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PRENATAL CARE AND PREGNANCY OUTCOME

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The background preparation for a recent research project funded by DHHS* included collection of the available information on the relationship of prenatal care to pregnancy outcome, particularly low birthweight and infant mortality. Shortly after this exploration began, it became very clear that there was a full range of opinion among professionals. Some investigators claim that the major cause of adverse pregnancy outcomes is lack of prenatal care; others totally discount the importance of prenatal care itself, considering such care a proxy for other characteristics that are the actual determinants of adverse outcomes.

With these polar positions recognized, the studies on this topic were reviewed, and specific attention was given to determining whether a beneficial effect of prenatal care could be demonstrated. This review covered studies conducted in the United States, mostly in urban areas characterized by poverty. Its goal was to explore the possible impact of improving prenatal care in such settings. The following material summarizes some of the studies that were significant for this purpose. In addition, it describes others because they have helped in the identification of particular prenatal care activities that seem to be important for beneficial effects to be observed in specific at-risk groups.

Examination of demonstrated effects of prenatal care permits

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better assessment of the conditions under which prenatal care influences pregnancy outcome. In addition, such an examination may reveal the methodologies that are useful for demonstrating that prenatal care can be of value. Therefore, this selective review of the literature examines both the methods used to evaluate the effectiveness of prenatal care and the characteristics of those prenatal programs shown to be effective.

It is commonly argued that prenatal care has a positive effect on the outcome of pregnancy. This conviction appears to be based on both logic and observation. On the one hand, it is logical that medical problems that persist in women who do not get prenatal care are treated in women who do. Since women experiencing medical problems during gestation (anemia, hypertension, diabetes, etc.) are very likely to experience adverse pregnancy outcomes, it is reasonable to expect that treatment may improve outcome. This logic carries some persuasive weight. Aside from this theoretical approach, the value of prenatal care appears to be clinically supported, since women receiving no care prior to delivery have consistently worse outcomes than women who receive prenatal care. Innumerable studies have documented this relationship.

Despite these considerations, doubts about the ability of prenatal care to improve outcomes persist, particularly in regard to programs to extend care to pregnant women who would otherwise receive little or no prenatal care. These doubts rest on the recognition that women who do get prenatal care are, in a sense,

self-selected or "volunteers." The self-determination, health interest, and resource allocation that enable them to get care may, more than the care itself, determine that they will have better pregnancy outcomes. Women who get little or no care, on the other hand, may exercise less self-control and self-care generally, and may expose themselves to a variety of health risks (alcohol, drug, or cigarette use; emotional problems; poor nutrition; etc.). Women with these risk factors are quite likely to be highly represented among those who fail to seek prenatal care. If these other behaviors or circumstances are the real causes of adverse outcomes (i.e., if lack of prenatal care plays no role), then extending care to these women, by whatever means, will have no beneficial effect.

Although the "volunteer" problem has been widely used to discredit the importance of prenatal care, little attention has been paid to factors that reduce our ability to detect an effect of care. One of these factors is improper reporting of receipt of care. It has been noted that birth certificates and other record sources may have the number of prenatal visits listed as "none," or the item may be left blank, for many women who actually obtained care, but at a site other than the hospital where they delivered (such as a Maternity and Infant Care [MIC] center). Thus, when women who had no prenatal care are separated from those who had care, the "no care" group may contain many mothers who had adequate care. This means that differences between the "no care" and "any care" groups will be harder to detect, and the differences that are observed will be smaller than the real differences. The effect may be considerable,

markedly attenuating the apparent relationship between poor outcome and no prenatal care.

The importance of this consideration is indicated by an interview study of women delivering in four New York City hospitals between December 1977 and May 1978 (Chao et al., 1981). Women identified as having had no prenatal care (that is, who had not been registered for prenatal care either in the hospital in which they delivered or with a physician affiliated with that hospital) had actually obtained prenatal care in more than 75 percent of the cases. Considering that so large a portion of the "no care" group had actually received care, the consistent association between no care and poor outcome is even more impressive, having persisted through possibly as much as a fourfold dilution. Nevertheless, several factors whose quantitative impact is difficult to assess might be contributing to the residual relationship between inadequate care and poor outcome, and the causal connection remains disputable.

