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## Body Composition in Pregnant Women

### Grantee

Columbia University

### Investigator

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**Project Number** 360601

**NTIS Number** PB97-155071

**Project Period** 10/01/90–12/30/95

Costs	Awarded	Requested
Year 1	\$356,227	\$404,376
Year 2	\$280,451	\$419,464
Year 3	\$251,730	\$232,608
Year 4	no cost extension	
Year 5	no cost extension	
Year 6		

### Year 2000 Objectives

14.5, 14.6, 14.7, 14.14, 22.4

### Study Design

Observational

### Time Design

Longitudinal

### Care Emphasis

Noninterventional

### Population Focus

Pregnant women

### Racial/Ethnic Focus

African Americans

## Summary

### *Statement of the Problem*

Weight gain during pregnancy has been shown repeatedly to be associated with infant birthweight. Birthweight in turn is highly associated with perinatal mortality, even in infants delivered at term. Precisely why birthweight and maternal weight gain are associated is not known. Despite the lack of a detailed mechanism demonstrating a causal relationship, it is common practice to encourage maternal weight gain, with the expectation that appropriate weight gain will optimize fetal development.

In 1990, the Institute of Medicine (IOM) issued new weight gain guidelines for pregnancy. The recommendations were determined after a review of the literature that related weight gain to pregnancy outcomes of mothers and birth outcomes of infants. The literature on pregnancy weight gain was silent on the issue of how maternal weight gain and body composition changes, particularly fat gain, were related. In addition, little information was available relating maternal fat or other body component changes to birthweight. The information that had been reported was generally based on simple and imprecise estimates of body composition. Yet there is wide interest in fat gain during pregnancy, since the conventional wisdom has been that pregnancy weight and fat gain contribute to obesity in U.S. women.

To understand the relationship of maternal weight gain to fat gain, it was necessary to study weight gain and body composition changes in a sufficiently large group of American women so that different body mass

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index (BMI) subgroups could be examined separately. Because concerns persist about differential birth outcomes in black, white, and Hispanic women, the study included women from these groups.

### ***Research Questions or Hypotheses***

The main purpose of this research was to test the following hypotheses:

1. There is a positive correlation between gestational weight gain and body fat gain (i.e., higher weight gain is associated with higher fat gain) in adult pregnant black women and adult pregnant white women.
2. White women store more fat than black women during pregnancy, after adjustment for gestation duration (after 37 weeks), initial body fat, height, parity, and age.
3. Fetal growth (birthweight, length, and head circumference) is greater in white women than in black women after adjustment for initial body fat, height, parity, age, gestation duration (after 37 weeks), and infant's sex. The research team postulated a positive correlation between fetal growth and gestational fat mass increase in both ethnic groups. Therefore, fat mass increase will be a significant covariant (predictor) of fetal growth.

### ***Study Design and Methods***

Body composition was measured twice during pregnancy, at 14 and 37 weeks on average. Many different body composition measures were used, so that in addition to the determination of body fat based on the most advanced body composition models, a variety of approaches to body composition assessment could be evaluated. Selected measurements obtained were combined with bone mineral mass measurements determined at 3 weeks postpartum, and used

in a multicompartiment model to estimate changes in fat and lean tissue during the measurement period. The fat estimate obtained in this way for each woman was used to evaluate historical approaches to body composition assessment, including estimates based on anthropometry, total body water, body density, and total body potassium.

### ***Study Sample and/or Population***

Two hundred nonsmoking, healthy black, white, and Hispanic women ages 18–35 were recruited from prenatal care clinics located at Harlem Hospital Center, Presbyterian Hospital in the City of New York, St. Luke's Roosevelt Hospital, and the Maternity Center, all in the borough of Manhattan, New York City.

### ***Findings***

The study showed that as weight gain increased during pregnancy, fat gain also increased in all BMI categories. Underweight women, the group for whom the highest weight gain was recommended, gained the most fat between weeks 14 and 37, when they were gaining as recommended (for the whole of pregnancy). Obese women gaining as recommended did not gain body fat during the measurement period.

An array of biological and demographic variables was examined for a relationship to birthweight, with backward elimination regression analyses. The key findings of these analyses were as follows: First, higher weight gain was associated with increased birthweight, but higher fat gain was associated with lower birthweight; second, when total body water was studied in place of fat gain, higher body water was associated with increased birthweight and weight gain was no longer an independent predictor of birthweight.

Study of prior anthropometric equations for the prediction of body fat demonstrated that these equa-

tions, which were developed based on nonpregnant women, significantly misestimated body fat, particularly at the second measurement (at or after week 37 of gestation). New equations were developed with a random half of the study population. In an internal validation study, these equations predicted fat at weeks 14 and 37 and fat change from week 14 to 37 in the remaining sample of the study women.

Weight gain, fat gain, and birthweight did not differ among the black and white women studied. The methodologic studies of the standard methods used traditionally to estimate body composition (underwater weighing, total body water, total body potassium) indicate that they can give significantly different estimates of body fat when each measure is used separately. The research team has reported preliminary data comparing these methods and allowing fuller interpretation of differences in fat changes reported in studies using the different methods.

The anthropometric equations developed in this study should be tested for use in the clinical setting so that those women whose fat gain near term has been high can be identified and counseled before delivery about weight control measures that might be advisable postpartum. Further study is also needed concerning the factors that interfere with loss of gestational fat gain.

Studies should be directed at determining whether specific dietary patterns can influence the partitioning of nutrients between the mother and the infant, so that birthweight can be optimized while maternal fat gains are limited.

Finally, efforts are needed to assist breastfeeding women during the early weeks of lactation, especially in light of the recent reductions in length of postpartum hospital stays.

## Publications

### Articles, Books, and Chapters

Lederman SA. In press. Nutritional support for the pregnant adolescent. *Proceedings of the New York Academy of Sciences*.

Lederman SA. 1993. Recent issues related to nutrition during pregnancy. *Journal of the American College of Nutrition* 12(2):91-100.

Lederman SA, Paxton A, Heymsfield SB, Wang J, Thornton JC, Pierson RN. 1997. Body composition changes during pregnancy: Body fat increments in women who gain weight as recommended. *Obstetrics and Gynecology* 90 (4):483-488.

Lederman SA, Pierson RN, Wang J, Paxton A, Thornton J, Wendel J, Heymsfield SB. 1993. Body composition measurements during pregnancy. In KJ Ellis and J Eastman, eds., *Human Body Composition: In Vivo Methods, Models, and Assessment* (pp. 193-195). New York, NY: Plenum Press.

Paxton A, Lederman SA, Heymsfield SB, Wang J, Thornton JC, Pierson RN. In press. Anthropometric equations for studying body fat in pregnant women. *American Journal of Clinical Nutrition*.

