Maternal Substance Abuse:

Impact of Prenatal Care on Newborn Outcomes and Costs

by

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Abstract

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The impact of prenatal care on newborn birth weight, costs, and hospital length of stay associated with exposure to illicit drugs was examined in a multivariate context. The data set contains over 75,000 mother/infant pairs that were generated from a linkage of birth certificates and hospital discharge records. The study population consisted of low income, urban women who delivered an infant in any of the 11 municipal hospital in New York City during the years 1990 – 1992. The information on the use of illicit drugs during pregnancy was based on ICD-9 codes from discharge abstracts and indicators from birth certificates. The underlying economic model is one in which infant health is produced by a variety of prenatal and neonatal inputs. Prenatal care was measured by the Kotelchuck APNCU index, modified by the addition of two categories – women who received no prenatal care and women with unknown care.

Separate estimates of the effect of prenatal care on outcomes mentioned above were obtained for infants who were identified as prenatally exposed to illicit drugs and for infants classified as unexposed. The analyses revealed that prenatal care was associated with a greater reduction in newborn costs and a greater increase in birth weight among drug-exposed infants than among unexposed infants. The marginal benefits of prenatal care were largest for exposed infants whose mothers obtained *inadequate* care, as defined by the APNCU index, compared with *no care*. Higher levels of care were not associated with improved outcomes. The receipt of *adequate plus* care was generally an indication of a high-risk pregnancy. The impact of prenatal care on outcomes of unexposed infants was modest and primarily operated through decreased incidence of low birth weight. Despite the larger effects of prenatal care in the sample of substance abusers, the impact of prenatal care on newborn costs was small compared to the costs associated with exposure to illicit drugs. These findings suggest that further improvements in newborn outcomes and costs seem unlikely without the treatment of addiction itself.

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I. Introduction

Substance abuse in pregnancy has a profound effect on birth outcomes and a major impact on newborn costs. This issue has emerged as a major area of concern for clinicians, researchers, and public health officials. The medical literature offers convincing evidence that substance abuse during pregnancy poses serious health threats to both the woman and the fetus.[1] Complications, including increased rates of spontaneous abortion, premature detachment of the placenta, early onset of labor, and preterm delivery are common among drug-using pregnant women (MacGregor et al. 1987; Chasnoff et al. 1989; Little et al. 1989; Evans and Gillogley 1991; Behnke and Eyler 1993).

Clinical studies show that infants exposed prenatally to illicit drugs may suffer intrauterine growth retardation, congenital malformations, neurobehavioral deficiencies, and a variety of other medical problems and long-term developmental abnormalities (Chasnoff et al. 1986, 1988; Zuckerman et al. 1989; Frank et al. 1990; Bandstra and Burkett 1991; Zuckerman 1991). Moreover, increased risk of low birth weight (LBW) represents one of the most common complications affecting the mortality and morbidity of infants delivered to drug-dependent women (Doberczak et al. 1987; Keith et al. 1989; Kay et al 1989; Petitti and Coleman 1990; Bateman et al. 1993).[2] Given the medical risks and complications, drug-exposed infants often require expensive neonatal intensive care, have longer hospital stays, and are substantially more expensive to treat than unexposed

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[1] Complications associated with the use of a specific substance are described in the Appendix.

[2] LBW (less than 2.5000 grams) is the single largest contributor to infant mortality (Fiscella 1995).

infants (Kay et al. 1989; GAO 1991; Phibbs et al. 1991; Joyce et al. 1995; Norton et al. 1996; Joyce et al. 1996; Behnke et al. 1997).

Maternal substance abuse may affect the cost of newborns and length of stay in two different ways. First, it can affect infant's health and cause complications such as premature delivery, low birth weight, or neonatal infection, which require expensive neonatal intensive care or other medical treatments that raise costs. This is the indirect effect. Second, the direct effects are the costs associated with exposure conditional on health at delivery. For example, the cost of resources used to treat withdrawal from exposure to opiates may be independent of birth weight across a wide range of weight. The total effect of exposure is the sum of the two.

The adverse effects of prenatal substance abuse have been shown to be minimized by comprehensive care, which includes both prenatal care and drug treatment (Finnegan et al. 1972, 1982; Connaughton et al. 1977; Rosner et al. 1982; Fitzsimmons et al. 1986; Keith et al. 1989). However, these programs are expensive to operate and are often in short supply. A number of recent studies report that provision of quality prenatal care, even if not linked to drug treatment, is associated with improved pregnancy outcomes (MacGregor et al. 1989; Chazotte et al. 1995; Racine et al. 1993; Berenson et al. 1996). According to these studies, early prenatal care and frequent visits may help prevent or at least ameliorate some of the problems associated with pregnancies in drug-addicted mothers, such as the risk of LBW and preterm deliveries. If prenatal care alone can improve pregnancy outcomes, efforts to enroll pregnant substance abusing women may realize substantial savings in costs associated with drug-exposed infants. However, there have been no studies of the impact of prenatal care alone on newborn costs associated with exposure.

Aim of the Study

The aim of this analysis is to measure the effect of prenatal care utilization on newborn costs. hospital length of stay, and birth weight among women who were identified as exposed to illicit drugs during pregnancy as compared to women who were classified as unexposed. The study improves upon previous research in several ways. First, the analytical data set contains over 75,000 mother/infant pairs that were generated from a linkage of New York birth certificates and discharge abstracts. The sample consists of low income. urban women who delivered an infant in any of the 11 municipal hospitals in New York City over a three-year period from 1990 to 1992. Most previous studies on the effect of prenatal care on birth outcomes among women exposed to illicit drugs were based on single institution experiences thus applicable only to a small segment of a population. Although this analysis is limited to a single city, by including the experience of an ethnically diverse group of women from several delivery sites. the likelihood of a selection bias is greatly reduced. Moreover, the estimates can then be used to target interventions in specific groups of women.

Second, the large number of birth in this sample and the number of infants exposed to illicit drugs (over 5,000) permits separate regressions to be fitted for newborns exposed to illicit drugs and for unexposed newborns. In addition, by allowing the coefficients of the independent variables to vary between the two groups, the study further explores whether the impact of prenatal care on pregnancy outcomes and newborn costs differs between two groups with different levels of maternal risk and different patterns of prenatal care utilization. Earlier investigations have shown that improved prenatal care was associated with greater benefits for mothers at high risk for poor birth outcomes than for low risk populations (Gortmaker 1979; Alexander and Cornely 1987; Showstack et al. 1984; Greenberg 1983; Murray and Bernfield 1988). Thus, larger effects are expected in the sample of substance abusers than in the sample of unexposed women.

Third, the study uses two independent sources of exposure information on the same set of mother/infant pairs. Exposures to cocaine, opiates, marijuana, and other illicit drugs are determined from ICD-9 codes on discharge abstracts, and from indicators on New York City birth certificates. Although the screens were not universal, a combination of two sources increases the reliability of exposure information. Moreover, given no false positives, fitting separate regressions for women identified as exposed to illicit drugs by either source reduces the ascertainment bias associated with false negatives in an unselected sample.

Fourth, the measure of newborn costs is the expected revenue for each discharge based on the New York Prospective Hospital Reimbursement Methodology (NYPHRM IV), an all payer reimbursement system in effect in New York State between 1988 and 1996. The prospective per case reimbursement system is based on over 800 diagnosis related groups (DRGs) rather than based upon length of stay and hospital charges. Under this system, hospitals have relatively little control over the rate of reimbursement and reimbursement cannot be raised or lowered by the hospital to raise profits. Therefore, the expected revenue should be a good measure of resource consumption by newborns exposed to illicit drugs. Estimates of cost of exposure in previous studies were often based on hospital charges or prospective per-diem reimbursement where length of stay and thus costs can be easily inflated. Furthermore, a study by Phibbs and his colleagues (1991) used seven Medicare DRGs to assess newborn costs associated with exposure. Under the New York prospective payment system there are 39 DRGs for newborns. The more detailed breakdown of diagnoses provides a more accurate measure of resource utilization by newborns. A prospective payment system such as NYPHRM IV provides powerful incentives to minimize length of stay since reimbursement is fixed per diagnosis. Hence, estimates of length of stay associated with newborn exposure should represent an efficient use of hospital resources.

Finally, an important distinction of this work is use of the Adequacy of Prenatal Care Utilization Index (APNCU) to classify prenatal care utilization (Kotelchuck 1994). The index is based on two dimensions: the initiation of prenatal care and the continuity of visits attended. The first dimension is based on the first prenatal care visit, which is recorded on the birth certificate; the second is the ratio of the visits actually kept to the expected number of visits based on the American College of Obstetricians and Gynecologists (ACOG) schedule for a normal, low-risk pregnancy (ACOG 1994). None of the previous studies on the effect of prenatal care on birth outcomes among drug users have used a prenatal care utilization index. In several studies the receipt of prenatal care is not quantified but considered either present or absent (McCalla et al. 1991; Feldman et al. 1992; Miller et al. 1995; Chazotte et al. 1995). Other investigators designated an arbitrary number of visits, usually between three and five, as an adequate amount of prenatal care (Broekhuizen et al. 1992; Racine et al. 1993; Berenson et al. 1996). When considering prenatal care as either present or absent, or as an arbitrary number of visits, it is difficult to determine whether the poor birth outcomes of drug-exposed women are associated with delayed care or insufficient care. Both postponed entry into prenatal care and the failure to return for scheduled visits have been repeatedly associated with drug use (McCalla et al. 1992). Therefore, identifying the independent components of utilization of care such as initiation and frequency of visits may be of particular interest when trying to recruit drug-exposed women into a program.