One of the factors that may enhance the relationship between no care and poor outcome is gestational length. In a study of 197 low-birth-weight infants (those weighing 2,500 g or less) and controls matched for gender, birth order, and maternal age and marital status (Terris and Gold, 1969), no association was found between low birthweight and prenatal care (defined as week of first prenatal visit or number of visits corrected for gestational length). This result is important because it suggests that where a relationship is found between prenatal care and reduced low-birthweight rates, it may be an artifact of early

delivery, since preterm delivery could prevent initiation of care or reduce the number of prenatal visits. (For example, this may explain the benefits of prenatal care observed by Ryan et al., 1980.) A later life-table analysis of the relationship of prenatal care to low birthweight and to shortened gestation (Terris and Glasser, 1974) gave further support to this interpretation. As a result of these findings, current studies generally adjust the expected number of visits for gestational length. With this adjustment, however, many studies have shown a persisting association between care and outcome, as we will see below.

In a study designed to compare pregnancy outcomes of the women enrolled in a health maintenance organization (HMO) with those of the general population, the relationships between the number of prenatal visits and both infant mortality and low-birthweight rates were examined (Quick et al., 1981). Using three levels of prenatal care (each based on the number of prenatal visits, adjusted for gestational length), the investigators observed consistent decreases in low-birthweight rates and in infant mortality as the level of care increased. This finding held in both the HMO and the general populations. Although some maternal attitudes that may be related to failure to obtain adequate care and to poor outcome were not measured or statistically controlled, the many sociodemographic variables available from birth and death records were controlled for. Thus, those differences in attitudes that would be expected in different demographic groups and that might determine both outcome and care-seeking differences did not explain the positive

relationship between prenatal care and outcome demonstrated in this study.

Furthermore, the salutory effect of more prenatal visits was most notable in women classified as having medical-obstetric risk factors, as opposed to those with no risk factors or with sociodemographic risk factors only. This finding supports the hypothesis that prenatal care improves pregnancy outcome by reducing the impact of medical problems, and suggests that the association between level of care and outcome will be weaker in populations at lower risk of adverse outcomes. Among women at low risk, we would expect the effect of care to be undetectable. Surely, in low-risk women there may be no relationship between the number of visits and outcome.

Nevertheless, various high-risk groups may respond differently to the same prenatal care. For example, analysis of records of high-risk pregnant women who were referred to an intensive care clinic (De George et al., 1971) indicated that in white women who had had two early deliveries, prenatal care could increase gestational length. The results for black women were not improved. Whether the difference between the groups was due to different etiologies for the early deliveries, different maternal characteristics, or different interaction with the health team cannot be determined. However, rather than indicating that the effect in white women was merely fortuitous, the finding suggests that a prenatal program needs to be tailored to the population it serves.

Other studies of programs for special populations have been

reported and provide some interesting perspectives. For example, one study compared students receiving care in a high school MIC clinic and a matched comparison group served at a nonschool MIC clinic (Berg et al., 1979). In such a comparison, we might expect the nonschool clinic participants to have been more motivated and organized, since the school clinic was more accessible. Thus, in this case, the nonschool clinic patients would have better outcomes if volunteerism were a factor and the care itself insignificant. In fact, however, the school clinic students began prenatal care earlier and made more prenatal visits. In addition, they had reduced incidence of low-birthweight babies, anemia, toxemia, urinary tract infections, complicated delivery, and cephalopelvic disproportion. Some of the differences in outcome may have been due to small differences in the age distributions of the two populations. Mean age was the same in the two groups; but 8.4 percent of the comparison group were 14 years of age or less, while all of the study group mothers were older than 14. Since the age distribution of the women who had adverse outcomes was not given, we can consider these findings only suggestive that more prenatal care in a familiar setting can benefit young mothers. Since volunteerism is so frequently used to minimize the importance of the observed relationship between prenatal care and good outcome, it is important to recognize that not all studies that show a beneficial effect can be dismissed on this basis.

Another study also attempted to eliminate the problem of self-selection (Sokol et al., 1980). Investigators examined the influence of prenatal care provided by an MIC program by

comparing a group of women receiving such care with a similar group who were ineligible for the MIC program because they lived outside of the target areas. All patients delivered in the same hospital and received the same intrapartum care.