### Abstracts

Kral J, Wang J, Kotler D, Lederman S, Heymsfield SB, Thornton JC, Albu J. 1992. Measuring the quality of the fat free mass: Electrolyte and water profiles in normals, aging, obesity, AIDS, and pregnancy. *FASEB Journal* 6:A1363.

Lederman SA, Paxton A, Heymsfield S, Wang J, Thornton J, Pierson RN. 1996. Changes in body fat in pregnant women gaining as recommended or less or more than recommended. *124th Annual Meeting of the American Public Health Association: Abstracts*.

Lederman SA, Paxton A, Heymsfield S, Wang J, Thornton J, Pierson RN. 1994. The effect on birthweight of maternal body composition during pregnancy. *122nd Annual Meeting of the American Public Health Association: Abstracts*.

Lederman SA, Paxton A, Heymsfield SB, Wang J, Thornton J, Pierson RN. 1993. Weight gain and fat gain in pregnant women of different BMI. *FASEB Journal* 7(3):A154.

Lederman SA, Paxton A, Heymsfield SB, Wang J, Thornton J, Wendel J. 1992. Body fat changes during pregnancy: A comparison of results. *American Journal of Clinical Nutrition* [abstract #78].

Lederman SA, Paxton A, Heymsfield SB, Wang J, Thornton J, Wendel J, Pierson RN. 1992. Pregnancy body composition determined by four methods. *FASEB Journal* 6(5):A1941.

Lederman SA, Paxton A, Wang J, Thornton J, Heymsfield SB, Burastero S, Pierson RN. 1994 Changes in hydration of fat free mass (FFM) between weeks 14 and 37 of pregnancy. *FASEB Journal* 8(4):A617.

Lederman SA, Paxton A, Wang J, Thornton J, Pierson RN. 1992. The relationship between increases in intracellular and extracellular water during pregnancy. *American Journal of Clinical Nutrition* [abstract #77].

Paxton A, Lederman SA, Burastero S, Wang J, Pierson RN. 1992. Anthropometric methods for estimating body fat during pregnancy: Comparison of results. *American Journal of Clinical Nutrition* [abstract #98].

Paxton A, Lederman SA, Heymsfield S, Wang J, Thornton JC, Burastero S, Pierson RN. 1993. New prediction equations for estimating body fat in pregnant women using anthropometry. *Abstracts of the American College of Nutrition Annual Meeting*.

Paxton A, Lederman SA, Wang J, Thornton J, Heymsfield SB, Burastero S, Pierson RN. 1994. Pelvic and total body bone density at three weeks postpartum and at 6 months and one year postpartum. *FASEB Journal* 8(3):A164.

Paxton A, Lederman SA, Wang J, Thornton J, Heymsfield SB, Burastero S, Pierson RN. 1994. Pelvic and total body bone density at three weeks postpartum and at 6 months and one year postpartum. *FASEB Journal* 8(3):A164.

Paxton A, Lederman SA, Wang J, Thornton JC, Heymsfield S, Pierson RN. 1994. Pelvic and total bone density at three weeks postpartum and at 6 months and one year postpartum. *FASEB Journal* 8(3):A 164.

Wang J, Lederman S, Burastero S, Mazariegos M, Ma KZ, Yu WW, Thornton J, Leonard E, Pierson RN. 1992. Multi-frequency bio-impedance analysis to estimate total body water and extracellular water in pregnancy. *American Journal of Clinical Nutrition* [abstract #135].

Wendel J, Wang J, Lederman S, Burastero S, Pierson RN. 1992. Prediction of total body water in pregnancy by anthropometric measurements. *American Journal of Clinical Nutrition* [abstract #138].

Wendel J, Wang J, Lederman S, Russell M, Thornton J. 1992. The density of fat free mass during pregnancy. *FASEB Journal* 6:A19 [abstract #5930].

## **Presentations**

Kral J. 1992. *Measuring the quality of the fat free mass: Electrolyte and water profiles in normals, aging, obesity, AIDS, and pregnancy*. Presented at the Annual Meeting of the Federation of American Societies for Experimental Biology.

Lederman SA. 1995. *Maternal weight gain*. Presented at the March of Dimes 12th Annual Maternal-Infant Nutrition Symposium, Washington, DC.

Lederman SA. 1994. *Changes in hydration of fat free mass (FFM) between weeks 14 and 37 of pregnancy*. Presented at the Annual Meeting of Experimental Biology, Anaheim, CA.

Lederman SA. 1994. *The effect on birthweight of maternal body composition during pregnancy*. Presented at the 122nd Annual Meeting of the American Public Health Association, Washington, DC.

Lederman SA. 1994. *Pelvic and total body bone density at three weeks postpartum and at 6 months and one year postpartum*. Presented at the Annual Meeting of Experimental Biology, Anaheim, CA.

Lederman SA. 1993. *Weight gain and fat gain in pregnant women of different BMI*. Presented at the Annual Meeting of Experimental Biology, New Orleans, LA.

Lederman SA. 1992. *Body fat changes during pregnancy: A comparison of results*. Presented at the Annual Meeting of the American Society for Clinical Nutrition, Baltimore, MD.

Lederman SA. 1992. *Pregnancy body composition determined by 4 methods*. Presented at the Annual Meeting of the Federation of American Societies for Experimental Biology, Anaheim, CA.

Lederman SA. 1992. *The relationship between increases in intracellular and extracellular water during pregnancy*. Presented at the Annual Meeting of the American Society for Clinical Nutrition, Baltimore, MD.

Paxton A. 1992. *Anthropometric methods for estimating body fat during pregnancy: Comparison of results*. Presented at the Annual Meeting of the American Society for Clinical Nutrition, Baltimore, MD.

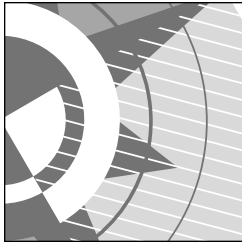
Paxton A, Lederman SA, Heymsfield S, Wang J, Thornton JC, Burastero S, Pierson RN. 1993. *New prediction equa-*

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*tions for estimating body fat in pregnant women using anthropometry.* Paper presented at the American College of Nutrition Annual Meeting, Chicago, IL.

Wang J. 1992. *Multi-frequency bio-impedance analysis to estimate total body water and extracellular water in pregnancy.* Presented at the Annual Meeting of the American Society for Clinical Nutrition, Baltimore, MD.

Wendel J. 1992. *The density of fat free mass during pregnancy.* Presented at the American Society for Clinical Nutrition, Baltimore, MD.