To compare the effect of prenatal care on costs when the Kotelchuck index is used with the effect of prenatal care on costs when other measures often used in the literature are employed, the cost and length of stay regressions will be re-estimated using different specification of prenatal care.

The present study represents the first effort to examine the relationship between utilization of prenatal care and newborns costs associated with exposure to illicit drugs. The importance of this research is underscored by the enormous costs associated with adverse birth outcomes of substance abusing women and the paucity of analyses on whether prenatal care alone can reduce these costs. The questions the study seeks to address are both methodological and policy oriented. Is it possible to separate the perinatal outcome effects of quality prenatal care from the other characteristics found in substance-abusing women who obtain such care, and if so, is the provision of early and adequate prenatal care a cost effective treatment?

II. Literature Review

Since none of the previous studies has focused specifically on the effect of prenatal care on newborn costs associated with exposure to illicit drugs, the following section summarizes the findings from literature in three related areas of research. The first group includes studies that estimate the prevalence of illicit drug use during pregnancy. As Joyce et al. (1996) point out, accurate information on newborns who have been prenatally exposed to drugs and on methods employed for identification of substance use are crucial for obtaining reliable cost estimates. In this study, the exposure information was determined from ICD-9 codes on discharge abstracts and indicators from birth certificates. A review of prevalence studies with more sensitive screens in rural and urban settings will help assess the reliability of exposure information in this analysis

The second group consists of studies that attempt to measure the newborn costs associated with prenatal exposure to illicit drugs. There has been relatively little research in this area and many of the cost investigations are institution-specific studies with too few cases to allow for multivariate analysis. Thus, the cost estimates of these studies may not be applicable to the general population.

Finally, the third set of studies in this review evaluates the impact of prenatal care on pregnancy outcomes among women who use illicit drugs. The number of prenatal visits and other measures of adequacy of prenatal care are often used as a means to identify women at risk for delivering low birth weight infants and other poor pregnancy outcomes (Gortmaker 1979; IOM 1985). Alternatively, many studies suggest that drug users seek less prenatal care than nonusers (Cherukuri et al. 1988; Abma and Mott 1991;

McCalla et al. 1991). Of particular interest therefore, is the ability of the studies to control adequately for confounding variables known to affect pregnancy outcomes, and for demographic and socioeconomic characteristics of women who obtain prenatal care.

A. Prevalence Literature

As public concern about maternal substance abuse has increased in recent years, several attempts have been made to determine how many women use illicit drugs during pregnancy. The exact magnitude of this behavior has been however, difficult to determine. First, studies vary in their methods of substance use detection and protocols for deciding whom to test. Commonly used criteria for toxicology screens include infant withdrawal, lack of prenatal care, a family history of child neglect or abuse, and a history of maternal drug use. Few if any private care hospitals screen for maternal drug use. Even in large public hospitals screening is rarely universal, and infants are evaluated with urine toxicology only if a severe complication occurs at the time of labor or delivery (Chasnoff 1989). Because many of the drugs to which the fetus is exposed do not produce immediate or recognizable effects in the neonates, when selective screening is performed the number of exposed infants may be underestimated. (Kandall and Gartner, 1974).

Second, since the ascertainment of substance abuse often relies on clinical interviews, a significant amount of underreporting probably takes place due to the illicit nature of drug use. A mother is under enormous pressure to deny the use of illicit drugs during pregnancy because of fear of confrontation with legal authorities and possible termination of parental rights. [3]

As a result of this tendency to underreport illicit drug use, there are currently a number of more reliable biologic methods used to detect prenatal drug exposure in the pregnant woman or her infant. These methods include urine toxicological analyses at various times during pregnancy and delivery, newborn urine, umbilical cord blood, or meconium screening at delivery, and maternal or infant hair analyses at delivery. Each method has its advantages and shortcomings, and varies in sensitivity and ability to detect certain drugs within a certain time span. Recent reports comparing different methods to identify drug use during pregnancy emphasize the need to combine biologic screens with clinical interviews (Zuckerman et al. 1989; Ostrea and Welch 1991).

Because the patterns of illicit substance use vary in different regions and patient population across the country, sampling procedures play an important part in estimating the prevalence of this behavior. Investigations based on a national probability sample can provide a more useful picture of the overall prevalence of drug use than local studies. Although such studies are prohibitively expensive they may produce less sample bias than studies limited to a group of patients in a single institution, a number of specific medical facilities, or a particular geographic area. Estimates based on studies of small non-random samples may not apply to the general obstetric population.

[3] In 13 states the law requires that pregnant women or newborn infants who test positive for illicit drugs be reported to either social service agencies or criminal justice agencies, and in 10 states such reports are categorized as child abuse or neglect (Adrim and Gupta 1991).

Finally, estimates of the rate of illicit substance use in pregnancy depend on which substances are included in categories denoted as all illicit drugs. Most studies separately classify the use of opiates, cocaine, and marijuana. Others may also include the use of hallucinogens, amphetamines, heroin, and methadone. Some studies attempt to distinguish between licit and illicit use of frequently abused prescription drugs such as amphetamines, sedatives, tranquilizers, and analgesics. When studies group substances together, prevalence estimates may vary depending upon what is included in their scope of illicit substance use.

1. National Surveys

The National Pregnancy and Health Study (NPHS) sponsored by the National Institute on Drug Abuse administered a survey to 52 individual hospitals on women delivering live birth between November 3, 1992 and August 18, 1993. The objective of the national probability sample survey was "to produce annual estimates of the percentages and numbers of mothers of newborns in the U.S. who used licit and illicit substances before and during pregnancy." Of the 3,340 women found eligible for the survey sample, 2,613 completed a questionnaire regarding the use of marijuana and hashish, cocaine, methamphetamine, heroin, methadone, inhalants, hallucinogens, prescription psychotherapeutics, alcohol, and cigarettes. In addition, nonblinded urine toxicology screenings were conducted in all 52 hospitals, and 47 hospitals conducted anonymous urine toxicology screenings to validate self-report. Hair samples were collected and analyzed at 6 participating hospitals from 83 percent of eligible subjects. The survey found that an estimated 5.5 percent, or 221,000 women, used an illicit drug at some time during pregnancy. 2.9 percent used marijuana, 1.1 percent used cocaine, and

1.5 percent or 61,000 women used prescription drugs without physician orders. [4] The rates of use of any illicit drug were highest among blacks (11.3%) compared to whites (4.4%) and Hispanics (4.5%). Blacks also had the highest rate of use of cocaine (4.5%) compared to whites (0.4%) and Hispanics (0.7%). The rates of crack cocaine use were highest in women age 25-29 and age 30 or older. The rates of use for alcohol and cigarettes were much higher at 18.8 and 20.4 percent respectively. A comparison of rates of self-reported use with rates based on urine toxicology analysis indicated selective underreporting during the last 3 days before delivery. These results suggest that recent use of cocaine was significantly underreported and the actual rate of use of heroin may have been substantially underestimated based on self-reports since the analysis of urine specimens could not clearly distinguish between morphine, classified as an analgesic, and heroin.

Gomby and Shiono (1991) combined 27 reports published in the 1980s with existing National Institute on Drug Abuse (NIDA) data to estimate the prevalence rate of exposure among pregnant women to cocaine, marijuana, opiates, stimulants, hallucinogens, and tranquilizers. NIDA interviewed individuals in households across the nation about their use of a variety of legal and illegal substances. Results were not reported separately for pregnant women. Gomby and Shiono multiplied the substance exposure rate of women within the previous year by the 1987 birth rates for three age groups (ages 12-17, 18-25, and 26-34) since in 1987, according to national data, 92 percent of all births occurred among these age groups. The authors estimated that in the late 1980s about 4.5% of infants (158,000/year) may have been exposed to cocaine, about

[4] The number of women who used illicit drugs in pregnancy is found by applying the estimated rate of use to the number of annual live-birth deliveries in the U.S., estimated at approximately 4 million.

2 to 3% (75,000/year) may have been exposed to opiates, 17% (611,000) may have been exposed to marijuana, and 73% (2.6 million) may have been exposed to alcohol. They concluded that between 554,0000 and 739,000 infants annually may have experienced intrauterine exposure to illegal drugs, aside from exposure to harmful licit substances such as alcohol and tobacco.

In their report, Gomby and Shiono assumed that pregnant women use illicit drugs at the same rate as other women do. This assumption may have overestimated the number of drug-exposed infants because some women abstain while pregnant. However, as previously mentioned, studies that rely on self-report often underestimate the use of illicit drugs during pregnancy.

2. State surveys

In a statewide population study during a 17-day period in 1989 an anonymous urine screening was performed on 465 (65.2%) women giving birth at eight Rhode Island hospitals. (Hollinshead et al. 1990). 7.5 percent of the urine samples were positive for at least one drug. Marijuana was detected in 3.0 percent, opiates in 1.7 percent, and cocaine in 2.6 percent. The rate of drug use also varied with insurance status. Of women with public insurance 16.1 percent tested positive whereas 4.1 percent of women with private insurance tested positive.

