

Trends in Prenatal Care Use and Low Birthweight in Southeast Brazil

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Because prenatal care has been considered a cost-effective way of improving birth outcomes,^{1,2} access to adequate prenatal care has been one of the most important goals of women's health programs. In Brazil, in 1989, a new program was established to reduce inequalities in access to women's health care, with a new emphasis on prenatal care. The Health Ministry recommended that all pregnant women initiate prenatal care during the first trimester of pregnancy and be examined by an obstetrician on at least 6 occasions.³ Because socioeconomic barriers are strongly related to access to adequate prenatal care,^{4–6} increasing the provision of services to underprivileged women was one of the goals of this new strategy. Following the sanitary reform in the 1980s, which established free and universal access to all public services under the new Brazilian Unified Health System, few studies have evaluated trends in the provision of and inequalities in access to prenatal care use.⁷

In some places, increasing provision of prenatal care has not been accompanied by the expected reductions in low birthweight.^{8–11} More recently, observational studies have obtained conflicting results related to the effect of prenatal care on birth outcomes, particularly in relation to low birthweight.^{8,9,12–14} Most of these studies have been carried out in developed countries. Little information is available in developing countries, whose populations may have higher rates of modifiable risk factors potentially reducible by prenatal care interventions.

Ideally, evaluation of the effect of prenatal care on birth outcomes would be performed with randomized controlled trials. However, randomizing subjects into no-care or inadequate-care groups would be considered unethical, because prenatal care is widely assumed to be beneficial. Therefore, evaluation of the effect of prenatal care on birth outcomes must rely on observational studies.^{8,10}

Objectives. We investigated trends in prenatal care use and its association with low birthweight in a developing country.

Methods. We examined data from 2 southeast Brazilian cohort surveys, 1 conducted in 1978–1979 and the other in 1994.

Results. Socioeconomic inequalities in prenatal care use increased during the 15-year period of 1979–1994. Although prenatal care use increases paralleled increases in low birthweight rate during this period, having no prenatal care was associated with higher risk of low birthweight in both surveys. Inadequate prenatal care use was also associated with higher risk of low birthweight in 1978–1979 only.

Conclusions. Increasing low birthweight rates among women who adequately used prenatal care may be causing a bias by reducing the estimates of the effect of inadequate prenatal care use on low birthweight rates. (*Am J Public Health.* 2004; 94:1366–1371)

This undertaking is difficult, because of the methodological problems presented. Prenatal care is not a single intervention: it is a non-standardized, multifaceted endeavor. Because prenatal care is difficult to measure, measurement error may be present in any study. Because women who already had a preterm birth usually attended fewer prenatal visits, preterm delivery bias will tend to overestimate the association between prenatal care and birth outcomes. Conversely, intensive use of prenatal care by high-risk women may contribute to an underestimate of the association between prenatal care and birth outcomes. Because women who are more health conscious are more likely to use adequate prenatal care and to be at lower risk of adverse birth outcomes, selection bias is a limitation that tends to overestimate the effect of prenatal care on birth outcomes. Confounding is yet another problem.^{8,10,14}

Comparison of adequate use with inadequate use tends to underestimate the possible benefits of prenatal care.¹⁰ In our study, we attempted to explain this possible source of bias by assessing the association between prenatal care use and low birthweight. We compared the effect on low birthweight of adequate prenatal care use with both inadequate use and no prenatal care use.

We used survey data from 2 birth cohorts: one in 1978–1979 before the Brazilian Health Ministry program was launched and another in 1994, 5 years after the new strategy's 1989 implementation. Both cohorts are from Ribeirão Preto, São Paulo state, southeast Brazil. Our study was designed to (1) estimate trends in prenatal care use, (2) identify social and biological factors associated with failing to receive the recommended level of prenatal care, (3) assess trends in socioeconomic inequalities in prenatal care over a 15-year period, and (4) evaluate whether inadequate prenatal care use is associated with lower low birthweight rates than with receiving no prenatal care and whether these associations changed between the time of the 2 surveys.

METHODS

In 1978, Ribeirão Preto had a population of 318 496 inhabitants; by 1994, the population had increased by 45%, to 461 427 inhabitants. All 8 maternity hospitals existing in 1978–1979 and all 10 existing in 1994 participated in the surveys. Deliveries occurring in a hospital accounted for more than 98% of all births in both surveys.