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## Relationship Between Infant Feeding and Infections

**Grantee**

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**Investigator**

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**Project Number** 360544

**NTIS Number** PB95-227666

**Project Period** 10/01/86–1/31/88

<b>Costs</b>	<b>Awarded</b>	<b>Requested</b>
Year 1	not available	not available
Year 2	\$84,028	not available
Year 3		
Year 4		
Year 5		
Year 6		

**Year 2000 Objectives**

2.11\*, 14.9\*, 20.9

**Study Design**

Quasi-experimental

**Time Design**

Longitudinal

**Care Emphasis**

Noninterventional

**Population Focus**

Non-pregnant women, Infants

**Racial/Ethnic Focus**

None

**Summary*****Statement of the Problem***

In developing countries, breastfeeding is associated with lower infectious morbidity. In the United States and other developed countries, the association between breastfeeding and infectious morbidity is still unclear. Clarifying this relationship has become a major public health issue in view of recent campaigns to increase the percentage of breastfed infants. Research supporting the claim that breastfeeding is protective is contradictory and has numerous research flaws.

***Research Questions or Hypotheses***

The principle aim of this study was to determine the relationship between infant feeding and infectious illnesses during the first year of life.

***Study Design and Methods***

The design of this study attempted to correct previous methodological flaws in studies examining the relationship between infant feeding and infectious illnesses. Prior studies investigating the relationship between infant feeding and infectious illnesses in developed countries have provided conflicting data about whether breastfeeding protects against common infectious illnesses early in life. These conflicts may be due in part to the failure to consider the following methodologic issues: (1) Collecting data prospectively at frequent intervals for detection of infections and of feeding practices; (2) specifying what is

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meant by infectious illnesses and breastfeeding; (3) controlling for confounding variables such as social class or the presence of siblings in the household; and (4) applying appropriate analytical strategies to a population in which both feeding and exposure to illness change over time.

The research team obtained information from mothers during a postpartum interview and mailed questionnaires monthly during the first year of the child's life. Study participants were living in Copenhagen, Denmark. Rates of illness were compared in breastfed and formula-fed infants with incidence density ratios (IDR), controlled for major covariants.

Enrollment and postpartum interview

Study participants were informed that the research team was examining infant feeding and illness during the first year of life, but were told neither the specific illnesses nor the preconceived hypotheses regarding the relationship between infant feeding and illness.

Interviews were conducted by the principal investigator or by one of three research assistants trained to use a structured precoded Danish interview. The questionnaire was piloted to ensure that the information was obtained and recorded in a reliable manner by all four interviewers.

The purpose of the postpartum interview was to collect demographic information as well as information on the mother's plans for infant feeding and child care. Socioeconomic status was assessed with the Hollingshead Scale of Social Class and a standardized Danish classification of social class based on the mother's job and education. Both classifications use a scale from 1 (highest social class) to 5 (lowest social class). The research team found no important or statistically significant differences between the results of the Hollingshead and Danish classifications.

Monthly questionnaire

The purpose of the questionnaires was to gather information about feeding, infectious illnesses, and

covariants that might be related to the risk of infection. A questionnaire was mailed to each participant every month during her child's first year of life. To ensure that it would be completed correctly, the questionnaire was reviewed for clarity and understanding with the mother after the postpartum interview. To elicit information about illnesses, the mother was asked whether the child had been sick, the type and duration of symptoms, and how the mother responded to the symptoms (e.g., called a friend or physician, went to a physician, etc.). To elicit data about symptoms in a systematic manner, the mother was asked about a list of 17 specific symptoms (e.g., "Did the child have a temperature > 38.5° C?"). Feeding histories and changes in feeding method also were obtained; the research team asked specific questions about the frequency (time and number) of feedings with breastmilk and formula, the brand of formula, and whether solid foods were given. Finally, information was obtained on illnesses in the household and on child care arrangements.

### ***Classification of feeding method***

Each infant's feeding method for the month was categorized in one of five feeding groups, by using the amounts of breastfeeding and formula feeding reported in the monthly questionnaire. This categorization was based on a modified version of the World Health Organization's classification of infant feeding. The categories were (1) 100 percent breastfeeding; (2) breastfeeding > formula feeding; (3) breastfeeding = formula feeding; (4) breastfeeding < formula feeding; and (5) 100 percent formula feeding. For the basic analyses, the research team defined the "breastfeeding group" as categories 1 and 2 and the "formula feeding group" as categories 3, 4, and 5. This classification of feeding was independent of the feeding of solids.

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### ***Classification of infectious illnesses***

Diagnoses of infectious illnesses were based on the mothers' monthly reports of specific symptoms of illnesses and on information learned about their child's health through doctor visits. In this study, the research team focused on four types of illnesses: (1) Gastroenteritis (GE), (2) upper respiratory illnesses (URI), (3) otitis media, and (4) lower respiratory illnesses. The diagnoses of gastroenteritis and upper respiratory infections were made by a computer algorithm, based on the presence of several symptoms and the timing of these symptoms as reported by the mother.

A diagnosis of GE required one of the following mutually exclusive categories: (1) The presence of at least two of the following symptoms for a duration of 2–20 days: temperature > 38.5° C, increased frequency of stools, loose stools, or vomiting; (2) at least three of these symptoms if the duration of symptoms was not reported; or (3) a physician diagnosis of gastroenteritis as reported by the mother after consulting with the physician in person or by telephone.

A diagnosis of URI required one of the following mutually exclusive categories (after excluding patients who received a physician's diagnosis of otitis media or lower respiratory infection such as bronchiolitis, croup, pneumonia, and asthma): (1) The presence of at least two of the following symptoms for 2–20 days: temperature > 38.5 C, rhinorrhea, cough, or fast breathing; (2) at least three of the above symptoms noted if the duration of the symptoms were not reported; or (3) a physician diagnosis of upper respiratory illness as reported by the mother after consulting with the physician in person or by telephone.

The diagnoses of otitis media and lower respiratory infectious illnesses (pneumonia, bronchiolitis, and croup) were made based on the mother's report of that diagnosis by a physician.

### ***Classification of covariants related to risk of infection***

Five susceptibility factors were considered: (1) Factors obtained while the mother and child were still in the hospital, namely, birthweight, social class, and the number of other children in the family; and (2) factors obtained from the monthly questionnaires, namely, child care and other illnesses in the family.

Social class was classified in two categories, upper (groups 1, 2, and 3) and lower (groups 4 and 5). Child care was classified in three categories, no child care, small-group child care (1–4 children), and large-group day care (5–20 children). "Other children in family" was classified in two categories, none and at least one. "Other infectious illnesses in family members" were classified in two categories, none and at least one other family member having an infectious illness.

### ***Study Sample and/or Population***

After obtaining informed consent, mothers were enrolled consecutively on the third or fourth postpartum day if their babies met the following criteria: (1) birthweight > 2000 grams, (2) gestational age > 36 weeks, and (3) no evidence of serious congenital disabilities or underlying illness. This population was chosen to exclude infants who might be preferentially fed in a specific manner and/or those at increased risk for infections due to an underlying condition.

