusted for all other risk factors. For instance, to estimate the population attributable risk of low birthweight for unmarried mothers—adjusting for the simultaneous effects of age, education, hospital of birth, and prenatal care (model 1b)—we calculated the *individual* risks according to the binomial regression model and assumed that each mother was married. We totaled these individual risks to calculate the *expected number* of low-birthweight infants if all mothers had been married and compared that expected number with the actual number of low-birthweight infants observed in the population. The following formula was used:

$$\text{Population Attributable Risk} = 100 \times (\text{Observed} - \text{Expected})/\text{Observed}.$$

Because the models selected showed a good fit to the data, the observed number of low-birthweight infants in the population was very close to the one predicted by the binomial regression model.

## Results

According to our study, the average infant mortality rate in Puerto Rico from 1986 through 1989 was 13.1 infant deaths per 1000 live births (76% died in the neonatal period), and the average low-birthweight rate was 8.9 per 100 live births (90% of low-birthweight infants weighed between 1500 and 2499 g at birth). During this period, approximately 1 in 6 mothers were under 20 years of age, 1 in 3 were unmarried, 1 in 3 had less than 12 years of formal education, 2 in 3 gave birth in public hospitals, and 1 in 50 were unable to obtain any prenatal care (Table 1). Of all deliveries in the public sector, 99% occurred in hospitals owned by the Puerto Rico Department of Health. Public sector hospitals were more likely than private sector hospitals to receive mothers under 20 years of age (25% vs 4%), unmarried mothers (45% vs 12%), and mothers with less than 12 years of formal education (50% vs 9%).

**TABLE 1—Low Birthweight (< 2500 g) and Infant Mortality Rates, by Selected Maternal Characteristics: Puerto Rico Birth Cohorts, 1986/87 through 1989/90**

| Maternal Characteristics | No. (%[a]) | Low Birthweight[b] | Infant Mortality[b] | Neonatal Mortality[b] |
|---|---|---|---|---|
| Age y | | | | |
| < 20 | 45 010 (17.5) | 11.0 | 16.3 | 12.6 |
| ≥ 20 | 212 527 (82.5) | 8.5 | 12.4 | 9.4 |
| Marital status | | | | |
| Unmarried | 84 722 (32.9) | 11.1 | 17.4 | 12.9 |
| Married | 172 815 (67.1) | 7.8 | 11.0 | 8.5 |
| Level of education, y | | | | |
| < 12 | 91 214 (35.4) | 10.7 | 16.1 | 11.7 |
| ≥ 12 | 166 323 (64.6) | 7.9 | 11.4 | 9.0 |
| Type of hospital | | | | |
| Public | 165 073 (64.1) | 10.5 | 16.5 | 12.5 |
| Private | 92 464 (35.9) | 6.1 | 7.3 | 5.5 |
| Prenatal care | | | | |
| None | 5 207 (2.0) | 19.9 | 49.5 | 39.4 |
| Some | 252 330 (98.0) | 8.7 | 12.3 | 9.4 |
| Total | 257 537 (100.0) | 8.9 | 13.1 | 10.0 |

[a]Percentage of total.
[b]Rate per 1000 live births.

Low-birthweight rates differed markedly according to the maternal characteristics examined in this study (Table 2). Mothers with no prenatal care were 2.29 (95% confidence interval [CI] = 2.16, 2.42) times more likely to deliver a low-birthweight newborn than were mothers who had some prenatal care. Mothers in public hospitals were 1.73 (95% CI = 1.68, 1.78) times more likely to deliver a low-birthweight newborn than were mothers in private hospitals. Unmarried mothers were 1.42 (95% CI = 1.39, 1.46) times more likely to deliver a low-birthweight infant than were married mothers (infants of single mothers and of mothers living in consensual unions had similar low-birthweight risks). Less educated mothers were 1.35 (95% CI = 1.32, 1.38) times more likely to deliver a low-birthweight infant than were more educated mothers. Mothers 19 years of age or younger were 1.29 (95% CI = 1.25, 1.33) times more likely to deliver a low-birthweight infant than were older mothers.

After adjusting for all other variables included in the model, we found that (1) the low-birthweight risk among mothers with no prenatal care was still 1.99 (95% CI = 1.88, 2.10) times higher than among women who received some prenatal care, (2) the risk among mothers delivering in public hospitals was still 1.55 (95% CI = 1.50, 1.60) times higher than the risk among mothers delivering in private hospitals, (3) the risk among unmarried mothers decreased and was 1.18 (95% CI = 1.15, 1.21) times higher than the risk among married mothers, (4) the risk among mothers 19 years old or younger decreased and was 1.07 (95% CI = 1.04, 1.11) times higher than the risk among older mothers, and (5) the risk among less educated mothers decreased and was 1.05 (95% CI = 1.02, 1.08) times higher than the risk among more educated mothers.