Vega et al. (1993) tested urine samples from 29,494 women presenting for delivery in 202 hospitals in California during an 8-month period in 1992. The number of subjects screened in each hospital was proportional to the number of births; however, the number of births was unreported. Based on the urine results, the authors estimate that

5.16 percent of women in the State had used one or more of the following substances: amphetamines, barbiturates, benzodiazapines, marijuana, cocaine, methadone, opiates, or phencyclidine. The exposure to alcohol and cigarettes was much higher at 6.72 and 8.82 percent respectively. Of the women who tested positive, cocaine was detected in 1.11 percent, opiates in 1.47 percent, cannabinoid in 1.88 percent, and amphetamines in 0.66 percent. There were wide variations for prevalence estimates for racial and ethnic groups with 14.22 percent of blacks positive for any drug (including alcohol), as compared with 6.79 percent of whites and 2.75 of Hispanics. Cocaine was detected more frequently in the urine samples of black women, 7.79 percent, compared with 0.6 percent of white women and 0.55 percent of Hispanic women. The authors applied their results to survey data and estimated that 30,565 women of childbearing age were exposed to licit and illicit drugs in California in 1992, when 600,000 women gave birth.

In both studies, the prevalence estimates most likely represent an underestimation of the actual use because the mothers underwent a single test either shortly before of after delivery. Urine screening reveals drug use only within 48 hours preceding testing and tends to miss occasional users or those who abstain during later stages of pregnancy.

In 1994 a study in Georgia was the first to use newborn dried-blood spots (DBS) to conduct a population-based study for perinatal exposure to cocaine (Brantley et al. 1996). In Georgia a routine collection of DBS from a heel-stick of newborns is performed for screening of metabolic diseases. All newborns whose DBS specimens were submitted to the Department of Human Resources (DHR) during a 2-month period in 1994 and for whom an adequate specimen was available after completion of metabolic screening were eligible for this study. Of the 14,968 (91%) newborns whose DBS were submitted to DHR and tested for cocaine metabolite, 0.5 percent were found to have had perinatal exposure to cocaine. Maternal characteristics associated with high rates of cocaine exposure in newborns included older age; education of <13 years; self-reported cigarette smoking, alcohol drinking, or both during pregnancy. The authors recognized that this report may have underestimated the prevalence of cocaine exposure during pregnancy in Georgia for several reasons. First, screening of newborns provides information about cocaine exposure only near the time of delivery and not about exposure that may have occurred earlier, second, it does not identify cocaine use for newborns aged > 7 days. Finally, DBS samples were not collected for fetal deaths or newborns in intensive care, especially those with very low birthweight and infants born prematurely, two complications often associated with the use of cocaine.

3. Local surveys

By including women from several delivery sites in a certain area, studies can provide community-wide data without the expense of population-based studies or the selection bias of single-hospital studies. Between March 1 and May 27, 1993 meconium samples were collected at four urban and suburban hospitals from 1,333 consecutively born newborns in Minneapolis-St Paul, Minnesota (Yawn et al 1994). The samples were tested for cocaine, marijuana, and opiates. Cocaine was detected in 2 percent, marijuana in 2.6 percent, and opiates in 1.2%. Maternal smoking rate was much higher, 22.8 percent. The groups with the highest rates of illicit drug detection were minority, inner-city women who had no insurance or who received public assistance. Extrapolating the results to all deliveries in the Twin Cities in 1993, the authors estimated that approximately 600 newborns were exposed to prenatal cocaine in Minneapolis-St Paul in 1993.

While in several studies, drug use estimates in urban obstetrical clinic populations have been reported as even higher than general population estimates, a study by Chasnoff and colleagues (1990) demonstrates that patients in both public and private settings are at similar risk for drug use. Specifically, urine toxicology screens were obtained on all women enrolled in prenatal care at five county health clinics and twelve private obstetric practices in Pinellas County, Florida during the first six months in 1989. Pregnant women seen at public clinics and those examined in private practices tested positive for alcohol or illicit drugs at approximately the same rate, that is, 16.3 percent positive in public clinics and 13.1 percent in private clinics. Similarly, black and white pregnant women tested positive at comparable rates, with 14.1 percent black women and 15.4 percent white women testing positive for alcohol or any illicit drug. There was an interesting difference in the drug most commonly used by black versus white women. Cocaine use was evident in 7.5 percent of black patients but in only 1.8 percent of white patients; whereas marijuana use was evident in 14.4 percent of white patients as compared with 6 percent of black patients.

Another study in Jacksonville, Florida comparing urine toxicology screens of women presenting at delivery at one public and seven private hospitals reported different results (Vaughn et al. 1993). The proportion of positive screens in the public hospital was significantly higher than in the private hospitals 12.7 percent versus 3.9 percent. The authors attributed the differing results to differences between the study populations. The women in this study were assessed on delivery while the Pinnelas County group was screened on enrollment to prenatal care. Women who used cocaine and other drugs typically did not seek prenatal care until late in the pregnancy, and more than 50 percent of cocaine users do not obtain prenatal care at all (Ostrea et al 1992; McCalla et al 1992). Since, in this study, 60 percent of women with positive screens for cocaine received limited (fewer than three visits) or no prenatal care, screening in a prenatal care setting would have missed a large portion of this population.

4. Institution-based surveys

Several attempts to estimate the prevalence of illicit drug use during pregnancy have been made at individual hospitals. While these studies maybe less costly and more convenient to implement, they are often conducted with low-income urban women, they are often based on small nonrepresentative samples, and their results may not be applicable to the general population. Despite the limitations, it may be desirable to identify the population at risk within a particular institution so that proper prenatal and neonatal care can be offered.

Schulman et al (1993) investigated the prevalence of drug use in a population of women at Bronx Municipal Hospital Center (BMHC), a large public institution in New York City. From November 26 to December 24, 1990, anonymous urine toxicology screening of all patients on admission to the obstetric service, and selective infant urine toxicology screening were performed. The clinical criteria for infant testing included maternal history of drug use, poor prenatal care (5 or fewer visits), and infant symptoms of drug use. Urine was screened for the following drugs and their metabolites: cocaine, opiates, methadone, barbiturates, amphetamines, and benzodiazepines. Of the 204 women screened (83.6% of deliveries), 9.3 percent had positive toxicologies, 6.9 percent tested positive for cocaine, 1.5 percent for opiates, 1.5 percent for methadone, 1.5 percent for amphetamines, and 2.0 percent used more than one drug. Of those mothers who tested positive for cocaine fewer than 30 percent gave a history of use.

In another New York City hospital Matera et al (1990) collected anonymous urine samples from 509 of 614 women (83%) admitted to the labor suite between mid-November and December 31, 1988. Of the women screened, 24 percent had positive toxicologies, 10 percent tested positive for cocaine, 13 percent for amphetamines, 2.6 percent for marijuana, 0.9 percent for opiates. The rate of use of cocaine was higher in the clinic population (14%) than in the private population (1.4%). The medical history alone predicted only 37 percent of the cocaine-positive screen and none of the amphetamine-positive screens.

Of universally screened women on admission to the obstetric service at the University of California, Davis Medical Center, 20.5 percent were positive for cocaine, amphetamines, or opiates in 1988 (Gillogley et al 1990). Cocaine was detected in 9.5 percent, amphetamines in 7.4 percent, and opiates in 1.2 percent. The authors note that nearly 40 percent of toxicology-positive patients denied the use of drugs.

In comparison to the studies of urban medical centers where the majority of patients are indigent or on public assistance programs, Schutzman et al (1990) attempted to assess the incidence of prenatal cocaine exposure in a socioeconomically mixed suburban setting. Between February 1 and May 15, 1990 meconium was collected from 500 consecutively born infants and 11.8 percent tested positive for cocaine. The prevalence varied by insurance status. Of infants covered by private insurance, 6.3

percent tested positive, compared with 26.8 percent of infants covered by Medicaid or no insurance.

Ostrea et al (1992) also used meconium analysis to determine the prevalence of illicit drug abuse in a high risk, large population of women delivering at a tertiary perinatal center in Detroit. Between November 1988 and September 1989, the meconium of every other infant was analyzed for metabolites of cocaine, morphine, and cannabinoids. Of the 3010 newborns screened, 44 percent tested positive for one of the three drugs, cocaine was detected in 31 percent, and cannabinoids in 12 percent. In contrast, by self-report the incidence of drug abuse in the mothers was 11 percent. These results, as well as other recent reports suggest that meconium testing is superior to urine toxicology or self-report and provides a wider window of detection of prenatal exposure to illicit drugs (Ostrea and Welch 1991).

Summary

On a national level, the estimated prevalence of drug use near the time of delivery ranges between 5.5 percent to more than 20 percent for illicit drugs, between 0.4 percent and 4.5 percent for cocaine, and between 2.5 percent and 17.4 percent for marijuana. The high rates of exposure to alcohol and tobacco in the entire population suggest a high relative contribution of these drugs to adverse pregnancy outcomes. Prevalence rates varied by population subgroups, race, and socioeconomic status. Higher prevalence rates have been reported in populations receiving care at large urban medical centers, between 9.3 percent to 44 percent for illicit drugs and between 6.9 to 31 percent for cocaine. A major weakness of all prevalence studies is the imprecision with which exposure is determined. Given the poor sensitivity of urine screening at a single point in time for detection of anything but recent use, and the unreliability of self-reporting, prenatal drug use is most likely underestimated. Institutional policy affects the reported community rates since universal screening is recommended (ACOG 1994). Drug-screening protocols vary considerably even between institutions in the same city, leading to a variety of estimates (Birchfield et al 1995). Moreover, the method of testing may contribute to the wide range of prevalence rate reported. When methods with greater sensitivity in detecting maternal drug abuse are employed, the estimates of exposure rate more than double. Finally, neither urine nor meconium analysis provides a way of assessing maternal pattern of use, such as amount, frequency, and duration of exposure.