The first survey was conducted from June 1978 through May 1979. All singleton live

births to resident families, totaling 6750 mother–child pairs, were included in the analysis. Because no seasonal effects were found in the first survey,¹⁵ the 1994 survey was conducted within only a 4-month period. All singleton live births occurring from May through August 1994 to resident families were included, yielding a sample of 2846 mother–child pairs.

The same methodology was used in both surveys and has been described elsewhere.^{15,16} Shortly after delivery, the newborn's weight was measured and the mother answered a standardized questionnaire administered by trained personnel on the maternity ward. In 1978–1979, 2.5% of mothers were discharged from the hospital before they could be interviewed; in 1994, this figure was 3.2%. In both surveys, less than 1.0% of mothers refused to be interviewed. In the first survey, mothers provided oral consent to conduct the interviews, and in the second survey, they provided written consent. Hospital directors gave us permission to access medical records.

A new index of adequacy of prenatal care use based on Brazilian Health Ministry recommendations was used.³ In this index, prenatal care was determined by self-report and was considered to be adequate when a woman attended at least 6 visits for a term gestation, 5 visits for a gestation ending between 33 and 36 weeks, 4 visits for a gestation ending between 29 and 32 weeks, 3 visits for a gestation ending between 24 and 28 weeks, and 2 visits for a gestation lasting fewer than 24 weeks. Although early initiation of care was also an important part of prenatal care evaluation, it was not possible to incorporate this dimension into the analysis because a large proportion of the 1978–1979 cohort was missing data regarding the time of initiation of prenatal care. However, including this dimension in the index for the 1994 cohort did not substantially change the proportion of mothers receiving adequate care. Gestational age was estimated according to the last normal menstrual period. Subjects who experienced a gestation of fewer than 20 or more than 50 weeks (10 subjects in 1978–1979) or reported implausible gestational ages (27 and 23 subjects in 1978–1979 and 1994, respectively) were recorded as having missing gestational age. Records with missing data on prenatal care (869 in 1978–1979

and 249 in 1994) and gestational age (1001 in 1978–1979 and 393 in 1994) were excluded from some analyses. The category “missing information on gestational age” refers to women who attended at least 1 prenatal examination but for whom it was not possible to clarify prenatal care use as adequate or inadequate on the basis of number of visits in relation to gestational age. Women with missing information were significantly more likely to be younger or older (aged <20 or >34 years), to be multiparous, to be single, to have fewer years of schooling, and to have public insurance (all significant at the .05 level).

We used the following independent variables: maternal age (<20, 20–34, or ≥35 years); maternal education (≤4, 5–11, or ≥12 years); maternal marital status (noncohabiting, cohabiting, or married); parity, including the current pregnancy (primiparity, 2–4 pregnancies, or ≥5 pregnancies); type of health insurance (public or private); and maternal smoking during pregnancy (yes or no). A “not known” category was added to the regression models for all variables.

Crude and adjusted prevalence risk ratios were estimated by a Cox regression model using Breslow modification for a cross-sectional design (assuming equal and complete follow-up duration for all subjects). Because the standard errors of the coefficients tend to be overestimated when Cox regression is applied to sectional studies, the robust method of calculating the variance matrix¹⁷ was used in-

stead of the conventional inverse-matrix-of-second-derivatives method. The regression models identified factors associated with inadequate prenatal care use. These models were adjusted for all independent variables under analysis, and subjects with missing information about prenatal care or gestational age were excluded. To examine the association between prenatal care use and low birthweight, prenatal care use was classified as adequate (reference category), inadequate, no prenatal care, or missing. This classification allowed us to assess whether adequate prenatal care produced better birth outcomes than no prenatal care. Because continued smoking during pregnancy may be a consequence of poor prenatal care, separate models were estimated with and without adjustment for maternal smoking.

RESULTS

Adequacy of prenatal care use increased over the study period, from 39.4% in 1978–1979 to 64.0% in 1994, whereas low birthweight rate increased, from 7.2% to 10.7% (Table 1).