Infant mortality rates also differed markedly according to the maternal and infant characteristics examined (Table 3). Low-birthweight infants were 19.60 (95% CI = 18.28, 21.02) times more likely to die within their first year of life than were normal-birthweight infants. Infants of mothers who did not have prenatal care were 4.03 (95% CI = 3.57, 4.54) times more likely to die within their first year of life than were infants of mothers who did have some prenatal care. Infants delivered in public hospitals were 2.35 (95% CI = 2.16, 2.55) times more likely to die within their first year of life than were infants delivered in private hospitals. Infants of unmarried mothers were 1.58 (95% CI = 1.48, 1.69)

TABLE 2—Relative Risks and Population Attributable Risks of Low Birthweight, by Selected Maternal Characteristics: Puerto Rico Birth Cohorts, 1986/87 through 1989/90

| Maternal Characteristics | Crude Relative Risk | Adjusted Risk | | |
|---|---|---|---|---|
| | | Model 1a Relative Risk[a] | Model 1b Relative Risk[b] | Population Attributable Risk |
| Age < 20 y | 1.3 | 1.1 | ... | 1.6 |
| Education < 12 y | ... | ... | 1.1 | ... |
| Education ≥ 12 y | ... | ... | 1.0 | ... |
| Unmarried | 1.4 | 1.2 | ... | 6.6 |
| Education < 12 y | ... | ... | 1.2 | ... |
| Education ≥ 12 y | ... | ... | 1.1 | ... |
| Education < 12 y | 1.3 | 1.0 | ... | 3.0 |
| Age < 20 y, unmarried | ... | ... | 1.2 | ... |
| Age < 20 y, married | ... | ... | 1.1 | ... |
| Age ≥ 20 y, unmarried | ... | ... | 1.1 | ... |
| Age ≥ 20 y, married | ... | ... | 1.0 | ... |
| Public hospital | 1.7 | 1.5 | ... | 27.6 |
| No prenatal care | ... | ... | 2.0 | ... |
| Some prenatal care | ... | ... | 1.6 | ... |
| No prenatal care | 2.3 | 2.0 | ... | 2.2 |
| Public hospital | ... | ... | 2.0 | ... |
| Private hospital | ... | ... | 1.6 | ... |

*Note.* The reference group in the relative risk estimates is the group with opposite attributes (i.e., the reference group for unmarried mothers is the group of all married mothers). The population attributable risk is the proportion of low-birthweight newborns potentially prevented if the risk associated with a given factor is eradicated from the population after adjustment is made for all other risk factors.

[a]Adjusted estimates with all main effects in the binomial multiple regression model but with no interactions included.

[b]Stratum-specific estimates with all main effects and statistically significant ($P < .05$) interactions included (hierarchical modeling).

times more likely to die within their first year of life than were infants of married mothers (infants of single mothers and of mothers living in consensual unions had similar risks of death). Infants of mothers with less than 12 years of schooling were 1.41 (95% CI = 1.32, 1.51) times more likely to die within their first year of life than were infants of more educated mothers. Infants of mothers 19 years old or younger were 1.31 (95% CI = 1.21, 1.42) times more likely to die within their first year of life than were infants of older mothers.

After adjusting for all other variables included in the model, we found that (1) the risk of death among low-birthweight infants was still 17.95 (95% CI = 16.72, 19.26) times higher than among normal-birthweight infants, (2) the risk among infants of mothers with no prenatal care was 2.04 (95% CI = 1.82, 2.30) times higher than among infants of mothers with some prenatal care, (3) the risk among infants delivered in public hospitals decreased and was 1.65 (95% CI = 1.50, 1.81) times higher than among infants delivered in private hospitals, (4) the risk among infants of unmarried mothers decreased and was 1.09 (95% CI = 1.01, 1.16) times higher than among infants of married mothers, (5) the risk among infants of less educated mothers decreased and was 0.94 (95% CI = 0.88, 1.02) times that among infants of more educated mothers, and (6) the risk among infants of mothers 19 years old or younger decreased and was 0.99 (95% CI = 0.91, 1.07) times that among infants of older mothers.