B. Cost Literature

Despite the high prevalence of drug use, with its frequent and sometimes severe complications to mother and fetus, only a handful of studies have attempted to estimate the economic costs associated with maternal substance abuse. Clinical reports have documented a greater need for neonatal intensive care and extended length of stay in nurseries for drug-exposed infants compared to nonexposed infants (Noble et al. 1989; Hurt et al. 1989), and for opiate-exposed infants, compared to those born to cocaine abusers (Kay et al 1989). The medical complications, the greater need for intensive care, and the longer hospital stays of exposed infants are often reflected in substantially higher hospital charges than for nonexposed infants.

In one of the first and frequently cited reports regarding the costs associated with prenatal drug exposure, the United States General Accounting Office (GAO 1990) estimated that median hospital charges for infants exposed to illicit drugs were $1.100 to $4,100 higher than those for nonexposed infants. The estimates were based on a survey of 10 urban hospitals primarily serving patients eligible for Medicaid, as well as hospital discharge data and medical chart information. They concluded that drug-exposed infants had significantly lower birth weights, were more likely to be premature, and had longer hospital stays for medical and nonmedical reasons, with hospital charges up to four times greater than those for nonexposed infants.

There are several reasons why these cost estimates may not be accurate. First, the report relies on information recorded on medical charts regarding newborn exposure. By not including infants who may have been exposed but had no visible symptoms of exposure and thus not recorded on medical charts, the effect of exposure on cost may be overestimated. Moreover, the report does not differentiate between types of maternal drug use and their different impact on costs. Finally, the authors do not control for confounding variables that may also affect pregnancy outcomes and thus cost.

Calhoun and Watson (1991) investigated an urban sample of 91 indigent women and their cocaine-exposed infants. The exposure was ascertained with urine toxicology screens. A comparison group was matched for socioeconomic status, age, and parity. The hospital stay for cocaine-exposed infants was 11 days compared with 3 days for the control infants. Although maternal charges for users were only 15 percent greater than those of controls, neonatal charges were nearly 10 times greater in the cocaine exposed group than in the control group ($13,222 versus 1,297). The authors noted that most of the differences in perinatal costs between the cocaine-positive and control populations were related to prematurity. The study infants were more likely to be born prematurely, with a mean gestational age of 37 weeks versus 39.7 weeks for controls. The cocaine-exposed infants were also more likely to require neonatal intensive care than the infants of controls. The researchers estimated a direct perinatal cost of about $12,000 for each infant born to cocaine-using mothers. Using a prevalence rate of 15 percent, and 3.4 million annual births in the United States, the authors estimated that an additional $6.12 billion was spent on the acute care needs of this infant population.

It should be noted however, that their conclusion cannot be easily generalized to the entire obstetric population. First, the small sample of exposed women precluded the authors from using multivariate analysis to control for confounding variables known to affect pregnancy outcomes. The prevalence rate for cocaine in this indigent patient population was high compared to the general population (25%), and 22 percent of exposed women in the sample used more than one drug. The high charges associated with exposure may reflect the fact that the indigent women in this study were heavy cocaine and polydrug users and their infants were severely affected. These drug-exposed newborns may have required more intensive treatment even when not born prematurely. It is misleading therefore to estimate national costs of maternal substance abuse from this patient population. Although, some investigators reported that similar rates of prenatal substance abuse were detected in both private and indigent patient groups (Chasnoff et al 1990), others concluded that the rate of illicit drug use during pregnancy was significantly more common in women receiving care from public versus private hospitals and in women on public assistance programs versus those with private insurance (Vaughn et al 1993; Schutzman et al 1990).

Phibbs et al. (1991) studied over 2,800 deliveries at Harlem Hospital in New York City between September 1, 1985 and August 31, 1986. Drug exposure during pregnancy was ascertained with maternal self-report and urine toxicology screens of all newborns. The authors used multivariate analysis to control for the independent effects of variables associated with neonatal risks and costs such as, maternal characteristics, prenatal care, infant's gender, and use of alcohol and tobacco. They reported that neonatal lengths of stay and costs attributable to cocaine, crack, or polydrug exposure ranged from 4 to 10 additional days at a cost of between $2,610 and $8,450 in 1990 dollars. Cocaine in combination with other drugs and crack exposure produced larger increases in hospital costs and lengths of stay than did cocaine exposure alone. The authors reported that receiving any prenatal care was associated with a cost reduction of between $4,300 and $5,000. The length of stay for infants whose mothers received any prenatal care was shorter from 2.9 to 3.6 days. Using the national estimate of 158,000 cocaine exposed infants born in the United States in 1991 (Gomby and Shiono 1991), and an average cost of $3,182 per cocaine-exposed infant, the authors estimated a national cost of $540 million in 1990 dollars for the direct costs of maternal exposure to cocaine (not including physicians' fees and extended length of stay for nonmedical reasons).

Although the large sample size and the use of multivariate analysis in the Phibbs study was an improvement over previous studies, the estimates of both length of stay and costs are questionable for several reasons. The cost estimates in this study were based on diagnosis-related group (DRG) per diem averages from national samples of 28 urban tertiary care hospitals with neonatal intensive care units (adjusted for the teaching status of Harlem Hospital). Between 1983 and 1987, New York State hospitals were reimbursed on a prospective per diem basis. If infants exposed to illicit drugs provided net gains to per diem revenue, the length of stay and thus costs reported under such system could be inflated (Joyce et al. 1996). Second, DRGs based on medical records were assigned to each infant to capture newborn costs. However, the authors acknowledge that the seven Medicare DRGs used for newborns had significant variations in both lengths of stay and per diem resource consumption. Therefore, the costs may have been overstated and statistical inferences may have been misleading.

The study by Joyce et al. (1995) combined urine toxicological screens with maternal self-report to determine newborn exposure among 1,279 women who delivered at a large municipal hospital in New York City between November 18, 1991 and April 11, 1992. The authors included three measures of infant health at delivery, birth weight measured in grams, a dichotomous indicator of prematurity, and a dichotomous indicator of newborn infection, in order to attempt to separate the direct and total effects of drug exposure on outcome. The indicators for prematurity and newborn infection were based on International Classification of Diseases, Ninth Edition (ICD-9) codes on the infant or mother's discharge abstract. The total effect excludes measures of infant health at delivery and captures the indirect effects of exposure on birth outcomes. The authors reported that infants exposed prenatally to cocaine and some other drugs stay on average 6.6 days longer at a cost of $7,731 more than unexposed infants. They attributed approximately 60 percent of these costs to adverse birth outcomes and newborn infection. The effect of exposure to cocaine combined with other drugs decreased substantially (40 percent) when the birth outcome variables were included in the regression. The effect was even greater for the coefficients on exposure to only cocaine or drugs other than cocaine, which nearly fell to zero when gestational age, birth weight, and congenital infection were included as independent predictors of infant cost and length of stay.

These findings were similar to those reported by Phibbs et al. (1991), who found that the increased hospital costs were concentrated among infants who required NICU stays related to low birth weight and prematurity. and Calhoun and Watson (1991) who reported that the most statistically significant differences in perinatal cost between the cocaine-positive and control population were due to premature births.

In their study, Joyce et al. also compared costs and length of stay for newborns for whom exposure was recorded on discharge abstracts, therefore known to clinicians. to those for whom exposure was captured by anonymous screen and remained undisclosed. They found that costs and length of stay associated with illicit substances based on discharge abstracts were higher than those determined by universal toxicologic screens. The explanation they offer is that clinicians and other health care providers tend to screen the sickest women and infants - those who are affected enough by maternal substance abuse to show symptoms. By not including in the analysis newborns who were exposed but who showed no symptoms the costs and length of stay may have been substantially overestimated.

Norton et al. (1996) examined hospital discharge abstracts for 67,767 singleton live birth from 54 hospitals in Maryland in 1991. The inclusion of a large number of hospitals in both urban and rural areas was a clear improvement over previous studies. Using ICD-9 codes to define drug-exposed newborns, and controlling for potential confounding variables such as birth weight and infant comorbidities, the authors were able to estimate the direct and total effect of drug exposure on newborn cost and length of stay. The types of drugs were not specified. They reported that exposure to drugs in newborns was associated with hospital charges that were 90 percent higher than charges of unexposed infants, and length of stay that was 76 percent longer than length of stay of unexposed infants. As in the study by Joyce et al. (1995), the independent effect of drug exposure on charges and length of stay decreased dramatically when newborn's health at delivery was included in the regression. Prematurity, low birth weight, or other adverse outcomes accounted for nearly 50 percent of the total hospital charge.

While the Norton study found that maternal substance abuse led to higher hospital charges and longer hospital stays, the mean cost of exposure reported was significantly lower than that reported by Phibbs (1991), and Joyce (1995). Norton reported unadjusted mean cost per case of approximately $1,275 in Maryland in 1991 while Joyce reported a mean cost of $3,771 for unexposed newborns from a municipal hospital in Brooklyn in 1991-92. There were also important differences in the mean length of stay of unexposed infants between the two studies: 2.95 days Norton versus 5.2 days Joyce. One reason for the discrepancy may be the differences in the institutions; the one used in the Joyce study such as teaching hospitals are often associated with longer lengths of stay and higher costs. Therefore, estimates of national costs associated with newborn exposure to illicit drugs will differ considerably based on which cost figures are used.

Despite the large number of hospitals and a geographically dispersed sample, the study by Norton et al. suffers from several limitations. First, the prevalence rate of prenatal drug exposure of 1.7 percent was significantly lower than that in other studies that reported rates between 7.5 and 15 percent (Vega et al. 1993; Chasnoff et al. 1990). One reason for this is the use of ICD-9 codes to identify maternal substance use. While only those newborns who have symptoms severe enough to diagnose were recorded as exposed, newborns with several comorbidities may have not been recorded as exposed due to lack of space since the Maryland discharge data base only records five diagnoses.