This study was a prospective evaluation (over the first 12 months of life) of 500 infants born consecutively at the Gentofte University Hospital, a university-affiliated community hospital serving the Northeast region of greater Copenhagen. Between February 1 and June 30, 1985, women whose children were eligible were invited to participate in the study until a cohort of 500 was reached. To enroll this number, 548 women were contacted, and 48 refused. Potential sub-

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jects were infants delivered consecutively (except for weekends).

The return rate of monthly questionnaires was 92 percent at 1 month, 75 percent at 6 months, and 44 percent at 12 months. Of a possible 6,000 infant months (500 subjects X 12 months), the research team obtained data for 4,364 infant months (73 percent).

## **Findings**

All or mostly breastfeeding decreased from 88 percent at 1 month to 20 percent at 12 months of life. After adjusting for major covariants, the research team found no statistically significant relationship between the type of infant feeding and the incidence of four categories of infectious illnesses: Gastroenteritis, upper respiratory illness, otitis media, and lower respiratory illness. The adjusted incidence density ratio was 1.067 for gastroenteritis and .984 for upper respiratory illnesses. These data suggest that breastfeeding conveys no substantial protective effect against the occurrence of infectious illnesses early in life in a largely middle-class urban population in a developed country.

As expected, during the first 6 months of life, there was a predominance of breastfeeding, while during the second 6 months, formula became the predominant method of feeding.

The monthly incidence densities of illness in each feeding group were similar, suggesting no substantial effect of infant feeding. The results were similar when the research team examined the relationship between infant feeding and infection using two different categorizations of feeding: (1) no breastfeeding versus at least some breastfeeding (which included categories 1, 2, 3, and 4); and (2) each of the original feeding categories compared simultaneously. To examine whether there was a delay in the biological effect of breastfeeding, the research team also examined

the method of feeding at each month and the occurrence of infections in the following month. Again, no significant protective effects of breastfeeding on the incidence of illnesses were found by using this method.

Breastfeeding had a statistically significant protective effect for otitis media even after adjustment for birthweight, social class, number of children in the family, child care, and other illness in the family. However, when the research team added the age variable, this effect was no longer statistically significant, although there was still a trend favoring breastfeeding. The change from statistically significant to nonsignificant reflects the age-dependent nature of otitis media. Finally, breastfeeding had no protective effect on lower respiratory illnesses.

To examine whether children who dropped out of the study affected the results, the research team compared subjects who continued in the study and those who dropped out. At each 3-month interval, subjects who returned the questionnaire at the end of the interval were considered as continuing in the study. Subjects who missed the last month of the interval, but had returned the questionnaire of the previous month were considered as having dropped out. Of the 32 comparisons (8 comparisons for each 3-month time period), there were statistically significant differences between the two groups at 3 and 6 months only in terms of (1) more representation of the upper social classes in those who continued in the study at 3 and 6 months, and (2) more representation of older mothers who continued in the study at 6 months. There were no statistically significant differences at 9 and 12 months.

The research team also found no substantial difference in feeding patterns between those who "stayed in" versus those who "dropped out" within the upper respiratory and gastroenteritis illness categories. The results of this prospective evaluation suggest that breastfeeding does not provide substantial protection

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against common infectious illnesses during the first year of life in a largely middle-class urban population in a developed country. The lack of a protective effect of breastfeeding against infectious illnesses has been noted in other studies in developed countries. Few studies, however, have attempted to address the specific methodologic problems noted in recent critiques of this field of research.

A potential bias might have occurred in this study. It is well known that breastfed infants have more frequent and softer stools than formula-fed infants during the first few months of life. Could this have produced a detection bias due to overreporting of illness of apparent diarrhea among mothers who breastfed their infants, and therefore obscured a true protective effect of breastfeeding? The research team believed that this was unlikely to have happened, because the instrument asked whether the child had been sick and then inquired separately about changes in 17 specific symptoms. In addition, the algorithm specified that the symptoms had to be of short duration.

There are a number of limitations of this study. First, although the research team ascertained subjects' illnesses and feeding histories each month (a relatively short time interval), a shorter period of recall by parents may have provided more accurate information. Second, the research team did not supplement parental reports of illness by reviewing physicians' records or by directly examining the children. Such procedures would have been extremely costly. Third, the research team was not able to study severity of illness to determine whether breastfeeding protected infants from severe versus nonsevere illnesses. Fourth, the research team did not have complete information on every subject for all 12 months of the study. Although there were a few demographic differences between the two groups, such differences may have occurred by chance. In contrast, there were

no differences in the incidence of illnesses and feeding behaviors in these comparisons. Fifth, all of the subjects were enrolled during a short time period (February–June, 1985). Since there was only a 5-month difference between the youngest and oldest child, all of the infants were subjected to the winter viruses at a narrow range of ages. The research team could not examine the possibility of a protective effect of breastfeeding on infants who were born later in the year and were exposed to these viruses at a younger age.

By paying careful attention to the various methodologic issues, the research team found no protective effect of breastfeeding against common infectious illnesses early in life in this population. It is likely that the information derived from this study in Denmark may be extrapolated to middle-class populations in the United States. The frequency of illnesses in the cohort was roughly similar to those of other studies in this country, and a recent study showed that the percentage of women breastfeeding in the United States was similar to that found in this study.

Most importantly, the conclusions cannot be extrapolated to developing nations, where the evidence for the value of breastfeeding in reducing infections is strong, nor can the conclusions be extrapolated to rural or low-income urban populations in developed nations. Further efforts should be directed toward examining whether breastfeeding may be protective in these latter groups, which often have high rates of infectious morbidity.

## Publications

### *Articles, Books, and Chapters*

Rubin DH, Krasilnikoff PA, Leventhal JM, Berger A. 1988. Cigarette smoking and alcohol consumption during pregnancy by Danish women and their spouses—A potential source of fetal morbidity. *American Journal of Drug and Alcohol Abuse* 14(3):405–417.

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Rubin DH, Leventhal JM, Krasilnikoff PA, Kuo HS, Jekel JF, Weile B, Levee A, Kurzon M, Berget A. 1990. The relationship between infant feeding and infections: A prospective evaluation of infants during the first year of life. *Pediatrics* 85:464-471.

Weile B, Rubin DH, Krasilnikoff PA, Kuo HS, Jekel JF. 1990. Infant feeding patterns during the first year of life: Factors associated with the discontinuation of breastfeeding. *Journal of Clinical Epidemiology* 43(12):1305-1311.

### **Abstracts**

Rubin DH, Leventhal JM, Krasilnikoff PA, Jekel J, Weile B, Kurzon M, Levee A, Palmer L, Menasse L. 1987. The relationship between infant feeding and infection. *Pediatric Research* 21:262A.

### **Presentations**

Rubin DH. 1990, May. *The relationship between infant feeding and infectious illness*. Presented at the Danish Pediatric Society Annual Meeting, Copenhagen, Denmark.