The risk of death among low-birthweight infants who had more educated mothers and were born in public hospitals was 1.9 times higher than the risk among low-birthweight infants who also had more educated mothers but were born in private hospitals. On the other hand, we found no difference in the risk of death among normal-birthweight infants who had less educated mothers and were born in public hospitals compared with normal-birthweight infants who also had less educated mothers but were born in private hospitals.

## Discussion

Our results confirm that low birthweight is the most important determinant of infant mortality in Puerto Rico. Approximately 6 of every 10 infant deaths on the island could be prevented if low birthweight were eradicated, regardless of other associated factors (Table 3). The eradication of risk associated with the sociodemographic and socioeconomic factors included in our study (including hospital of birth) would potentially decrease the incidence of low birthweight in Puerto Rico by one third (Table 2). The elimination of the risk associated with hospital of birth alone, as a proxy for socioeconomic risk factors, would potentially decrease the incidence of low birthweight in Puerto Rico by 28%, regardless of other factors considered in our study.

By considering the impact of sociodemographic and socioeconomic factors on the entire population, we have demonstrated that the independent contribution of most of these factors was generally small after accounting for hospital of birth. Specifically, the independent contributions of age and marital status to the incidence of low birthweight were substantially lessened after accounting for hospital of birth. Therefore, health planners should reconsider the widely held expectation that infant mortality in Puerto Rico will significantly improve if interventions focus on younger pregnant mothers.

Although we could postulate an etiologic role for hospital of birth in contributing to the incidence of infant mortality,[1,5] it is not plausible to consider hospital of birth as a causal factor in the incidence of low birthweight. More likely, hospital of birth is another marker for socioeconomic disadvantage unaccounted for by variables such as maternal education and marital status. It is reasonable to assume that most patients served by the public sector in Puerto Rico lack private health insurance.

Hospital of birth may reflect nutritional practices, personal habits (such as illicit drug use, alcohol use, and smoking practices[6]), access to prenatal care,[7] psychological and social stresses,[11] and parenting skills, among other behavioral, social, environmental, and economic disadvantages that have been traditionally associated with the public health concept of race.[12]

The usefulness of the concept of race in medical and public health research has been reviewed recently.[12–17] Although the Puerto Rico Department of Health collects data on race in its vital statistics system, race has never been used in the analyses and reports of these data because it is believed to contain unavoidable and significant misclassification. In Puerto Rico, there is as yet no risk marker equivalent to

the public health concept of race to help identify populations at high risk of low birthweight and infant mortality and thus rally support and target intervention strategies to prevent these outcomes. We propose that hospital of birth, instead of the public health concept of race, be used in Puerto Rico to define health care and pregnancy outcome gaps between the public and private sectors.

Our study also demonstrates, however, that hospital of birth is a significant independent contributor to infant mortality after controlling for birthweight, regardless of other sociodemographic factors. This finding suggests that the survival of infants delivered in public hospitals could be improved regardless of the sociodemographic profile of the mother.[1,5]

We found a complex but interesting relationship between maternal education and hospital of birth. The association between hospital of birth and infant mortality was substantially reduced among infants of less educated mothers. The relative risk of death associated with public hospitals was 60% to 90% higher among infants of more educated mothers but only 0% to 20% higher among infants of less educated mothers. This interaction is also reflected in the complex relationship between birthweight, hospital of birth, and maternal education (Table 3). The association between maternal education and infant mortality seems more pronounced among infants delivered in private hospitals. Conversely, it could be argued that the association between hospital of birth and infant mortality is more distinct among the more educated mothers. In fact, the (absolute) risk of death among low-birthweight infants who had less educated mothers was 86.5 per 1000 live births in public hospitals compared with 70.7 in private hospitals. Among low-birthweight infants who had more educated mothers, the risk of death was 111.3 per 1000 live births in public hospitals compared with 59.1 in private hospitals (data not shown). Therefore, maternal education may not fully reflect socioeconomic status among low-birthweight infants. On the other hand, the risk of death among normal-birthweight infants who had less educated mothers was 5.7 per 1000 live births in public hospitals compared with 5.6 in private hospitals. Among normal-birthweight infants who had more educated mothers, the risk of death was 5.1 per 1000 live births in public hospitals compared with 3.3 in private hospitals (data not shown). Therefore, normal-birthweight infants who had less educated mothers were at higher risk of death regardless of where they were born.