Second, the study did not distinguish between different types of drugs even though such information was available on the ICD-9 codes. Previous studies have shown that the increase in hospital costs varies significantly by type of substance. Infants exposed to cocaine, opiates, or polydrug users have worse birth outcomes and are more costly to care for than infants exposed to marijuana (Kaye et al. 1989). Even among infants exposed to cocaine, those whose mothers were polydrug users had lengths of stay and costs almost double those exposed only to cocaine.

Finally, the study by Norton had no measure of maternal smoking or prenatal care. The bias on the direct effect is most likely minimal, because prenatal care and tobacco affect costs primarily through low birth weight and prematurity. The bias due to omission may be greater for the total effect estimates given the correlation of these variables with maternal substance abuse.

Joyce et al. (1996) used a sample of 72,899 women from 11 municipal hospitals in New York City to estimate newborn costs associated with prenatal exposure to illicit drugs. Exposure to cocaine, opiates, marijuana, and other illicit substances was determined from ICD-9 codes on discharge abstracts, and from indicators on New York City birth certificates. The prevalence rate based on the two sources was as follows: 1.52

percent were exposed to cocaine, 3.10 percent were exposed to opiates, 1.77 percent to cocaine plus opiates, .265 percent to marijuana, and .09 percent to unspecified drugs.

The authors used multivariate analyses and estimated that exposure to cocaine raised infant cost 85 percent compared to unexposed infants; exposure to opiates raised costs 286 percent and exposure to cocaine plus opiates raised costs by 320 percent. Evaluated at the geometric mean of newborn costs for unexposed infants, $1,827, the adjusted newborn cost in 1991 dollars were: $3,377 for infants exposed to cocaine, $7,049 for those exposed to opiates and $7,666 for those exposed to cocaine plus opiates. The length of stay increased from 3.5 days for infants unexposed to 10.3 days for infants exposed to cocaine, 13.0 days for those exposed to opiates, and 14.2 days for infants exposed to cocaine and opiates.

The authors concluded that 50 percent of the additional costs associated with exposure to cocaine and nearly 30 percent of the additional costs associated with opiates and opiates plus cocaine were indirect, the result of adverse birth outcomes. Based on the drug use prevalence rate estimated by NIDA (1996), (1.1 percent for cocaine and 0.2 percent for heroin or methadone) the authors estimated that maternal exposure to illicit drugs increased newborn costs by $106,406,900 in 1991 dollars.

The findings in this study are consistent with previous published data that maternal substance abuse substantially increases the cost of newborn care and that newborns prenatally exposed to cocaine plus opiates are three times more costly to care for after delivery than are unexposed infants. However, increases in newborn costs and length of stay associated with exposure to cocaine alone may have been overestimated in this study. Previous studies have found that infants exposed to cocaine alone when determined by urine analysis but not recorded on discharge abstracts were only slightly more costly to treat after delivery than unexposed infants (Joyce et al. 1995; Phibbs et al. 1991). The screen for illicit drugs based on discharge abstracts and birth certificates identifies the newborns that have readily observed conditions severe enough to be diagnosed. The infants exposed to cocaine but not detected in the selective screen apparently did not differ much from unexposed infants. Because these relatively healthy, but exposed infants were not included among the exposed, the estimates of costs and length of stay associated with cocaine exposure may be biased upwards.

Summary

The published studies on newborn costs associated with maternal substance abuse have consistently shown that newborns exposed to illicit drugs were more costly to care for after delivery than were similar unexposed infants. The effects were substantially greater when the infant was exposed to "crack" cocaine or to cocaine combined with other drugs than to a single drug. Several studies also showed that between 30 and 60 percent of the effect of maternal substance abuse on newborn resource utilization was indirect, attributable to adverse birth outcomes such as prematurity and low birth weight. However, a substantial portion of the total cost associated with exposure to cocaine and cocaine plus other drugs was independent of infant health at delivery.

Furthermore, illicit drug use was often associated with other ills in the lives and environment of pregnant women, such as low socioeconomic status, increased unemployment, crime, poor housing, and lack of access to medical care, which not only contributed substantially to adverse pregnancy outcomes but often precluded them from obtaining prenatal care (McCalla et al. 1991; Broekhuizen et al. 1992). Analysis of these covariates of substance use is essential when analyzing the cost associated with newborn exposure.

C. The Effect of Prenatal Care on Birth Outcomes Among Drug Users

A few studies have tried to examine whether prenatal care has improved perinatal outcomes among drug-using pregnant women. Any such study may be complicated by a variety of methodological problems. First, drug abusers who initiate prenatal care are not always comparable to drug abusers with inadequate or no prenatal care. Substance abusers who receive adequate prenatal care are likely to be lighter users, use marijuana rather than crack cocaine or heroin, and to have decreased drug use during pregnancy. Second, studies that report improved pregnancy outcomes of a specific patient population, for example, women enrolled in a program for pregnant addicts, include the possibility of sample bias. Substance abusing women who are more motivated to abstain from drug use during pregnancy are more likely to participate in special drug dependence programs. Moreover, patients enrolled in a comprehensive prenatal care program may have higher educational levels and different socioeconomic characteristics than patients in the drug-addicted urban clinic population (Rosner et al. 1982; Fitzsimmons et al. 1986; Keith et al. 1989; Chang et al. 1992). Thus a comparison between these patients and other groups of patients who received different prenatal care or no prenatal care is not always possible. Finally, some of the same important factors that influence receipt of prenatal care including inner-city environments, unemployment, limited economic resources, and a history of alcohol and tobacco abuse can also influence pregnancy outcome (McCalla et al. 1992). To reduce the problems of self-selection and to examine the independent effect of prenatal care on pregnancy outcome in the drug-using population, it is essential to control for the societal and environmental factors that lead to substance abuse, complicate pregnancy, and reduce the likelihood of prenatal care.

Several studies of the consequences of drug use on perinatal outcome have included prenatal care in their study design. The combination of no prenatal care and drug abuse had very often a greater deleterious effect on perinatal outcomes such as preterm delivery and LBW, when compared with drug using patients who utilized prenatal care (McCalla et al. 1991; Feldman et al. 1992; Miller et al. 1995). Among drug-using patients, prenatal care appeared to reduce the risk of low birth weight by increasing gestational age (Miller et al. 1995; McCalla et al. 1991).

Using multiple logistic regression models and adjusting for factors such as cigarette and alcohol use, hypertension, maternal age and parity, and the use of prenatal care, Feldman et al. (1992) estimated the effect of drug exposure on birth outcomes. The sample consisted of 1111 inner-city parturients of whom 17 percent used drugs (cocaine, marijuana, opiate, and methadone), ascertained with urine tests and self-report. The authors reported that drug use and absence of prenatal care were each associated with a two to threefold increase in the risk of premature birth and low birth weight (LBW) compared to nonusers who obtained prenatal care. Drug use in pregnancy combined with lack of prenatal care increased the risk of LBW and prematurity nearly 10 times. Documented prenatal care was associated with a two to threefold reduction in prematurity even in drug users. According to the researchers, the risk of LBW and preterm delivery increased more for drug-using women with documented prenatal care than for the drug-free group without prenatal care.

MacGregor et al. (1989) compared birth outcomes of 120 cocaine users who received comprehensive prenatal care at the Perinatal Center for Chemical Dependence of Northwestern University with 21 users who received little or no prenatal care. (two or fewer visits).[5] These investigators observed that prenatal care significantly improved the gestational age and birth weight at delivery and decreased the incidence of preterm delivery in pregnancies complicated by cocaine abuse. Furthermore, the authors noted that drug users who received care still delivered preterm or growth-retarded infants more frequently then nonusers who received similar care. The study suffers from several limitations including a small sample size and the possibility of sample bias. According to the researchers, among cocaine-dependent women receiving care, two-thirds continued to use cocaine during pregnancy. However, these women may not be comparable to drug users without prenatal care. The women enrolled in comprehensive care may have been lighter users and more likely to agree to participate in a structured program than the women who did not seek prenatal care, who may have been more seriously addicted. Reliable data to quantitate drug abuse among the patients in the two groups were not available. Thus, this study is informative, but it may not represent the population of cocaine-exposed pregnant women as a whole.

Broekhuizen et al. (1992) analyzed computer records of 23,936 deliveries in an urban perinatal center from 1983 to 1990. The authors compared outcomes for three groups of patients: 1) drug users with five or fewer prenatal care visits; 2) drug users with more than 5 prenatal care visits; and 3) nonusers with more than 5 prenatal care visits. The three groups were matched for race, age, alcohol and tobacco use, and socioeconomic variables. In each year, the incidence of low birth weight (LBW) rate was approximately two to three times higher for drug users with five or fewer prenatal visits than for drug users with more than five prenatal care visits. The authors reported that drug users with more than five prenatal visits did not have a higher incidence of LBW compared with nonusers. Similar relationships were found for perinatal mortality rate. The most pronounced differences were between group 1 with inadequate prenatal care and groups 2 and 3 with adequate prenatal care. The authors concluded that drug use seemed to have a lesser effect than adequacy of care, and that the number of prenatal visits reflected the social chaos in the life of drug users which affected outcome more than the drug use itself.

Although the authors made an effort to separate the perinatal outcome effects of inadequate prenatal care from illicit drug use, the study design precluded the use of multivariate analysis to control for confounding variables. Furthermore, the authors did not include a control group of drug-free patients with inadequate prenatal care. Finally, information on outcomes according to the specific type of drug abuse would have been helpful in determining whether drug abusers with or without prenatal care were comparable or whether women who used prenatal care had a different pattern of use than those who did not.