Using the clinical records, investigators ranked the patients on a previously developed and tested risk assessment scale (Hobel et al., 1973) based on over 300 antepartum and intrapartum risk factors. Since referred patients in both groups tended to have a higher risk score than did non-referred patients, all referred patients were excluded from the study. Patients who had received no prenatal care were also eliminated. The resulting groups of MIC patients had significantly higher risk scores than did non-MIC patients, an observation that would lead us to expect poorer outcomes in the MIC patients. Nevertheless, the MIC group had 24 percent fewer preterm deliveries than the non-MIC group, and their babies had higher mean birthweights and a 16 percent lower low-birthweight rate than the infants born to the other women. Furthermore, perinatal mortality was half as high among babies born to women in the MIC group as among those born to the other women.

Use of the risk scoring system in this study, and elimination of women receiving no prenatal care, minimized the likelihood that maternal characteristics (and not prenatal care) were responsible for better outcomes in the MIC group. Furthermore, since many of the MIC patients were seen by the same medical personnel as the non-MIC patients, basic prenatal care was largely the same in both groups. This finding suggests that

the ancillary services offered by the MIC program and the fact that the MIC mothers made more prenatal visits than the non-MIC mothers may have determined the improved outcome. Other services provided by MIC facilities include patient education, home visits, nutrition assessment and counseling, social service assessment and intervention, and dental care.

This study is important because it establishes a link between improved outcome and the services actually obtained during prenatal care. In general, the studies of prenatal care do no more than determine if a woman has appeared for a visit. Although receipt of appropriate care depends on her appearing for her prenatal visits, the quality of care received undoubtedly varies over a wide range. No studies have attempted to assess what aspects of care (processes) are most important in influencing outcome. This study, however, suggests that routine services may not be as effective as is a package that also includes ancillary medical and social services.

The mechanism by which ancillary services may improve outcome is suggested by a study of over 90,000 births (Gortmaker, 1979). In this study, many demographic characteristics (parental education, maternal age, birth order, marital status), as well as gestational medical conditions, type of hospital service, and gestational length, were controlled.

Prenatal care was grouped into adequate, intermediate, or inadequate, on the basis of the number of prenatal visits, adjusted for gestational length. Although adequate prenatal care did not affect relative risk of postneonatal mortality, it did affect the risk of low birthweight and, in black infants, of

neonatal mortality, two risks that would most likely be determined by gestational events. It is also worth noting that parental education, marital status, family size, and type of hospital service were independently associated with the probability of having prenatal care. In fact, parental education, maternal age, birth order, and marital status all predicted the adequacy of care received, indicating the importance of controlling for these factors, as the authors did. However, important maternal variables not available on birth or death records (smoking, infection rate, employment, etc.) could not be controlled and may contribute to the 50-100 percent difference in low-birthweight rates, as well as to the different amount of prenatal care sought.

Nevertheless, this study indicated that even when several important sociodemographic factors that might distinguish among women with different risk are controlled, prenatal care may decrease infant mortality, and do so via the relationship of care to reduced low-birthweight rates. This association was muted, however, in white women who delivered on a private service, supporting the suggestion made earlier that care may not have as important an effect in low-risk populations.

These results suggest why ancillary services may be necessary for improving outcome in some groups. In this study, the observed relationship between inadequate prenatal care and infant mortality was due largely to the relationship between inadequate care and low birthweight. Routine care may result in increased birth weight if the incidence of smoking, anemia,

infection, and low maternal weight gain can be reduced. In some cases, however, these conditions will not be affected without the intervention of social and nutrition counselors and services. In poor populations, it is particularly likely that ancillary services will be necessary to improve the chances that such changes will occur, as suggested by a previously cited study (Sokol, et al., 1980). On the other hand, where women's health behavior is not limited by inadequate knowledge or financial constraints, prenatal care that includes only routine advice to optimize iron status, weight gain, etc., may be sufficient to ensure a good pregnancy outcome, and ancillary services may be less important.

Further support for the importance of more than routine care for poor mothers is derived from information obtained from over 3,300 mothers interviewed at the University of Kansas Medical Center (Miller et al., 1978). Women were stratified into four socioeconomic categories, and further divided into groups according to whether or not they had gestational medical complications or behavioral risk factors (drug use, no prenatal care, age under 17 or over 35, smoking, or low weight or weight gain). In upper class women, about half of the low-weight babies were born to women with medical complications only. Among the poorest women, only about a third of the low-weight births were born to women with medical complications. Most of the remaining low-weight babies were born to women with behavioral conditions (specifically, smoking, low weight gain, and low prepregnant weight). Thus, it is particularly those programs directed to poor women that must be able to affect behaviors as well as

medical conditions, and ancillary services may be essential for success. This may partly explain why poor women have worse pregnancy outcomes even when they receive early and continuous routine prenatal care. Rather than suggesting that prenatal care cannot erase these differences, the data indicate that the essential components of prenatal care are different for poor, high-risk women, and that effective care must be tailored to the population it serves.