**TABLE 3—Relative Risks and Population Attributable Risks of Infant Mortality, by Selected Maternal Characteristics: Puerto Rico Birth Cohorts, 1986/87 through 1989/90**

| Maternal/Infant Characteristics | Crude Relative Risk | Adjusted Risk: Model 2a Relative Risk[a] | Adjusted Risk: Model 2b Relative Risk[b] | Adjusted Risk: Population Attributable Risk |
|---|---|---|---|---|
| Low birthweight | 19.6 | 17.9 | ... | 62.0 |
| Public hospital, education < 12 y | ... | ... | 15.1 | ... |
| Public hospital, education ≥ 12 y | ... | ... | 21.8 | ... |
| Private hospital, education < 12 y | ... | ... | 12.6 | ... |
| Private hospital, education ≥ 12 y | ... | ... | 18.1 | ... |
| Age < 20 y | 1.3 | 1.0 | ... | 0.2 |
| Education < 12 y, no prenatal care | ... | ... | 1.4 | ... |
| Education < 12 y, some prenatal care | ... | ... | 1.0 | ... |
| Education ≥ 12 y, no prenatal care | ... | ... | 1.1 | ... |
| Education ≥ 12 y, some prenatal care | ... | ... | 0.8 | ... |
| Unmarried | 1.6 | 1.1 | 1.1 | 3.6 |
| Education < 12 y | 1.4 | 0.9 | ... | −1.0 |
| Low birthweight, public hospital, age < 20 y | ... | ... | 1.0 | ... |
| Low birthweight, public hospital, age ≥ 20 y | ... | ... | 0.8 | ... |
| Low birthweight, private hospital, age < 20 y | ... | ... | 1.6 | ... |
| Low birthweight, private hospital, age ≥ 20 y | ... | ... | 1.2 | ... |
| Normal birthweight, public hospital, age < 20 y | ... | ... | 1.4 | ... |
| Normal birthweight, public hospital, age ≥ 20 y | ... | ... | 1.1 | ... |
| Normal birthweight, private hospital, age < 20 y | ... | ... | 2.2 | ... |
| Normal birthweight, private hospital, age ≥ 20 y | ... | ... | 1.7 | ... |
| Public hospital | 2.3 | 1.6 | ... | 22.6 |
| Low birthweight, education < 12 y | ... | ... | 1.2 | ... |
| Low birthweight, education ≥ 12 y | ... | ... | 1.9 | ... |
| Normal birthweight, education < 12 y | ... | ... | 1.0 | ... |
| Normal birthweight, education ≥ 12 y | ... | ... | 1.6 | ... |
| No prenatal care | 4.0 | 2.0 | ... | 3.9 |
| Age < 20 y | ... | ... | 2.5 | ... |
| Age ≥ 20 y | ... | ... | 1.9 | ... |

*Note.* The reference group in the relative risk estimates is the group with opposite attributes (i.e., the reference group for low-birthweight infants is the group of all normal-birthweight infants). The population attributable risk is the proportion of infant deaths potentially prevented if the risk associated with a given factor is eradicated from the population after adjustment is made for all other risk factors.

[a]Adjusted estimates with all main effects in the binomial multiple regression model but with no interactions included.

[b]Stratum-specific estimates with all main effects and statistically significant ($P < .05$) interactions included (hierarchical modeling).

We did not attempt to assess the full effect of prenatal care on low birthweight and infant mortality. In fact, our classification of prenatal care as "none" or "some" reflects how crudely we were able to approach this matter. Using vital records in Puerto Rico, other researchers have found no appreciable differences in pregnancy outcomes examined according to the trimester in which prenatal care began.[7] Therefore, the low population attributable risks associated with prenatal care should not be viewed as evidence of ineffectiveness but as evidence of our inability to measure what really works and what does not work in prenatal care. Nevertheless, our analysis suggests that a lack of prenatal care either sorts out those at high risk of low birthweight and infant mortality or is associated with a twofold increase in both, regardless of other risk factors. The impact of this increased risk on the population as a whole is constrained by the low prevalence of women with no prenatal care on the island.

The results of this and previous stud-

ies[1,5] are being used to document the need to improve the perinatal health care provided in Puerto Rico's public hospitals, and a special tax has been enacted for making such improvements. Few neonatal intensive care beds are available in Puerto Rico's private sector, because most high risk neonates are usually transferred to tertiary, public health care facilities. Therefore, the special tax revenues will be used to reduce infant mortality by improving the survival of newborns in Puerto Rico.