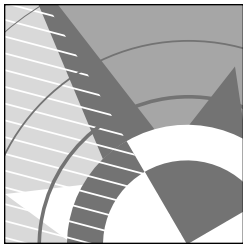
Rubin DH. 1988, October. *The relationship between infant feeding and infection*. Invited guest speaker at Pediatric Grand Rounds, University of California, San Francisco General Hospital, San Francisco, CA.

Rubin DH. 1987, September. *The relationship between infant feeding and infectious illnesses*. Presented at the Annual Pediatrics Research Day, Department of Pediatrics, Albert Einstein College of Medicine, Bronx, NY.

Rubin DH, Leventhal JM, Jekel JF, Kuo HS, Krasilnikoff PA, Weile B. 1989, May. *The relationship between size of day care and infectious illness*. Presented at the Society for Pediatric Research Meeting, Washington, DC.

Rubin DH, Leventhal JM, Krasilnikoff PA, Jekel J, Weile B, Levee A, Kurzon M, Kuo S. 1988, November. *Infant feeding patterns in a developed country with low neonatal and infant morbidity and mortality*. Presented at the American Public Health Association Meeting, Boston, MA.

Rubin DH, Leventhal JM, Krasilnikoff PA, Jekel J, Weile B, Levee A, Kurzon M, Kuo S. 1988, May. *Does breastfeeding protect against infectious illnesses in the first 6 months of life in developed countries?* Presented at the European Society for Pediatric Gastroenterology and Nutrition meeting, Copenhagen, Denmark.



## Otitis Media in Children and Later Language and Learning

### Grantee

University of North Carolina at Chapel Hill

### Investigator

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**Project Number** 370599

**NTIS Number** PB97-155030

**Project Period** 10/01/90-09/30/95

Costs	Awarded	Requested
Year 1	\$281,154	\$281,153
Year 2	\$226,372	\$292,977
Year 3	\$238,630	\$308,604
Year 4	\$251,942	\$325,170
Year 5	\$233,776	\$336,949
Year 6		

### Year 2000 Objectives

8.3, 17.15, 20.9

### Study Design

Observational

### Time Design

Longitudinal

### Care Emphasis

Noninterventional

### Population Focus

Infants, Toddlers, Preschool children

### Racial/Ethnic Focus

African Americans

## Summary

### *Statement of the Problem*

After the common cold, otitis media or middle ear disease is the most prevalent illness of early childhood and the most common diagnosis made by physicians in children under age 15. When there is fluid in the middle ear, the condition is called otitis media with effusion (OME). Fluid in the middle ear may persist for several weeks or even months after the onset of an episode of otitis media. Children with OME generally have some hearing loss that continues as long as the fluid is present. The loss is usually mild to moderate in degree, averaging about 25 dB HL, although the loss can range from none to as much as 50 dB HL. It has been hypothesized that children who experience hearing loss due to repeated bouts of otitis media during the early formative years of language learning will experience later speech and language disorders, learning disabilities, and academic problems. Many studies have found that children who experienced repeated or persistent bouts of otitis media have poorer scores on measures of speech, language, and academic performance during their preschool and school-age years. Although a growing number of studies have shown a significant relationship between OME and later measures of speech, language, and learning, many studies have not supported this association. Further, others have criticized the validity of previous OME language learning studies and claim that no reliable relationship has been identified.

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## ***Research Questions or Hypotheses***

This study examined how otitis media with effusion (OME) and its associated hearing loss during early childhood relate to the development of language and learning during the preschool years. The specific aims were to examine (1) the relationship between the amount of OME with accompanying hearing loss during infancy and the preschool period and the patterns of speech, language, and neuropsychological development during the preschool period, and (2) other factors, such as stimulation within the home environment or quality of the child care environment, which might interact with OME to predict later development of language and learning skills.

## ***Study Design and Methods***

Ear status was assessed with pneumatic otoscopy and immittance measures every other week. Hearing sensitivity was measured with age-appropriate pure tone measures every 3 months as well as during episodes of OME. Beginning when the child reached 12 months of age, speech and language and other developmental measures were administered annually.

On average, children's ears were examined with otoscopy and tympanometry 71.9 times (SD = 18.6) between study entry and 4 years of age. Children's hearing was tested, on average, 20.6 times (SD = 4.1) during this period. The number of completed developmental assessments and the age of administration are as follows: 95 children assessed at 12 months, 87 at 18 months, 88 at 24 months, 88 at 30 months, 88 at 36 months, 87 at 42 months, and 87 at 48 months.

Patterns of development over time for the outcome measures were studied in relation to hearing loss and OME. Structural equation analyses and regression analyses were used to examine how OME, OME-associated hearing loss, and mediating factors (child's

home and child care environments) affected the development of children's language and cognitive skills. Based on study findings, guidelines were developed for intervention with children with persistent OME.

## ***Study Sample and/or Population***

In total, 87 African-American children attending center-based child care participated in the study through 4 years of age. Two-thirds of these families had low income levels. All parents of African-American infants enrolled in nine community-based child care centers in two small southern cities were invited to join the research project. At entry into the study, the mean level of maternal education was 12.5 years; 27 percent of the mothers had not graduated from high school, 31 percent had completed high school only, and 42 percent had pursued education beyond high school.

## ***Findings***

The results showed a higher incidence of OME than reported in previous studies among young children. From 6 to 12 months of life, children experienced bilateral or unilateral OME 89 percent of the time; 80 percent of the OME was bilateral. From 12 to 24 months, children experienced OME 55 percent of the time. The incidence of OME decreased to 21 percent of the observations between 2 and 3 years and to 15 percent between 3 and 4 years. Sixty-five percent of the children had at least 4 months of continuous bilateral OME between the ages of 6 months and 2 years; in 76 percent of children, this had resolved by age 2. Hearing loss (defined as 25 dB HL or greater for more than half of the frequencies tested) was present 57 percent of the time in children from age 6 months to 1 year, 40 percent from 1 to 2 years, 18 percent from 2 to 3 years, and 9 percent from 3 to 4 years.

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There was a direct association between OME and associated hearing loss and measures of children's language and cognition at 1 and 2 years of age. However, these relationships were no longer significant when the quality of home and child care environments were taken into account. In other words, there were indirect associations between OME and associated hearing loss and language and cognitive skills at 1 and 2 years of age as mediated by the quality of the home and child care environments: Children with more frequent OME and associated hearing loss tended to have less responsive home and child care environments, and this association was linked to poorer performance in language and cognitive development at 1 and 2 years of age.