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[5] Comprehensive prenatal care was described in the authors' previous studies and included: 1) antenatal visits and educational activities; 2) monitoring the use of illicit substances; and 3) comprehensive sychosocial evaluations, support, and therapy (Rosner et al. 1982; Keith et al. 1989).

Using multivariate analysis, Racine et al. (1993) analyzed the association of antenatal cocaine use and low birth weight (LBW) with respect to the number of prenatal visits. The data from New York birth certificate tapes included all women residents of New York City who used cocaine prenatally and who delivered during the period from 1988 through 1990. The cocaine exposure was ascertained through a combination of physician reports, self-report, and urine toxicology, and reported on the birth certificate. The authors compared two outcomes, birth weight and the rate of LBW deliveries, based on four categories of prenatal care: women who had no visits, one to three visits, four or more visits, and an unknown number of visits.

Receiving four prenatal visits or more halved the odds of an LBW delivery and increased mean birth weight by between 247 and 317 grams compared with women who reported no prenatal care. These relationships were found in all three racial/ethnic groups studied (African American, Hispanic, and white). The receipt of one to three prenatal visits lowered the risk of LBW significantly for African American and Hispanic women and was associated with an increase of at least 120 grams in mean birth weight relative to women with no prenatal care. The effect of one to three visits was insignificant for white women and the effect of an unknown number of visits did not differ from that of no care for all groups. These findings demonstrate that the number of prenatal care visits has a significant effect on perinatal outcomes, and that provision of adequate prenatal care alone may have an important impact on preventing LBW among cocaine-exposed women.

This Racine study improves on previous research in several ways. First, by limiting the analysis to only women identified as positive for cocaine on birth certificates the ascertainment problems in an unselected sample are minimized. Second, the sample is large enough to allow control for multiple covariates and potential confounding effects. Third, the large sample may represent the population of cocaine-exposed women more accurately and therefore be more generalizable than an institution or program based study. Finally, a relative large sample size for users of cocaine permitted multivariate analysis to examine the effect of prenatal care independent of other characteristics of exposed women who chose such care. For example, by including covariates such as participation in WIC,[6] health insurance status, and labor force participation, the multivariate analysis was partially able to control for self-selection bias among the women who enrolled in prenatal care.

Two other studies have examined whether prenatal care ameliorates the adverse effects of illicit drug use during pregnancy. Berenson et al. (1996) conducted a record-based retrospective study of 238 patients who delivered at The University of Texas Medical Branch between June 1, 1989 and February 28, 1990. Of the sample, 91 tested positive for illicit drugs, of whom 52 obtained prenatal care. The results of multiple regression analysis that controlled for the potentially confounding effects of race, cigarette smoking, and alcohol use showed that among women who tested positive for drugs, prenatal care was significantly associated with infant birth weight and head size, but not with gestational age. Among drug-using women, those who obtained prenatal care

[6] WIC – special supplemental food program for Women, Infants, and Children. It raises the availability of appropriate nutrition, an important non-medical input into the production of healthy infants.

at least 3 times while pregnant were more likely to deliver an infant of greater weight compared to those who did not obtain care (2,950.3 versus 2,530.4 g).

Chazotte et al. (1995) report birth weight outcomes of 140 cocaine users who were delivered of an infant between January 1992 and December 1993 at Bronx Municipal Hospital Center (BMHC). Prenatal care was categorized as received at BMHC, received at other clinics, or no care. The number of visits of prenatal care was not reported. These investigators observed that the incidence of LBW was significantly lower for cocaine-using women who received prenatal care at any site compared with those with no care (34.3% vs. 52.3%). The difference in the incidence of very low birth weight (VLBW), less than 1,500 grams, was even more prominent between the two groups. The rate of VLBW for cocaine-using women who had any prenatal care was 5.2 percent compared with 18.2 percent for those with no care. However, the incidence of preterm delivery did not differ significantly between the two groups.

It is important to note that while patients who obtained care at BMHC had access to a very specialized prenatal care program whose team included an obstetrician, a perinatologist, a social worker, a nutritionist, and a financial counselor, as well as referrals to substance abuse treatments, there was no information about the nature of the prenatal care at other sites, and yet there was no difference in the rate of LBW between prenatal care sites. This fact may further suggest that it is either prenatal care, regardless of site or content, that has a positive impact on birth weight or the type of patient who seeks care, and that self-selection bias is a problem difficult to eliminate.

Summary

These aforementioned studies have demonstrated that prenatal care is associated with improved neonatal outcomes among drug-using pregnant women. As previously noted, the studies on newborn costs associated with maternal use of illicit drugs have documented that prematurity, LBW, and lack of prenatal care were significant factors in neonatal costs. Calhoun and Watson (1991) noted that most of the additional costs in the exposed infant nursery population were related to prematurity. Although indirect costs were not specifically reported, Phibbs et al. (1991) have estimated that the receipt of any prenatal care was associated with a significant cost reduction of between $4,300 and $5,000. These findings were consistent with the results reported by Feldman et al. (1992), who estimated that the risk of LBW decreases threefold for drug users with any prenatal care compared to those with no care, and Chazotte et al. (1995), who estimated that the rate of LBW decreased nearly 20 percent for users who obtained prenatal care.

More recent multivariate analyses have shown that the magnitude of the coefficient on the effect of drug exposure decreased significantly when controlling for covariates related to infant health. Norton et al. (1996) estimated that 49 percent of the increase in total neonatal charges was attributable to the indirect effect of maternal substance abuse or other medical problems such as LBW, infections, and malnutrition. Joyce et al. (1995) have found that the cost effects of exposure to cocaine and drugs other than cocaine nearly diminished completely when gestational age, birth weight, and congenital infection were included in the analysis as independent predictors of neonatal costs. Exposure to cocaine plus other drugs had a strong direct effect on costs, but even there 60 percent of newborn costs were a consequence of adverse birth outcomes and newborn infection.

It appears that effects of exposure on birth outcomes and neonatal costs works primarily through birthweight, preterm delivery, and newborn infection. Moreover, the incidence of LBW infants may be reduced from over 50 percent for drug-using women with no prenatal care to less than 20 percent for those who obtain any prenatal care. As several studies have demonstrated, prenatal care seems to improve perinatal outcomes in drug-dependent women.

III. Measurement of Prenatal Care

Studies of prenatal care and its effect on birth outcomes have used various indices to measure prenatal care utilization. Because of difficulties in measuring qualitative differences in prenatal care, many investigations have focused on differences in the timing of initiating of care and the number of prenatal visits. However, simply counting the number of prenatal care visits may be misleading because the number is determined by several factors, including the gestational age at which the woman starts her prenatal care, pregnancy complications, the woman's compliance, and the gestational age at delivery. Thus, for a woman who delivers prematurely, the reduced opportunity for prenatal care visits leads to a spurious relationship between a reduced number of prenatal visits and prematurity. The Kessner index was the first to address this bias by adjusting for the number of visits relative to gestational age (IOM 1973). The Kessner index is based on the number of visits in relation to the duration of pregnancy and the timing of initiation of prenatal care. Care is classified as adequate, intermediate, or inadequate based on the trimester of initiation. The rating can be lowered but not raised depending on the number of prenatal care visits a woman receives. Although the Kessner index minimizes the effects of preterm delivery bias, it too has been subject to critisicm. First, the index is primarily a measure of trimester of initiation and only 14 percent of women have their ratings reduced due to insufficient visits (Kotelchuck 1994a). Second, the Kessner index does not distinguish inadequacy of care due to late initiation from inadequacy of care due to insufficient visits. Third, the Kessner index is limited to nine visits, which is fewer visits than the ACOG recommended for normal birth. Finally, the

Kessner index has no classification for intensive prenatal care services (Kotelchuck 1994a, 1994b). Women who receive intensive prenatal care either from early enrollment or a higher rate of visits often experience complicated pregnancies. Thus, not taking into account the potential poor pregnancy outcomes of women in this group, may understate the benefits of prenatal care.

The measure of utilization of prenatal care in this analysis is a two-factor Adequacy of Prenatal Care Utilization (APNCU) Index (Kotelchuck 1994a). The index considers two independent dimensions: Adequacy of Initiation of Prenatal Care and Adequacy of Received Services. The first factor, Adequacy of Initiation of Prenatal Care, characterizes the adequacy of timing of initiation of prenatal care, such as the month prenatal care begins. The underlying assumption is that the earlier the initiation, the more adequate the prenatal care (Kotelchuck, 1994a 1994b). Early care is especially important when specific health risks can be identified early and treated more effectively. The month in which care is initiated is grouped into four adequacy groupings: months 1 and 2, month 3 and 4, months 5 and 6, and months 7 through 9.

The second factor, Adequacy of Received Services, or expected visits index, characterizes the adequacy of the prenatal care visits received from initiation of prenatal care until the delivery. The expected number of visits is based on the American College of Obstetricians and Gynecologists (ACOG) prenatal care visitation standards adjusted for gestational age at initiation of care and for gestational age at delivery. For a full-term (40 week) uncomplicated pregnancy ACOG recommends prenatal-care visits every 4 weeks for the first 28 weeks of pregnancy, every 2-3 weeks until 36 weeks of pregnancy, and weekly thereafter. The measure for Adequacy of Received Services is the ratio of the actual number of visits to the expected number of visits.