Risk Factors for Inadequacy of Prenatal Care Use

Unadjusted analysis. In both the 1978–1979 and 1994 surveys, women aged younger than 20 years, those beyond their fourth pregnancy, smokers, single women (including those cohabiting with a partner), women who had less than

TABLE 1—Percentages of Adequate Prenatal Care Use and Low Birthweight: Ribeirão Preto, Brazil, 1978–1979 and 1994

	1978–1979, No. (%)	1994, No. (%)
Adequacy of prenatal care use*		
Inadequate	1712 (25.4)	309 (10.9)
Adequate	2657 (39.4)	1820 (64.0)
No prenatal care	490 (7.3)	75 (2.6)
Missing information on gestational age	1022 (15.1)	393 (13.8)
Missing information on prenatal care	869 (12.9)	249 (8.8)
Birthweight, g*		
<2500	483 (7.2)	303 (10.7)
≥2500	6235 (92.3)	2536 (89.1)
Not known	32 (0.5)	7 (0.2)
Total	6750 (100.0)	2846 (100.0)

**P* < .001.

TABLE 2—Crude Risk Factors for Inadequacy of Prenatal Care Use, Ribeirão Preto, Brazil, 1978–1979 and 1994

	1978–1979 (n = 4859)			1994 (n = 2204)		
	No.	Inadequate Use, %	Crude Risk Ratio (95% Confidence Interval)	No.	Inadequate Use, %	Crude Risk Ratio (95% Confidence Interval)
Maternal age, y						
<20	656	59.0	1.39 (1.29, 1.49)	386	29.8	1.99 (1.65, 2.42)
20–34	3826	42.5	1.00	1607	14.9	1.00
≤35	373	49.9	1.17 (1.05, 1.31)	209	13.9	0.93 (0.65, 1.33)
Not known	4	0				
Parity						
1	1825	37.5	0.81 (0.75, 0.87)	948	14.0	0.78 (0.64, 0.96)
2–4	2513	46.5	1.00	1142	18.0	1.00
≥5	508	67.3	1.45 (1.34, 1.56)	111	40.5	2.26 (1.75, 2.92)
Not known	13	0				
Marital status						
Married	4075	40.2	1.00	1392	8.9	1.00
Cohabiting	486	71.4	1.78 (1.66, 1.90)	527	36.8	4.13 (3.37, 5.06)
Single	297	72.7	1.81 (1.67, 1.96)	254	24.8	2.78 (2.12, 3.66)
Not known	1	31				
Maternal education, y						
≤4	1085	63.8	2.62 (2.25, 3.07)	264	39.4	15.07 (7.48, 30.35)
5–11	3228	42.5	1.75 (1.50, 2.04)	1497	16.3	6.23 (3.12, 12.47)
≥12	535	24.3	1.00	306	2.6	1.00
Not known	11	137				
Type of insurance						
Private	332	26.2	1.00	874	2.5	1.00
Public	4317	47.7	1.82 (1.52, 2.19)	1290	27.9	11.09 (7.27, 16.91)
Not known	210	40				
Maternal smoking						
No	3424	42.9	1.00	1749	14.0	1.00
Yes	1406	50.8	1.18 (1.11, 1.26)	453	30.5	2.17 (1.81, 2.61)
Not known	29	2				

Note. Subjects with missing information about gestational age and prenatal care were excluded from this analysis.

12 years of schooling, and women who had public insurance were more likely to have inadequate prenatal care use. Conversely, primiparous mothers were more likely to have adequate prenatal care use. Only women aged 35 years or older from the 1978–1979 cohort were also more likely than mothers aged 20 to 34 years to have fewer than the recommended number of prenatal visits. Inequalities in prenatal care increased from 1979 to 1994: among mothers with fewer years of schooling, the risk of attending less than the recommended number of prenatal visits was much higher in 1994 (15.07) than in 1978–1979 (2.62) (Table 2).

Adjusted analysis. After we controlled for various confounders, adjusted risks were re-

duced for most variables. Young maternal age (<20 years), multiparity (≥5 children), being single or cohabiting with a partner, public insurance, and maternal smoking were independently associated with inadequacy of prenatal care use. Primiparity protected from an inadequate use of prenatal care. The higher risk of inadequate use among mothers with fewer years of schooling was not completely explained by differences in maternal age, parity, marital status, type of insurance, and maternal smoking, because this risk remained significant after adjustment. Among mothers with public insurance, the risk of failing to attend the recommended number of prenatal visits increased from 1978–1979 to 1994. In

1994 the risk was approximately 5-fold higher than in 1978–1979 (Table 2).