Some evidence suggests that improvement of weight gain during pregnancy may have been of major importance for the women in the Kansas study. Among black women, the uniformly higher incidence of low-birthweight babies has been shown to occur only among those delivered after 36 weeks' gestation. In fact, black infants born early are less often small for date than are preterm white infants. Low birth weight in a term infant is a significant consequence of low maternal weight gain and low prepregnant weight. Smoking, which has a major effect on birth weight (Meyer, 1977), was not more common in the black women in the Kansas study. Other drug usage was a documented factor in very few of the pregnancies (Miller et al., 1978). Thus, of the identified behavioral risk factors in this location, low prepregnant weight and weight gain contributed to the differential risk of the poor black women. Clearly, these women need prenatal care that encourages and enables weight gains sufficient to compensate for prepregnancy weight deficits. Where lack of knowledge and inadequate finances are important, routine prenatal care will not be sufficient to bring about this change.

A recent analysis of the impact of Community Health Centers (CHC) on infant mortality is of particular interest because it also indicates that in high-risk groups, accessibility to health care may have a marked effect. This study (Goldman and Grossman, 1982) used aggregated county infant mortality data and a formula for relating current infant mortality rates to prior rates. The formula included terms dependent on the number of CHCs present in the county. The analysis was done separately and collectively for blacks and nonblacks. Unfortunately, although regression analysis was said to include consideration of median income and the number of office-based physicians in private practice (per 1,000 population), no further details were given. No other population characteristics were considered in the analysis.

A dichotomized variable representing the presence or absence of CHCs in the county was included in the analysis, and a significant effect of this variable on total infant mortality was observed. Five percent of the decline in total infant mortality (all races) was accounted for by the presence of a CHC, whereas among blacks the overall contribution of CHCs to the decline in total infant mortality was 12 percent. The effect on postneonatal mortality was also greatest among blacks: Eighteen percent of the decline in postneonatal infant mortality was associated with the presence of CHCs.

The greater influence on black mortality is probably a reflection of the location of these centers in poor, largely black areas, as well as the higher baseline mortality rate of black infants. Despite recent declines in infant mortality, the gap between black and white infant mortality remains, and there

is a keen interest in closing this gap. Thus, it is noteworthy that delivery of health care, even health care not particularly focused on pregnant women and newborns, can significantly reduce infant mortality in high-risk populations. Although this concept is universally accepted for less-developed countries, its importance in the United States has been discredited in recent years.

The effect of increased availability of prenatal care per se has also been examined (Levy et al., 1971). In a medically underserved area of California, a nurse-midwife program was established to provide services for women with normal pregnancies. During the three years the program operated, both the number of visits per woman and the proportion of pregnant women receiving some prenatal care increased. There were concurrent decreases in low birth weight rates and in neonatal mortality. After the program was terminated, the low-birthweight rate increased by almost 50 percent, and neonatal mortality almost tripled.

The benefits of this program must be credited, at least partly, to its focus on outreach and on making care accessible to those who were too poor to get care from the existing medical establishment. In New York City, women who do not receive prenatal care cite as major reasons lack of money or insurance, belief that care is unnecessary, and fear of hospitals, doctors or procedures (Chao et al., 1980-1981). Among women delivering at Harlem Hospital, 84 percent of those who had received no prenatal care gave one or more of these reasons as a

justification (Chao et al., 1980-1981). All of these concerns could be reduced if the availability of low-cost care provided by concerned people who reach out to the community were increased. If the apparent benefits of prenatal care were due only to maternal characteristics that are related to care-seeking, outreach activities would not improve outcome.

As was indicated above, interpreting findings of higher mortality among infants whose mothers did not receive prenatal care is complicated by the "volunteer" problem. That is, maternal behavioral characteristics might be responsible for both the higher infant mortality and the mother's failure to seek medical care. However, neither of the two studies just cited have this problem. Where additional CHCs or nurse-midwives were made available, more women got health care, and the increase in available care improved outcome. Although the reports do not permit us to extract information about which women benefited from the additional health facilities, or (in the case of the CHCs) whether more women received some prenatal care, we can state that increased availability of care was associated with improved outcomes. We must conclude that women who had previously gone without care and experienced poor outcomes were able to obtain care when specific obstacles were removed with the availability of the new facilities. Most important, the increased care improved outcome. In this case, we are not comparing women who chose to obtain care with those who chose not to. The results provide strong evidence that prenatal care made a difference.