For example, for a 40-week pregnancy, ACOG recommends 15 visits; if a woman initiates care in month 4 (3 missed visits), she would be expected to have 12 visits if her pregnancy lasted 40 weeks. If she actually obtains only 9 visits, then she is classified as having received 75% of expected utilization. The number of actual visits can be recorded from birth certificate data. Kotelchuck (1994a) groups the ratios of observed to expected visits into four categories: *inadequate* (less then 50% of expected visits), *intermediate* (50%-79%), *adequate* (80%-109%), and *adequate plus* (≥110%).

The initiation and utilization of services are combined into a single summary prenatal care index. Inadequate utilization is defined as either less than 50% of recommended visits or initiation of prenatal care after the fourth month of pregnancy. All other categories require initiation of prenatal care before the fourth month of pregnancy and are coded according to the utilization of services and shown in Table 1. For example, Kotelchuck defines adequate prenatal care as care initiated during the first four months of pregnancy, followed by ≥ 80% of the expected number of visits recommended by ACOG adjusted for the length of gestation.

For the purpose of this study, the Kotelchuck index is modified by adding two more categories of prenatal care utilization, *no care* and *care unknown*. It is important to distinguish between these groups for several reasons. First, among the sample of women who were identified as exposed to illicit drugs more than 33 percent have not received prenatal care and approximately 20 percent were recorded to have an unknown number of prenatal visits. Second, the rate of low birth weight and other birth outcomes varied significantly between women who received inadequate prenatal care and those who had *no care* or *unknown care* (see Tables 7 and 8). Thus, aggregating these groups into one category *inadequate* inappropriately combines different mothers and their corresponding birth outcomes. Third, though it is likely that the unknown prenatal care category may contain a high number of women with no prenatal care, a preliminary analysis suggested that it should be treated as a separate category.

The variables used to calculate the APNCU Index were obtained from the birth certificates. The information included prenatal visits, the month of pregnancy in which prenatal care began, and gestational age as reported by the mother. For observations with missing information on gestational age, an algorithm was used to estimate gestational age from sex and birth weight data.

Table 2 shows prenatal care utilization of women identified as exposed to illicit drugs by the two-factor summary index. The figures in Table 2 underscore the need to modify the Kotelchuck APNCU index with the additional categories. Over 40 percent of women exposed to cocaine plus opiates and over 30 percent of women exposed to cocaine or opiates received no prenatal care and nearly 20 percent in each of those categories had unknown care.

Tables 2A – 2D display the timing and frequency of care separately for women who were identified as exposed to cocaine, opiates, cocaine plus opiates, and a random sample of unexposed women. The totals along the bottom of Tables 2A and 2B reveal that only 27 percent of women identified as exposed to cocaine or opiates received at least 80 percent of expected visits (column 3 and column 4), and only a few initiate care in the first four months of pregnancy. More than 30 percent cocaine or opiate exposed women did not obtain prenatal care and between 19 and 21 percent had an unknown number of prenatal visits.

Illicit drug use has been implicated as one of the most important factors associated with underutilization of prenatal services (McCalla et al. 1991, 1992), and as shown in Table 2C, utilization of prenatal medical care was even lower among women identified as exposed to multiple drugs such as opiates plus cocaine. Among these women, 41.1 percent received no prenatal care, 18.8 percent had an unknown number of visits, and 19.5 percent received less than 80 percent of expected visits (column 1 and column 2).

What is especially striking is the small percentage of exposed women initiating prenatal care in the first or second trimester (column 7, rows 4 and 5). Only 24 percent of cocaine users, 26 percent of opiate users, and 19 percent of cocaine plus opiate users initiated care in the first or second trimester. These results are consistent with studies that found a significant relationship between social disorganization of women who use multiple drugs and poor health care arrangements such as delayed or lack of prenatal care (Gillogley et al. 1990; McCalla et al. 1991,1992; Chazotte et al. 1995; Broekhuizen et al. 1992).

A comparison with the utilization of prenatal care by unexposed women (Table 2D) highlights the different patterns of use among the different groups. Among unexposed women the percentage without prenatal care and unknown care was significantly lower than in each group of exposed women, 8.5 and 12.8 percent respectively. 50.7 percent of unexposed women had at least 80 percent of expected visits (columns 3 and 4), however, only a slightly higher proportion (38%) of unexposed women than exposed woman initiated care in the first four month of pregnancy. This may be because the sample in this study reflects low-income, non-white, unmarried women served at public hospitals in New York City. Studies of Medicaid population have shown that lack of first trimester care is a common deficiency for Medicaid patients. Despite the availability of providers and extended eligibility, women who are Medicaid recipients experience higher rates of late initiation of prenatal care and poorer use of care regardless of when they entered care (Krieger et al. 1992; Melnikow and Alemagno 1993).

An important feature of the APNCU Index is the establishment of the *adequate plus* category. Women receiving *adequate plus* care, or more than the ACOG-recommended number of visits adjusted for the timing of initiation, often have high-risk pregnancies and experience poor birth outcomes (Kotelchuck 1994b). The association between high utilization of care and poor birth outcomes may reflect adverse selection. Pregnant women who anticipate complications are more likely to initiate prenatal care earlier and follow a more intense schedule of visits. It is important to isolate this group of high-risk women because their poor birth outcomes may reflect poor health endowments that may confound the true relationship between prenatal care utilization and newborn health.

There are however, several limitations to the APNCU Index. First, the utilization measures alone does not address the content of prenatal care visits, an important factor in the quality of care (Peoples et al. 1988). Second, the self-reported data on the birth certificates that are used to calculate the APNCU Index may not always be accurate (Fingerhut and Kleinman 1985). Third, the ACOG designation of adequate amount of prenatal visits is for women with uncomplicated pregnancies. Women with medical or obstetrical risk should have more prenatal visits during their pregnancy. Thus the number of women with *inadequate* prenatal care utilization may be underestimated when high-risk pregnancy is not taken into account. In spite of its limitations, the Adequacy of Prenatal Care Utilization Index can provide useful information when describing prenatal care experience of drug-exposed women. Assessing the independent components of utilization of care can help develop strategies for cost-effective interventions designed for these high-risk pregnancies.

Previous studies on the effect of prenatal care on pregnancy outcomes among women who are exposed to illicit drugs have used different approaches to measurement of prenatal care utilization. In some studies the receipt of prenatal care was not quantified but considered either present or absent (McCalla et al. 1991; Phibbs et al. 1991; Feldman et al. 1992; Chazzote et al. 1995). Other recent reports compared outcomes for different number of visits with those of no prenatal care. The number of visits was often categorized as one to three and four or more visits (Racine et al. 1993), or fewer than five and more than five visits (Broekhuizen et al. 1992). In another study the number of prenatal care visits was used as a continuous variable (Berenson et al. 1996).

The sensitivity of the prenatal care parameter estimates to changes in the prenatal care categories specifications will be tested in several ways. First, newborn cost and length of stay regressions will be re-estimated using three categories of the trimester of initiation of care holding the number of visits constant. Second, the regressions will be re-estimated using the number of prenatal care visits categorized as one to three and four or more visits. The reference category in both cases will be no prenatal care. Third, the regressions will be re-estimated in order to assess the marginal effect of an additional prenatal visit from the first through the ninth visit. Finally, using a logistic regression the odds of low birth weight, very low birth weight, and preterm delivery will be estimated employing three different specifications of prenatal care utilization: the APNCU Index, the trimester of initiation of care holding the number of visits constant, and prenatal care visits categorized as one to three and four or more visits.

IV. Demand for Health

A. Theoretical Framework

Economic models stress the importance of parental decisions in the production of infant health. Since the focus of this analysis are pregnant women who use illicit drugs, of whom more than 90 percent are single, and the health input is limited to the use of prenatal medical care, a simplified three-good utility function model is used. Using this approach the mother maximizes a utility function which consists of her consumption (X), the health of her child (H), and the use of illicit drugs (D). Decision regarding infant health occurs in two stages: the mother chooses the level of prenatal care and drug use, while the physician determines length of stay given infant health at delivery.

The mother maximizes utility (U),

$$(1) \qquad U = u\left[H(M, D), X, D\right]$$

where H is the newborn's health at discharge, X is a composite consumption good purchased in the market at the price of $1 that has no impact on H, and D is the consumption of substances such as cocaine, opiate, and other illicit drugs that augment utility but have a harmful effect on H. In this framework, the mother is the decision-maker regarding infant health prior to delivery. The production of child's health is a function of her consumption of drugs D, and her choice of the prenatal medical care M, which does not augment utility other than through its effect on of infant health. The mother continues to consume D during her pregnancy either because she is unaware of the deleterious effects it has on H, or if she is aware of the harmful effects she consumes because these are outweighed by the positive utility she derives from its consumption. Infant health at discharge (H) is equal to the stock of health at birth (S) plus the increase in the stock between delivery and discharge (g).

(2) $$H = S + g$$

The stock of health at birth (S) is positively related to birth weight (B), while (g) is positively related to length of stay (L) and negatively related to birth weight. Birth weight is negatively affected by illicit drug use (D).