Subsequently, longitudinal analyses examining OME, hearing loss, and communication and cognitive measures were conducted at 1, 2, and 3 years of age and controlled for child, family, and child care characteristics. These results showed that OME and associated hearing loss during the preschool years appeared to be related to a developmental pattern of a slightly slower acquisition of receptive and expressive language skills over time. By age 3, the children with the most (versus least) amount of OME differed by as much as 3 months in expressive language and 2 months in receptive language. Thus, during the preschool years we are finding a very weak but direct association between OME and associated hearing loss and language skills. Measures of the home and child care environments, however, did explain more of the variance in the cognitive and language skills than did OME and associated hearing loss.

Further analyses examined how other factors, including the quality of the child care environment and stimulation within the home environment, influence children's cognitive and language development during early childhood. Children attending higher-quality child care settings with smaller teacher/child

ratios in infancy and the preschool years tended to have higher scores on standardized assessments of cognitive and language skills during the first 3 years of life. For example, on average, a difference of one point on the Infant Toddler Environment Rating Scale (a 7-point rating scale of child care quality, with 1 = inadequate, 3 = minimal, 5 = good, and 7 = excellent) was related on standardized measures to differences of about 6 points in cognitive development and 3 points in language development. Further, mothers who elaborated more on their children's verbalizations had children who scored higher in language skills. In addition, the number of social and family risk factors (e.g., living in poverty, stressful life events) also predicted developmental outcomes in infancy: The greater the number of risk factors, the lower the children's scores on the developmental outcomes.

The results of these studies have several implications for health care delivery. First, given that OME is highly prevalent in early childhood, particularly among children in child care settings, it is important to monitor children's middle ear status and provide routine hearing screenings for children at risk for OME or for those who have experienced repeated or prolonged bouts of OME. Second, given the finding of a weak association between OME and language outcomes, the language of children with recurrent or persistent OME should be screened. Third, given the importance of the caregiving environment in the context of a relationship between OME and later development, families, child care providers, and other health care providers should receive information about the signs and symptoms of OME, hearing loss, and language delay. Further, they should be encouraged to use strategies that promote health, language, listening, and learning among children who experience chronic OME. Examples of these promotion strategies include frequent handwashing (health promotion), responding positively to children's communication attempts

(language promotion), decreasing background noise in noisy environments (listening), and reading often to children, checking to see whether they understand what is being read (learning).

Finally, it is not possible to recommend more aggressive surgical management of children with frequent and/or persistent OME until research studies have examined the long-term effects of a history of OME into the school-age years. The research team is currently following the study children until second grade. The finding that quality of child care in community-based child care programs is related to cognitive and language development during the early preschool years has important implications. Community-based child care programs, especially for families living in poverty, should ensure that children receive high-quality child care beginning in infancy.

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## Infant Mortality and Socioeconomic Status

### Grantee

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### Investigator

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**Project Number** 390629

**NTIS Number** PB95-231916

**Project Period** 06/01/93–05/31/94

Costs	Awarded	Requested
Year 1	\$101,831	\$110,371
Year 2	n/a	n/a
Year 3	n/a	n/a
Year 4	n/a	n/a
Year 5	n/a	n/a
Year 6		

### Year 2000 Objectives

14.1, 22.4

### Study Design

Observational

### Time Design

Longitudinal

### Care Emphasis

Noninterventional

### Population Focus

Infants

### Racial/Ethnic Focus

African Americans

## Summary

### *Statement of the Problem*

Previous research based on data from metropolitan Ohio in 1960, 1970, and 1980 clearly revealed the existence of a pronounced inverse relationship between infant mortality and socioeconomic status. The nature and magnitude of the relationship has varied over time and often varies among particular subgroups in the population. Given the continued (albeit slower) declines in infant mortality during the 1980s, and especially the more rapid reduction in neonatal mortality, additional research is needed to determine whether these declines are characteristic of all socioeconomic segments of the study population and whether they have had any impact on the nature of the long-standing inverse relationship between infant mortality and socioeconomic status.

### *Research Questions or Hypotheses*

The overall objective of this study was to follow up and expand the previous research on trends in the relationship between socioeconomic status and infant mortality in metropolitan Ohio. The general aims were to (1) measure and describe the nature and magnitude of the relationship between infant mortality (total, neonatal, and postneonatal) and the aggregate family income status of urban residential areas, for both whites and nonwhites, by sex; and (2) assess the role of particular causes of death in contributing to any observed economic differentials.

The specific aims were to (1) update to 1990 the

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longitudinal analysis of the relationship between socioeconomic status and infant mortality in the three-city aggregate (Columbus, Dayton, Toledo) on which the previous research was based; and (2) take advantage of a larger data base involving several additional cities to undertake a more detailed analysis of the relationship for the 1990 period.

### ***Study Design and Methods***

The relationship between infant mortality and socioeconomic status was examined within an ecological framework in which the basic unit of analysis was the census tract of the mother's usual residence. Although some multivariate analyses were carried out, the major approach involved a social area analysis wherein the census tracts of the Ohio metropolitan centers were aggregated into broad economic areas, which were then ranked and compared in terms of infant mortality levels. These comparisons were carried out separately for whites and nonwhites, by sex, and for broad cause-of-death categories. In line with the specific aims of the research, two sets of comparisons were made: One based on a three-city aggregate comparable to the 1959–61, 1969–71, and 1979–81 aggregates that formed the basis of previous research; the other, based on a seven-city aggregate that provided an expanded data base for a more detailed cause-specific analysis for the 1989–91 period.

### ***Study Sample and/or Population***

The study population comprised the universe of infants less than 1 year of age in the major cities of Ohio between January 1, 1989, and December 31, 1991. The primary independent variable was defined as the percentage of low-income families in each census tract at the time of the 1990 census. As in previous research, the low-income cutoff point (\$15,000

in 1990) was set at roughly half the median family income for metropolitan Ohio. The dependent variable data consisted of counts of the number of live births in each census tract during 1990, and counts of the number of infant deaths occurring during the 3 years centering on the census data, thus providing the data needed to calculate conventional 3-year average infant mortality rates.

### ***Findings***

The findings revealed a very strong and persistent inverse relationship between infant mortality and family economic status in metropolitan Ohio. There appeared to be a blurring and general weakening of this relationship in 1970, but by 1980 and again in 1990, there was a pronounced and consistent inverse association between these two variables.

The general trend characterized by a weakening of the inverse differential in 1970 and its clear reemergence in 1980 was observed for both males and females, with the differential consistently more pronounced for males. It was generally characteristic of both whites and nonwhites, although nonwhite infant mortality rates were notably less sensitive to differences in economic status than those of the white population. Further, the overall trends and patterns were found to characterize both exogenous and endogenous cause-of-death categories. Although there were more deviations from the general pattern when more specific subgroups were considered, the existence of a general inverse association between infant mortality and income status was apparent in 1990. In fact, the magnitude of the inverse socioeconomic infant mortality differential was somewhat stronger in 1990 than it had been 30 years earlier. Based on these data, the research team concluded that despite the substantial declines in the overall infant mortality rate since 1960, there has been no progress in closing the

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gap that separates the more affluent from the poorest members of society.