This association is further supported by a study that showed decreases in infant mortality with each increase in the number of

prenatal visits (grouped as 0, 1-4, 5-8, or 9+) (Dott and Fort, 1975). Although it can be hypothesized that women who make no visits differ from those who make some visits, the differences should disappear as the number of visits increases. Yet, overall mortality halved with each additional increment of care. Although this uniform improvement in outcome with increased care is not consistently demonstrated (Eisner et al., 1979), many studies do not control for gestational length or time of initiation of care, and this failure may obscure the relationship. Furthermore, benefits of increased number of visits may accrue only to high-risk women.

For many years, some prenatal care programs have included supplemental feeding as part of their service delivery. Obviously, these programs are attempting to directly influence maternal nutrition and thereby improve fetal weight and survival. Supplementation experiments, mostly conducted in the last 10 years, have particularly examined the role of proteins and calories in affecting fetal weight. Specially prepared beverages have usually provided the supplement. Many of these studies have yielded ambiguous results, and numerous experimental design problems, which have been reviewed elsewhere (Rosso and Lederman, 1985), may be responsible. Perhaps more relevant for our purposes are evaluations of the Women, Infants and Children (WIC) supplementation program, which integrates prenatal care and nutrition education with provision of vouchers that enable purchase of specific nutritious foods. In one such program in Massachusetts, a high-risk population (over 30 percent were

underweight before pregnancy) showed an increased birthweight with each additional month of supplementation (Kennedy et al., 1982). Mean gestational length did not differ by duration of supplementation period. (Generally, undernutrition would be expected to affect birth weight but not gestational length, but women with shorter gestations could have had a higher representation in the groups supplemented for a shorter time).

A study of 19 WIC projects in 14 states showed an increase in birthweight and also in gestational length with WIC supplementation (Edozier et al., 1979). When other variables, including gestational length, were controlled for, the association between birth weight and duration of supplementation period was still observed. The observed increased maternal weight gain and reduction in maternal anemia may have indirectly improved fetal growth, while increased intake of specific nutrients may have contributed more directly.

Because a longer supplementation period, or receipt of more vouchers, probably reflects greater exposure to the medical and educational components of the WIC program, it is possible that the observed birth weight increment was not due solely to the foods provided. Nevertheless, the array of prenatal care components that are provided in these programs does seem to be able to improve pregnancy outcome. Where benefits are obtained, it need not be assumed that supplementation, by increasing maternal weight gain, is solely responsible. The multiplicity of provided services may contribute in a variety of ways, at times not reflected in maternal weight change.

It should also be stated that no studies that have examined

the relationship of prenatal care and outcome have shown increases in prenatal care to be related to worse outcomes. If there were no benefit from more prenatal care, thorough control for confounding factors would cause both positive and negative relationships to surface in studies having different designs. Nevertheless, studies have uniformly shown a positive effect or no effect. Adverse effects have not been observed. Although not persuasive by itself, this observation also supports belief in the benefits of prenatal care.

In summary, review of the literature indicates that appropriate prenatal care can significantly improve pregnancy outcome. Examination shows that studies with very different designs, and with different flaws and controls, nevertheless get the same results. A relationship between no care and poor outcome remains, even though groups reported as having had no care are highly diluted by women who have had care. The relationship persists even when other factors that influence care-seeking and, possibly, outcome are controlled. Clear benefits have been obtained by introducing new prenatal care facilities for a finite time period and observing outcomes before, during, and after the program's existence. This study design relies on the vicissitudes of government funding, and is not ideal for preplanned experiments. It is an important method, however, for evaluating the influence of specific new program components (such as smoking deterrence campaigns), and should be used more extensively to aid in the selection of effective approaches for specific settings.

Although no single study or study design is sufficient to prove the value of prenatal care, the conclusions of a multitude of different types of studies are clear. Specifically, the studies support the concept that in low-risk women, routine prenatal care can reduce low-birthweight incidence, in part by minimizing the effects of medical conditions. In blacks and poor women, medical conditions appear to be secondary: low birthweight is largely associated with the mother's behavioral risk factors, such as smoking, low prepregnancy weight, and low weight gain. Although smoking is a significant cause of low birthweight in all groups, the data suggest that it may have no greater role among blacks than among whites, and that inadequate weight or weight gain determines much of the differential risk.