Association Between Prenatal Care Use and low birthweight

In both surveys, pregnant women who failed to attend prenatal care visits had a significantly higher unadjusted risk of low birthweight. This association was reduced but remained significant after adjustment for maternal age, parity, marital status, maternal education, and type of insurance. In 1978–1979, women who attended fewer than the recommended number of prenatal visits had a significantly higher risk of low birthweight compared with those who attended the recommended number of visits. After adjustment, the association remained at a confidence limit very close to 1. However, in 1994, the association between inadequate prenatal care use and low birthweight was no longer detected. A linear *P* value for trend was significant in both years (Table 3). Additional adjustment for maternal smoking decreased the estimates slightly (data not shown).

DISCUSSION

Despite an overall increase in the adequacy of prenatal care use, low birthweight and socioeconomic inequalities in prenatal care use increased between 1978–1979 and 1994. Socioeconomic barriers were strong predictors of an inadequate number of prenatal care visits.

In previous studies, women of lower socioeconomic status (low education, low income) were found to have received less than adequate prenatal care both in Brazil^{18,19} and in developed countries.²⁰ Adolescent mothers (aged 10–19 years) showed a considerably greater risk of inadequate prenatal care use,^{4,21} as did single or cohabiting mothers^{4,21–23} and multiparous women.^{4,20} Our results corroborate these findings. Maternal smoking was associated with low prenatal care attendance, a finding also reported in other studies.^{24,25} Lack of adequate prenatal care attendance for all of these groups decreases opportunities for identifying and reducing the effects of modifiable risk factors for poor birth outcomes, especially factors related to lifestyle counseling, such as smoking cessation and reproductive health counseling.²²

Compared to groups who experienced good birth outcomes, groups more likely to

TABLE 3—Adjusted Risk Factors for Inadequacy of Prenatal Care Use: Ribeirão Preto, Brazil, 1978–1979 and 1994

	Adjusted Risk Ratio (95% Confidence Interval) ^a	
	1978–1979	1994
Maternal age, y		
<20	1.36 (1.26, 1.48)	1.56 (1.27, 1.92)
20–34	1.00	1.00
≥35	0.89 (0.80, 1.00)	0.78 (0.55, 1.10)
Parity		
1	0.75 (0.70, 0.81)	0.74 (0.60, 0.91)
2–4	1.00	1.00
≥5	1.33 (1.22, 1.44)	1.56 (1.19, 2.04)
Marital status		
Married	1.00	1.00
Cohabiting	1.44 (1.34, 1.55)	1.85 (1.50, 2.29)
Single	1.67 (1.54, 1.82)	1.77 (1.36, 2.32)
Maternal education, y		
≤4	1.69 (1.43, 2.00)	2.23 (1.07, 4.63)
5–11	1.35 (1.15, 1.59)	1.64 (0.81, 3.32)
≥12	1.00	1.00
Type of insurance		
Private	1.00	1.00
Public	1.31 (1.09, 1.58)	5.96 (3.75, 9.45)
Maternal smoking		
No	1.00	1.00
Yes	1.31 (1.00, 1.14)	1.39 (1.17, 1.65)

Note. Subjects with missing information on gestational age and prenatal care were excluded from this analysis.
^aCox regression was used to adjust risk ratios for all factors shown in table assuming equal duration of follow-up for all subjects and robust estimates of standard error would occur.

TABLE 4—Prenatal Care Use in Relation to Low Birthweight: Ribeirão Preto, Brazil, 1978–1979 and 1994

	n	Percentage Low Birthweight	Crude Risk Ratio (95% Confidence Interval)	P	Adjusted Risk Ratio ^a (95% Confidence Interval)	P
1978–1979				<.001		<.001
Adequate	2651	5.2				
Inadequate	1705	7.5	1.43 (1.13, 1.81)		1.26 (0.99, 1.60)	
No prenatal care	488	13.7	2.64 (2.00, 3.47)		1.88 (1.38, 2.56)	
1994				<.001		.020
Adequate	1818	9.5				
Inadequate	309	10.7	1.12 (0.79, 1.60)		0.98 (0.68, 1.42)	
No prenatal care	75	26.7	2.80 (1.88, 4.19)		2.21 (1.42, 3.42)	