Analysis of the expanded 1990 data base confirmed the preceding conclusion. Not only was the overall infant mortality rate higher in the seven-city aggregate than in the three-city aggregate, but many of the deviations noted earlier were eliminated. The inverse association was somewhat stronger in the seven-city aggregate, notably for postneonatal mortality. One exception concerned the nonwhite population. Although a modest inverse association was apparent for the three-city data base, it was considerably weakened in the expanded sample.

A more detailed cause-specific analysis revealed that both exogenous and endogenous death rates were inversely related to economic status, with the differential being widest for the exogenous causes but most consistent for the more prevalent endogenous causes. There were variations for some specific causes, and among specific sex-race groups, but not enough to detract from the overall major finding of the study. There continues to be a pervasive and pronounced inverse association between infant mortality and the aggregate family income status of residential neighborhoods in metropolitan Ohio.

These findings have identified three basic policy needs. First, there is a clear need to provide better and more accessible maternal and child health care for the economically disadvantaged groups in society. Second, there is a need to expand educational efforts aimed at reducing the incidence of unhealthy behaviors such as poor eating habits and/or smoking or other drug use during pregnancy. Finally, society needs to make a stronger commitment to reducing many of the existing economic inequalities that are the major determinants of many of the current infant mortality differentials.

The findings of this research also point out three areas with an especially important need for additional

research. First, there is a need for a large-scale national study of the relationship between socioeconomic status and infant mortality with a sufficiently large sample so that it is possible to control for such important variables as ethnic status, urban/rural residence, city size, and geographic region. Second, there is a serious need for continued research to clarify the etiologic mechanisms of sudden infant death syndrome (SIDS). A better understanding and control of this single cause would have a substantial impact on reducing the overall level of infant mortality in general and narrowing the gap between the higher and lower income groups in particular. Third, there is a continuing need for research on the development of more effective health intervention strategies so that economic status is not the basic criterion determining both the amount and quality of maternal and child health care received and the risk of infant death.

## Publications

### *Articles, Books, and Chapters*

Stockwell EG, Goza FW. 1996. Infant mortality and economic status in metropolitan Ohio, total and cause-specific: 1979–91 and 1989–91. *Sociological Focus* 29:379–388.

Stockwell EG, Goza FW. 1996. Racial differences in the relationship between infant mortality and socioeconomic status. *Journal of Biosocial Science* 28:73–84.

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Stockwell EG, Goza FW, Roach JL. 1995. The relationship between socioeconomic status and infant mortality in a metropolitan aggregate, 1989–1991. *Sociological Forum* 10(2):297–308.

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## **Abstracts**

None to date.

## **Presentations**

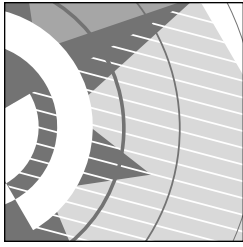
Stockwell EG, Goza FW. 1994, October. *Sudden infant death syndrome and the relationship between period and cause-specific death rates in infancy*. Presented at the annual meeting of the Southern Demographic Association, Atlanta, GA.

Stockwell EG, Goza FW, Jiang Y, Luse VO. 1994, May. *Trends in the relationship between socioeconomic status and infant mortality, total (1960–1990) and cause-specific (1980–1990)*. Presented at the annual meeting of the Population Association of America, Miami, FL.

Stockwell EG, Goza FW, Jiang Y, Luse VO. 1994, April. *Family income and infant mortality in Ohio, 1960–1990*. Presented at the annual meeting of the North Central Sociological Association, Columbus, OH.

Stockwell EG, Goza FW, Jiang Y, Luse VO. 1993, October. *Trends in the relationship between socioeconomic status and infant mortality in metropolitan Ohio, 1960–1990*. Presented at the annual meeting of the Southern Demographic Association, New Orleans, LA.

Stockwell EG, Goza FW, Roach JL. 1994, March. *The relationship between socioeconomic status and infant mortality in metropolitan Ohio, 1989–1991*. Presented at the annual meeting of the Eastern Sociological Society, Baltimore, MD.



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## Early Cortisol Deficiency and Bronchopulmonary Dysplasia

### Grantee

Pennsylvania State University

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**Project Number** 420627

**NTIS Number** PB96-187299

**Project Period** 03/01/93–6/30/95

Costs	Awarded	Requested
Year 1	\$245,964	\$325,656
Year 2	\$246,990	\$334,006
Year 3	n/a	n/a
Year 4	n/a	n/a
Year 5	n/a	n/a
Year 6		

### Year 2000 Objectives

2.4, 14.1, 17.2

### Study Design

Observational

### Time Design

Mixed

### Care Emphasis

Noninterventional

### Population Focus

Neonates

### Racial/Ethnic Focus

None

## Summary

### *Statement of the Problem*

**B**ronchopulmonary dysplasia (BPD), chronic lung disease following neonatal lung injury, is a leading cause of morbidity and mortality in very low birthweight (VLBW) babies. BPD occurs in about 30 percent of all babies weighing less than 1,500 grams, thereby affecting approximately 15,000 babies each year. BPD also has a well-recognized inverse relationship with birthweight, occurring in up to 70–90 percent of surviving babies weighing less than 750 grams. The introduction of exogenous surfactant therapy for respiratory distress syndrome has significantly decreased mortality rates in VLBW babies. Unfortunately, this therapy has had either modest or no success in decreasing the percentage of these babies who develop BPD. The introduction of a therapy that significantly reduces the incidence of BPD would be expected to substantially improve neonatal care and outcome for these small premature infants and decrease the cost of that care.

BPD may develop in response to oxygen toxicity and barotrauma; however, increasing evidence indicates that inflammation plays a key role in its pathogenesis. The research team and others had found elevated markers of inflammatory activity in intubated neonates who develop BPD. Additionally, the research team found a group of babies in whom basal cortisol values during the first week of life appeared to be disproportionately low for the severity of clinical illness. The research team postulated that these babies have a period of dampened responsiveness of their adrenal

axis, which allows the inflammatory process to be amplified and which may lead to the development of chronic lung disease.

### **Research Questions or Hypotheses**

This study was designed to test the three hypotheses:

1. At the end of the first postnatal week, all VLBW infants develop a nadir in cortisol concentration, independent of sex and gestational age and unresponsive to continued significant clinical acuity;
2. A transient cortisol deficiency develops in a subset of VLBW infants, resulting in an uncontrolled inflammatory response; and
3. Abnormally low cortisol concentrations in the first week of postnatal life result in BPD.