Because different factors are responsible for low birth weight in different groups, effective forms of treatment may also vary. Studies of successful programs suggest that those aimed at high-risk, poor populations must include a package of nutritional and social counseling and referral services, as well as an effective outreach effort tailored to the target population. Without these services, utilization of health facilities will be erratic, and many of the conditions providing a direct link to low birthweight will remain unchanged. The content as well as the form of prenatal care services must be tailored to the women served. This review suggests that subsequent evaluation of prenatal care programs must assess availability and appropriateness of these ancillary services as well as the delivery of routine prenatal care. Perhaps this approach will yield a declining rate of low birth weight and a narrowing of the

persisting differential between blacks and whites during the next decades.

REFERENCES

Berg, M., B. Taylor, L.E. Edwards, and E.Y. Hakanson, "Prenatal Care for Pregnant Adolescents in a Public High School," J. School Health 32-35, 1979.

Chao, S., S. Imaizumi, S. Gorman, and R. Lowenstein, "Reasons for Absence of Prenatal Care and Its Consequences." Report to the Robert Wood Foundation, 1980-1981.

De George, F.V., R.E.L. Nesbitt, and R.H. Aubry, "High Risk Obstetrics. VI) An Evaluation of the Effects of Intensified Care on Pregnancy Outcome," Am. J. Obstet. Gynecol. III(5):650-657, 1971.

Dott, A.B. and A.T. Fort, "The Effect of Availability and Utilization of Prenatal Care and Hospital Services on Infant Mortality Rates," Am. J. Obstet. Gynecol. 123(8):854-869, 1975.

Edozien, J.C., B.R. Switzer, and R.B. Bryan, "Medical Evaluation of the Special Supplemental Food Programs for Women, Infants, and Children," Am. J. Clin. Nutr. 32:677-692, 1979.

Eisner, V., J.V. Brazie, M.W. Pratt, and A.C. Hexter, "The Risk of Low Birthweight," AJPH 69(9):887-893, 1979.

Goldman, F. and M. Grossman, "The Impact of Public Health Policy: The Case of Community Health Centers." Working Paper #1020, National Bureau of Economic Research, Inc., November 1982.

Gortmaker, S.L., "The Effects of Prenatal Care Upon the Health of the Newborn," AJPH 69(7):653-660, 1979.

Hobel, C.J., M.A. Hyvarinen, D.M. Okada, and W. Oh, "Prenatal and Intrapartum High-risk Screening," Am. J. Obstet. Gynecol. 117(1):1-9, 1973.

Kennedy, E.T., S. Gershoff, R. Reed, and J.E. Austin, "Evaluation of the Effect of WIC Supplemental Feeding on Birth Weight," J. Amer. Diet. Assoc. 80:220-227, 1982.

Levy, B.S., F.S. Wilkinson, and W.M. Marine, "Reducing Neonatal Mortality Rate with Nurse-Midwives," Am. J. Obs. Gynec. 109(1):50-58, 1971.

Meyer, M.B., "Effects of Maternal Smoking and Altitude on Birth Weight and Gestation," in D.M. Reed and F.J. Stanley (eds.), The Epidemiology of Prematurity. Baltimore/Munich: Schwarzenberg, 1977, pp. 81-104.

Miller, H.C., K. Hassanein, and P.A. Hensleigh, "Maternal Factors in the Incidences of Low Birthweight Infants Among Black and White Mothers," Pediat. Res. 12:1016-1019, 1978.

Quick, J.D., M.R. Greenlick, and K.J. Roghmann, "Prenatal Care and Pregnancy Outcome in an HMO and General Population: A Multivariate Cohort Analysis," AJPH 71(4):381-390, 1981.

Rosso, P. and S.A. Lederman, "Nutrition and Fetal Growth," in A. Milunski, E.A. Friedman, and L. Gluck (eds.), Adv. Perinatal Med. New York and London: Plenum Press, 1985.

Ryan, G.M., P.J. Sweeney, and S. Solola, "Prenatal Care and Pregnancy Outcome," Am. J. Obstet. Gynecol. 137:876-881, 1980.