The Puerto Rico Department of Health has also launched a major initiative to improve the access, quantity, and quality of prenatal care in the public sector. Health officials in Puerto Rico agree that the most cost-effective way to reduce infant mortality is to prevent low birthweight through universal access to timely and good prenatal care.[18] Of course, further studies are needed to sort out the risk factors associated with low birthweight due to preterm delivery and to intrauterine growth retardation because vital statistics data do not provide reliable information on gestational age.[19] Further studies are also needed to assess how life-styles and personal habits, such as illegal drug use, smoking, and alcohol use, relate to pregnancy outcomes in Puerto Rico.

The prevention of low birthweight and infant mortality, as with most health outcomes, is seldom related to specific technological interventions. Public health officials and clinical practitioners can significantly improve infant mortality in Puerto Rico, however, by lowering birthweight-specific infant mortality risks.[1] Long-term prevention strategies designed to improve infant mortality, on the other hand, more likely will be associated with reducing the gap in low birthweight between the private and public sectors. □

## Acknowledgments

This study is the result of a collaborative agreement among the Centers for Disease Control and Prevention, the Health Resources and Services Administration, and the Puerto Rico Department of Health, which assigned a perinatal epidemiologist to the Commonwealth of Puerto Rico.

## References

1. Becerra JE, Hogue CJ, Atrash HK, Pérez N. Infant mortality among Hispanics: a portrait of heterogeneity. *JAMA.* 1991;265: 217–221.
2. Becerra JE, Castellanos RG, Pérez N, Saliceti JA. *Sistema de Vigilancia Epidemiológica de la Mortalidad Infantil (SIVEMI).* San Juan, Puerto Rico: Departamento de Salud de Puerto Rico; 1991.
3. National Center for Health Statistics. Advance report of final natality statistics, 1990. *Month Vital Stat Rep.* February 25, 1993;41(8) (suppl).
4. National Center for Health Statistics. Annual summary of births, marriages, divorces and deaths: United States, 1991. *Month Vital Stat Rep.* September 30, 1992; 40(13) (suppl).
5. Becerra JE, Smith JC, Pérez N. Evaluation of a regional perinatal care system through linked infant birth and death certificates: Puerto Rico 1980–1984. *PR Health Sci J.* 1989;8:305–311.
6. Becerra JE, Smith JC. Maternal smoking and low birthweight in the reproductive history of women in Puerto Rico. *Am J Public Health.* 1988;78:268–272.
7. Vázquez-Calzada JL, Rivera-Acevedo AL. Prenatal care, infant birthweight and infant mortality in Puerto Rico. *PR Health Sci J.* 1989;8:283–288.
8. Wacholder S. Binomial regression in GLIM: estimating risk ratios and risk differences. *Am J Epidemiol.* 1986;123:174–184.
9. Kleimbaum DG, Kupper LL, Morgenstern H. *Epidemiologic Research: Principles and Quantitative Methods.* Belmont, Calif: Lifetime Learning Publications; 1982.
10. Kooperberg C, Petitti DB. Using logistic regression to estimate the adjusted attributable risk of low birthweight in an unmatched case-control study. *Epidemiology.* 1991;2:363–366.
11. Syme SL. Social determinants of health and disease. In: Last JM, ed. *Maxcy-Rosenau Public Health and Preventive Medicine.* 12th ed. Norwalk, Calif: Appleton-Century-Crofts; 1986:953–970.
12. Weissman A, Buehler JW. Race-ethnicity: a dubious concept. *Public Health Rep.* 1990;105:102–103. Letter.
13. Cooper R. A note on the biologic concept of race and its application in epidemiologic research. *Am Heart J.* 1984;108:715–723.
14. Buehler JW, Stroup DF, Klaucke DN, Berkelman RL. The reporting of race and ethnicity in the National Notifiable Diseases Surveillance System. *Public Health Rep.* 1989;104:457–465.
15. Hahn RA. The state of federal health statistics on racial and ethnic groups. *JAMA.* 1992;267:268–274.
16. Osborne NG, Feit MD. The use of race in medical research. *JAMA.* 1992;267:275–279.
17. Jones CP, LaVeist TA, Lillie-Blanton M. Race in the epidemiologic literature: an examination of the American Journal of Epidemiology, 1921–1990. *Am J Epidemiol.* 1991;134:1079–1084.
18. *Healthy Children: Investing in the Future.* Washington, DC: Office of Technology Assessment; 1988.
19. Kramer MS, McLean FH, Boyd ME, Usher RH. The validity of gestational age estimation by menstrual dating in term, preterm, and postterm gestations. *JAMA.* 1988;260:3306–3308.