Note. A category denoting missing gestational age and prenatal care data was included in this analysis but is not shown.
P values for trend were calculated after exclusion of subjects with missing information on gestational age and prenatal care.
^aCox regression was used to adjust risk ratios for maternal age, parity, marital status, maternal education, and type of insurance with the assumption of equal duration of follow-up for all subjects and robust estimates of standard error.

experience poor birth outcomes showed fewer improvements in prenatal care use, resulting in increasing poor birth outcomes in terms of low birthweight over the study period, even after universal access was granted in 1989. These results are in contrast with 1981–1998 observations from the United States, where prenatal care use improved and inequalities were markedly reduced.²⁶

Some observational studies have shown that adequate prenatal care use is associated with reductions in either low birthweight or preterm birth after various confounders are controlled.^{22,27} Another recent study also found that prenatal care use (1 or more visits) was associated with a reduced risk of preterm birth²⁸ after adjustment for various confounders. However, other studies either failed to identify any association between prenatal care and low birthweight²³ or were able to detect only small differences in mean birthweight between women with adequate and with less-than-adequate prenatal care.¹¹ In our study, lack of prenatal care was associated with an increased risk of low birthweight in both surveys, whereas inadequate prenatal care use was only marginally associated with an increased risk of low birthweight in the first survey.

Variations among study findings may be the result of differential effects of prenatal care in different populations, differences in prenatal program characteristics, and adjustment for different confounders. Unknown confounders also pose a difficult problem, because most risk factors for low birthweight remain unknown.¹⁰ Differences in measurement of prenatal care use also may explain discrepant findings. Several indices have been proposed to overcome the problem of controlling for gestational age bias^{6,8}; however, none of these indices has completely solved this problem.^{8,9} (Indices are measures used to examine the adequacy of prenatal care or prenatal utilization. These indices usually take into account the number of prenatal care visits, the time of the first prenatal care visit and the gestational age.)

In the United States, Medicaid expansion has led to greater access to prenatal care. It also has resulted in improved birth outcomes in Florida²⁹ and Washington State.³⁰ However, in Florida, rates of low birthweight for low-income women with private insurance have remained unchanged.²⁹ In this study, lack of prenatal

care was associated with a higher risk of low birthweight in both survey periods, whereas, prenatal care use increased in parallel to the increase in low birthweight over the study period. Evaluation of the association between prenatal care and low birthweight, when rates are compared over time, may be misleading because of ecological fallacy.

Prenatal Care and Low Birthweight

We might ask why it is that, in our study, lack of prenatal care was associated with lower low birthweight rates in 1994 but inadequate prenatal care use was not. It is possible that factors other than prenatal care may have increased low birthweight rates among better-off women with adequate prenatal care. Improvement of vital statistic reporting, increasing use of obstetrical interventions, and increasing use of assisted reproductive techniques seem to be associated with increasing preterm birth and low birthweight rates, especially among women of higher socioeconomic status.³¹ Increased prenatal care use, especially intensive use (number of visits greater than the recommended number according to gestational age), is associated with both a greater use of medical interventions and preterm birth.^{6,20,32} In some instances, increases in preterm birth may reflect advances in perinatal care, because decreases in fetal death rates may occur more often among women receiving adequate care, thus reducing possible associations between prenatal care use and low birthweight.⁸ In Ribeirão Preto, increases in prenatal care use and cesarean delivery paralleled increases in low birthweight³³ and preterm birth.³⁴ Cesarean delivery was more common among more socially privileged women with an adequate number of prenatal care visits.³⁵ Increases in use of obstetrical interventions such as cesarean delivery could potentially explain the disappearance of the association between inadequate prenatal care use and low birthweight in 1994.

Another possible explanation for no significant association between prenatal care use and low birthweight is variation in measurement error of gestational age estimation⁸ and of the number of prenatal care visits. In fact, the frequency of missing data on gestational age was higher in 1978–1979 than in 1994. Changes in measurement error of the number of prenatal

visits could have resulted in attenuation bias, which may have underestimated the effect of prenatal care on low birthweight.¹⁴ The association between no prenatal care and low birthweight may have remained relatively stable, possibly because lack of prenatal care is a more objective measure and does not use gestational age data or the number of visits, both of which are more prone to measurement error.