### **Study Design and Methods**

This research was designed as an observational study, conducted at two centers. The eligible population included appropriate-for-gestational-age newborn infants weighing less than 1,501 grams at birth. The research team measured basal serum cortisol values on days 2, 4, and 6 of postnatal life. On one of those days, the research team administered cosyntropin (ACTH analog) and measured the stimulated cortisol concentration 30 minutes later. The research team collected tracheal lavage fluids from these babies on day of life 0, 2, and 6 if they were intubated, for measurement of markers of inflammatory activity. The research team also collected urine samples during the first 2 weeks of life for measurement of epidermal growth factor concentrations.

Basal cortisol concentrations and the response to ACTH stimulation were correlated with gestational and postnatal age, clinical measures of respiratory illness, markers of inflammation in tracheal aspirates, and urinary epidermal growth factor concentrations.

The research team evaluated the role of cortisol deficiency in the development of chronic lung disease by correlating cortisol concentrations and response to cosyntropin with the outcome variables for bronchopulmonary dysplasia (need for supplemental oxygen at 28 days of life) and chronic lung disease (need for supplemental oxygen at 36 weeks' postconception).

### **Study Population**

The research team enrolled 161 patients from 2 centers: The Milton S. Hershey Medical Center (HMC) and the University of New Mexico (UNM). Selected demographic and clinical data for the two sites are listed below.

	HMC (n=87)	UNM (n=74)	TOTAL (n=161)
Birthweight, g	1,005 ± 269 (523–1,484)	1,051 ± 224 (570–1,500)	1,026 ± 249 (523–1,500)
Gestational Age, weeks	27.5 ± 2.3 (23–33)	28.5 ± 2.0 (24–32)	28.0 ± 2.0 (23–33)
Surfactant Given	63 (72%)	45 (62%)	108
Males/Females	56/31	36/38	92/69
Prenatal Steroids	16	17	33
Died Before Discharge	5	7	12
Withdrawn	3	1	4
BPD	44/79	39/66	83/145

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## **Abstract**

The research team found that during the first week of life, babies who subsequently developed BPD had lower serum cortisol concentrations compared with babies who resolved their respiratory disease. This was true despite the additional finding that basal cortisol values were inversely correlated to gestation (e., less mature babies had higher basal cortisol concentrations).

The research team found that within this population of premature infants, the less mature newborns had lower responses to ACTH than did the more mature infants. At any gestational age, however, a decreased response to ACTH at the end of the first week of life correlated with an increased probability of developing BPD. Additionally, the population of babies who subsequently developed BPD showed a pattern through the first week of life of decreasing response to ACTH stimulation, whereas babies who recovered without BPD showed an increasing response to stimulation during this time period.

These findings are consistent with the hypothesis that babies who develop BPD exhaust their adrenal reserve during the first days of postnatal life, rendering them more susceptible to continuing lung injury. Less mature babies may have less adrenal reserve or may have less sensitivity to feedback mechanisms, predisposing them to develop BPD.

Other evidence of cortisol effect during the first postnatal week included the following findings: (1) As cortisol concentrations increased, urinary epidermal growth factor (EGF) concentrations also increased; (2) babies with higher cortisol values were more likely to be on oral nutrition by the end of the first week of life, independent of gestational age; and (3) cortisol concentrations correlated directly with weight loss during the first week, suggesting that cortisol is important for the diuresis of the newborn infant.

The research team found a significant inverse relationship between basal cortisol concentration and tracheal fluid proteins and between cortisol and tracheal fluid interleukin 6. For interleukin 1 and 8, the slope of the regression was negative, but the correlation was not significant.

This correlation provides evidence of a potential mechanism for a relationship between early cortisol concentration and respiratory outcome, namely, that cortisol insufficiency may potentiate increased inflammation and protein leak in the lung, resulting in chronic lung disease.

The data from this study strongly support, but do not prove, the hypothesis that decreased cortisol effect during the first week of life is causally linked with adverse respiratory outcome.

The findings also do not address whether supplementation with exogenous hydrocortisone would ameliorate this adverse outcome. These findings, in concert with the meta-analysis of previously conducted trials of early high-dose steroid therapy, clearly provide a theoretical basis to support the development of a randomized trial of early hydrocortisone replacement therapy to decrease the incidence of chronic lung disease in this population. This trial would evaluate the effectiveness of low-dose replacement therapy, thus decreasing exposure to high concentrations of exogenous steroids.

## **Publications**

### ***Articles, Books, and Chapters***

Scott SM, Watterberg KL. 1995. Effect of gestational age, postnatal age, and illness on plasma cortisol concentrations in premature infants. *Pediatric Research* 37:112–116.

Watterberg KL, Scott SM. 1995. Evidence of early adrenal insufficiency in babies who develop bronchopulmonary dysplasia. *Pediatrics* 85:120–125.

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Watterberg KL, Scott SM, Naeye RL. 1997. Chorioamnionitis, cortisol and acute lung disease in very low birthweight infants. *Pediatrics* 99(2):e6.

### **Abstracts**

Scott SM, Watterberg KL. 1994. Role of cortisol in weight change in premature infants. *Pediatric Research* 35:254A.

Watterberg KL, Scott SM. 1995. Babies who develop bronchopulmonary dysplasia (BPD) and chronic lung disease (CLD) have decreased serum cortisol [C] concentrations in the first week of life. *Pediatric Research* 37:356A.

Watterberg KL, Scott SM. 1995. The effect of chorioamnionitis on serum cortisol concentrations [C], tracheal interleukin 1B, and respiratory distress syndrome (RDS) in very low birth weight (VLBW) infants. *Pediatric Research* 37:244A.

Watterberg KL, Scott SM. 1993. Early cortisol deficiency precedes bronchopulmonary dysplasia. *Pediatric Research* 33:242A.

### **Presentations**

Scott SM. 1994. *Role of cortisol in weight change in premature infants*. Presented to the Society for Pediatric Research.

Scott SM. 1993. *Applicability of ACTH-stimulation test to premature infants*. Presented at the American Academy of Pediatrics, Perinatal Section.

Watterberg KL. 1995. *Babies who develop bronchopulmonary dysplasia (BPD) and chronic lung disease (CLD) have decreased serum cortisol [C] concentrations in the first week of life*. Presented to the Society for Pediatric Research.

Watterberg KL. 1995. *The effect of chorioamnionitis on serum cortisol concentrations [C], tracheal interleukin 1B, and respiratory distress syndrome (RDS) in very low birth weight (VLBW) infants*. Presented to the Society for Pediatric Research.

Watterberg KL. 1994. *Relationship of chorioamnionitis to respiratory distress syndrome and BPD in VLBW newborns, and to their serum cortisol concentrations*. Presented at the Mid-Atlantic Regional Neonatal Research Conference.

Watterberg KL. 1993. *Early cortisol deficiency precedes bronchopulmonary dysplasia*. Presented to the Society for Pediatric Research.