Sokol, R.J., R.B. Woolf, M.G. Rosen, and K. Weengarden, "Risk, Antepartum Care, and Outcome: Impact of a Maternal and Infant Care Project," Obst. and Gynec. 56(2):150-156, 1980.

Terris, M. and M. Glasser, "A Life Table Analysis of the Relation of Prenatal Care to Prematurity," AJPH 64(9):869-875, 1974.

Terris, M. and E.M. Gold, "An Epidemiologic Study of Prematurity in Relation to Prenatal Care, Birth Interval, Residential History, and Outcome of Previous Pregnancies," Am. J. Obst. Gynecol. 103(3):371-379, 1969.

APPENDIX 1

This paper was prepared as part of the conceptual research for a study funded by DHHS and entitled "Low Birth Weight Trends, NYC, 1960-1980." G. Solimano, M.D., is principal investigator and E. Struening, Ph.D., is co-principal investigator. S.A. Lederman, Ph.D. is staff associate.

This ecological study is intended to determine the contributions of several factors to changes in low-birth-weight rates in New York City health areas. These factors are socioeconomic conditions, fertility structure (age and parity of childbearing women), and availability of prenatal care.

Data from the 1960, 1970, and 1980 census tapes are being used to characterize the socioeconomic conditions of 338 health areas of New York City. Birth record tapes from 1960-1961, 1969-1971, and 1979-1981, are being used to describe, for the same health areas, the demographic characteristics of childbearing women, including their age, parity, and many other traits. The impact of prenatal care is being examined with specific reference to two federally funded health care programs that developed between 1960 and 1980, the Neighborhood Health Centers (NHC) and the Maternity and Infant Care (MIC) Program. Both of these programs were targeted to high-risk, service-poor areas of the city. The MIC program provides only prenatal care, but the NHCs provide an array of health services that vary from center to center.

This review, "Prenatal Care and Pregnancy Outcome," was

prepared to clarify for project staff what prior research had shown about the value of prenatal care. The literature review revealed sufficient disagreement about the meaning of the studies to warrant more than a summary comment. For this reason, an interpretive analysis was prepared. This analysis provided a framework for the subsequent development of the scale of program strength mentioned below.

The low-birthweight project will provide a great deal of valuable information about childbearing in New York City during this 20-year period. Low-birthweight rates, dichotomized as less than 2501 g (low birthweight) and less than 1501 g (very low birthweight) are being determined for each of the health areas. Several categories of gestational length are also being studied in these health areas. The categories are less than 31 completed weeks (very preterm), 31 to less than 37 completed weeks (preterm), and 37 or more completed weeks (term). As a result of this study, we will have a descriptive analysis of changes in the two groupings of low birth weight and in two groupings of preterm delivery for each of 338 health areas over a 20-year period.

The census data will permit us to determine whether health areas are sociodemographically heterogeneous or homogeneous. The relationship of specific sociodemographic characteristics of a health area can then be related to the observed pregnancy outcomes, both low birth weight and preterm delivery. Through use of multivariate techniques, the contributions or predictive values of these sociodemographic factors can be estimated. This analysis should provide important insight into the conditions predisposing to low birth weight or preterm delivery and into how

the importance of these factors has varied over 20 years.

The role of the availability of prenatal care will also be explored as part of the multivariate analysis. The prenatal care analysis will be initiated by the addition of a dummy "program" variable into the multivariate analysis. This variable will be set to zero in health areas with no NHC or MIC site, and to one for those health areas with a program site. Subsequently, more refined analyses will be undertaken. In this stage, the program variable will be allowed to assume values between zero and one, the value being determined by the proportion of the childbearing population in the health area actually receiving prenatal care through these programs. In this way, sites treating few patients will not be weighted as heavily as those treating many women, and a program's impact may be more readily detected.

If possible, some aspects of the prenatal care delivered by each NHC and MIC may be assessed by means of a scale of program strength. This scale will be limited to structural characteristics of the program, since process characteristics are really impossible to assess retrospectively. If significant variation is revealed among these programs, the score on the program-strength scale will be used to further differentiate the expected impact of each program site.

At the conclusion of this study, we will be able to describe the time trends in low-birthweight rates for New York City health areas. Further, we will be able to describe the areal characteristics most strongly related to low birth weight. The relative contributions of changes in areal sociodemographic and

in fertility structure to changing low-birthweight rates during the 20-year period will also be assessed. The effect on low-birthweight rates of siting either an NHC or an MIC within a given health area will also be determined.