If prenatal care use and low birthweight are causally related, another possibility is that the occurrence of low birthweight in 1999 was less amenable to prenatal care interventions. Preterm delivery accounted for 48% of low birthweight cases in Ribeirão Preto in 1978–1979 and for 55% in 1994.³³ Because preterm birth is less reducible by medical interventions, an increase in preterm birth may explain why low birthweight seems less responsive to the medical interventions included in prenatal care—a finding that has been replicated in both developing and developed countries.^{11,36,37} Today, most low birthweight babies are born preterm instead of growth-restricted (i.e., small-for-gestational-age babies) because of conditions less amenable to prenatal care interventions, such as spontaneous idiopathic preterm delivery or bacterial vaginosis.^{8,12} The potential benefits of prenatal care on birth outcomes may become less pronounced as the reproductive health of a population improves.¹¹

A possible protective effect of prenatal care on low birthweight may have resulted from prevention of small-for-gestational-age births. Better nutrition during pregnancy and decreases in maternal smoking rates may have been the mechanisms by which prenatal care interventions exerted their effects in reducing low birthweight rates.^{8,10} We have no data regarding body mass index or prepregnancy maternal weight with which to test this possibility. Adjustment for maternal smoking decreased our estimates only slightly, indicating that smoking was not an important mediator of a possible prenatal care effect.

Another possible explanation as to why inadequate prenatal care use was not associated with lower birthweights in 1994 is the increased intensive use of prenatal care by high-risk women. Because women with poor birth outcomes may have had better access to prenatal care in 1994 than in 1978–1979, comparison of inadequate versus adequate

care use may be more biased toward the null value in the latter survey.^{21,23}

Study Limitations and Strengths

Our study had some limitations. Because of the possibility of selection bias and confounding as a result of unaccounted for or unknown factors, the association identified in our study between prenatal care use and low birthweight may not be causal. We were unable to adjust for drug and alcohol use, urogenital infections, psychosocial stress, pregnancy complications, and body mass index, all of which are possible confounders of the association between prenatal care and low birthweight. Recall bias also could have attenuated the associations. Information regarding gestational age was unavailable for nearly 24% of the subjects in 1978–1979 and for 19% in 1994. Exclusion of records with missing values may have resulted in an underestimation of the association, because such records are positively associated with inadequate prenatal care use. Only the number of prenatal visits was taken into account; the content and quality of prenatal care was not examined. The use of number of visits relative to gestational age as a prenatal use index has been criticized for failing to discriminate the timing of care initiation, because early initiation of care has been a recommended goal for many prenatal programs.⁹ It was not possible to distinguish a category of intensive use to identify women who attended more than the recommended number of visits. Such a category has been considered an important component of recent prenatal care evaluations.²⁸

On the other hand, our study had several strengths. First, it was a population-based study, a framework which reduced possible selection bias, mainly considering differences imposed by socioeconomic variables. Second, because this study was based on prospective surveys, we had a high level of data consistency between dependent and independent variables. Third, the study was carried out in a city with high standards of health care for Brazil, confirming the presence of the barriers of access to prenatal care and its impact on birthweight in an ideal scenario.

In summary, inequalities in prenatal care use increased between 1979 and 1994. Although adequacy of prenatal care use improved, women with more need because of social and

biological risk factors continue to receive proportionally less prenatal care than do those with fewer health demands. Although increasing prenatal use paralleled ascending low birthweight rate over time, lack of prenatal care was associated with a higher risk of low birthweight in both survey periods. Although inadequate prenatal care use was associated with low birthweight in 1978–1979, this association disappeared in 1994. Increasing low birthweight rates among women with adequate prenatal care use may be causing a bias by reducing the estimated association between prenatal care use and low birthweight downward. Low birthweight may have been less amenable to prenatal care interventions in the last survey because most low birthweight children were born preterm. Maybe increasing the number of visits for prenatal care as it currently stands would not actually improve low birthweight substantially among certain subgroups in the population. Policymakers need to work to increase prenatal care use among underprivileged women, who are faced with a higher chance of not getting the attention they need compared to women of higher socioeconomic status. ■

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Contributors

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Human Participant Protection

Appropriate institutional review board approval was obtained at all participant hospitals. All mothers gave oral consent in the 1978–1979 survey and written consent in the 1994 survey.

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