(2a) $$H = S[B(D)] + g[B(D), L]$$

(3) $$\frac{\partial H}{\partial B} = H_B = S_B + g_B > 0$$

(4) $$\frac{\partial H}{\partial D} = H_D = S_B B_D + g_B B_D \leq 0$$

(5) $$\frac{\partial H}{\partial L} = H_L = g_L \geq 0$$

Let M be prenatal care, p be the price of M and π be the price of L, where p and π include waiting and travel time as well as psychic costs. Finally, let I be income. Maximizing utility subject to resource constraints yields the following first order conditions:

Note that $B_M \equiv \frac{\partial B}{\partial M} > 0$ and $B_D \equiv \frac{\partial B}{\partial D} \leq 0$

$$(6) \quad U_x = \lambda$$

$$(7) \quad U_H(S_H + g_B)B_M = \lambda p$$

$$(8) \quad U_H g_L = \lambda \pi$$

$$(9) \quad U_D + U_H H_D = \lambda c$$

where λ is the marginal utility of income. Equation (8) assumes that the mother or the physician as a perfect agent for the mother selects L. Given that g is a positive function of L and negatively related to birth weight, equation (10) may be a possible functional form for g using birth weight as a proxy for the stock of health at birth (S).

$$(10) \quad \ln g = a \ln L - b \ln B$$

$$(10a) \quad \ln B = c - dD$$

$$(10b) \quad \ln g = a \ln L - bc - bdD$$

The equation can then be solved for L as a function of p, π, B, and D, where $\frac{\partial L}{\partial B} < 0$. The mother chooses the intensity of her drug use, the level of prenatal care, and therefore birth weight, and the physician as a perfect agent for mother determines the optimal length of stay or resource utilization conditional on infant health at delivery.

An alternative model is one where the physician selects the length of stay. Following Joyce et al. (1995, 1996), the physicians maximize the sum of g_i, the difference between infant health at birth (S) and infant health at discharge (H). Infant health is improved by increasing length of stay (L), which represents an aggregation of inputs available to physicians. Length of stay is constrained by the number of newborn beds at the hospital, which is fixed. If a newborn's initial health is good, then the difference between (*H*) and (*S*) will be small, and the physician will conserve scarce resources (*L*) for less healthy newborns, those with a smaller (*S*). Physician choices regarding length of stay take prenatal behaviors and birth outcomes as given. Birth weight is included in the stay equation because it alters the marginal product of a given amount of (*L*), thereby shortening stays and reducing resource utilization. Prenatal care may also be included in the stay equation if it has direct effect on (*g*), after controlling for birth weight.

B. Empirical Framework

The empirical model emphasizes the direct and indirect effects of prenatal care on different measures of newborn costs. A linear model of newborn costs (*C*) can be specified as follows:

(11) $$C = \theta_0 + \theta_1' X + \theta_2 D$$

(12) $$C = \alpha_0 + \alpha_1' X + \alpha_2 B + \alpha_3 M + \alpha_4 D$$

(12a) $$B = \beta_0 + \beta_1' X + \beta_2 M + \beta_3 D$$

where B is a measure of infant health such as birth weight. M is prenatal care use as measured by a modified version of Kotelchuck index, and D is a measure of exposure to illicit drugs. A vector X captures a set of demographic, socioeconomic, and obstetrical characteristics. In equation (11), θ_2 measures the total effect of exposure on newborn costs. Maternal substance abuse can affect hospital costs in two different ways. First, it may cause premature birth that requires neonatal intensive care treatment. Second it can directly affect costs associated with exposure for example, treatment for symptoms of newborn drug withdrawal. The coefficient on D in equation (11), θ_2, measures the sum of the two effects. The objective here is to assess whether the subsequent addition of potentially endogenous variables such as prenatal care, WIC, and other covariates will diminish the total effect of exposure on cost.

In the model described by equations (12) and (12a) prenatal care has both a direct and indirect effect on costs. Prenatal care is generally assumed to have a beneficial impact on pregnancy outcome through birth weight. Recent evidence suggests however, that prenatal care may also minimize complications during pregnancy and birth through modification of risk-factors (Greenberg 1984; Showstack et al. 1984; IOM 1985). Thus, through early identification and reduction of health risks, prenatal care may have an impact on reducing newborn cost and length of stay independent of birth weight. For example, reducing the length of stay associated with newborn drug withdrawal. The direct effect, captured by α_3, measures the extent to which prenatal care operates on costs after controlling for birth weight. In equation (12a), β_2 captures the indirect effect of prenatal care on infant health at delivery as measured by birth weight. The total effect of prenatal care on newborn costs can be obtained by substitution for B in equation (12).

$$(13)\quad C=\gamma_0+\gamma_1'X+\gamma_2 M+\gamma_3 D$$

where $\gamma_2=\alpha_2\beta_2+\alpha_3$ is a measure of the total effect of prenatal care on newborn costs.

Obtaining consistent and unbiased estimates of parameters in equation (13) may be difficult if women posses information regarding their health and their pregnancy, which may alter their use of prenatal medical care and affect the child's health (Rosenzweig and Schultz 1982; 1983; Grossman and Joyce 1990; Joyce 1994). Women who expect to have a relatively healthy child and do not anticipate a problematic pregnancy based on their previous observations, may not feel strongly about obtaining prenatal care. Conversely, mothers with poor endowed health outcomes or previously established risks will seek to offset those by utilizing prenatal care earlier and have more frequent visits. On the other hand, the receipt of early prenatal care may be a marker for other healthy behaviors that cannot be observed. The researcher has no means of controlling or quantifying some of the factors that affect women's decisions. This creates an omitted variable bias in a regression of birth weight on a measure of prenatal care. By excluding these unobserved health characteristics the impact of prenatal care on newborn outcomes is either underestimated or overestimated depending on the net effect of the contrasting factors.

One method of obtaining unbiased estimates of the effect of prenatal care on infant health is the use of instrumental variable (IV). Rosenzweig and Schultz ((1983) use a measure of income and education variables as instruments for the unobserved health characteristics of the mother. Both variables may help determine the demand for prenatal care but they are likely to be correlated with women's health endowment and other unobserved factors such as nutrition, and quality of medical care. Recent work on instrumental variables (Bound, Jaeger and Baker 1995) has shown that even if a weak relationship exists between the instruments and the error in the structural equation, it can lead to large inconsistencies and yield misleading results.

Lacking relevant variables to instrument prenatal care equations (11) – (13) are estimated using ordinary least squares (OLS). The model also assumes that illicit drug use and smoking are behaviors that existed prior to pregnancy and are little affected by pregnancy. Studies on changing patterns of drug use during pregnancy report that except for heavy social drinking, drug habits at all levels of drug use remain essentially unchanged after the first trimester (Fried et al. 1980; Johnson et al. 1987; Day and Richardson 1991; NIDA 1996). Moreover, women who used drugs most frequently were least likely to reduce their use or become abstinent during pregnancy (Day et al. 1993). In a sample of women who were daily users of marijuana prior to pregnancy 70 percent reported that their use in the first trimester was similar to prepregnancy use and only three percent became abstainers (Fried et al. 1980; Day and Richardson 1991; Day et al. 1993). The patterns of cocaine and crack cocaine use were also found to be stable during pregnancy. In the survey of prenatal drug use by NIDA (1996), the overall prevalence of cocaine use was 0.9 percent in the first trimester and 0.8 percent in the last trimester, and the prevalence of crack cocaine was 0.7 percent in both, the first and last trimester. The results also held when examined by race or ethnicity. In another study of changes in cocaine use during pregnancy, the rate of cocaine use was 11 percent during the first trimester, 7 percent during the second trimester, and 9 percent during the third (Frank et al. 1988). A majority of smokers (70 percent) also failed to successfully quit during pregnancy. (Johnson et al. 1987). In a multivariate regression, therefore, prenatal drug use can be considered an exogenous determinant of infant health and newborn costs.

Finally following Joyce et al. (1995, 1996), an alternative justification for using OLS is that costs and length of stay are decisions made by physicians conditional on the health of the child at delivery. Physician choices regarding length of stay take prenatal behaviors and birth outcomes as given. It is safe to assume a minimal patient/physician interaction in the context of this model given that over 90 percent of exposed women are insured by Medicaid and 70 percent of them had fewer than 3 prenatal visits.

Functional form consideration

Figures 1 and 2 show the distribution of cost and acute care length of stay of infants exposed to illicit drugs. The mode of newborn costs and length of stay is between $5,000and $6,000 dollars and between 11 to 15 days. More than seven percent of newborns have costs over $30,000 and 15 percent of newborns remain in the hospital for more than 30 days. Since both distributions are clearly not normal, their natural log-transformed values are used in the analysis. Following Joyce et al. (1995, 1996), the regressions are estimated with the natural logarithm of cost and length of stay as dependent variables.

C. Data

The data consist of New York City birth certificates for the years 1990 through 1992 linked to discharge abstracts from the municipal hospital system by the Health and Hospitals Corporation (HHC). The creation of the data required several steps. First. all mothers who delivered in an HHC facility between January 1, 1990 and December 31 1992 were linked to their infants within discharge abstracts in the HHC database. This linkage was most successful in 1992 and least successful in 1990. Second, the mother infant pairs were matched to New York City birth certificates with a successful match rate of 98 percent. Full details of the matching as described by Joyce et al. (1996) can be found in the Appendix.

New York City Birth Certificate

The New York City birth certificate is one of the most detailed in the United States. Since 1988, New York birth certificates have included confidential information on prenatal substance abuse, by type of drug. The information on prenatal care includes the date of first prenatal visit, the type of prenatal care provider, private physician or clinic, and the total number of prenatal visits. In addition, the birth certificates provide information on medical insurance (Medicaid, self-pay, or private insurance), enrollment in the Supplement Nutrition Program for Women, Infant and Children (WIC), and whether the mother worked during pregnancy. Other data available from the birth certificates are: prepregnancy weight, weight gain during pregnancy, exposure to tobacco (more than half a pack of cigarettes per day), use of alcohol (two or more drinks per week), mother's nativity, race, age, and marital status, infant birth weight, and more.

Census Data

The data from birth certificates are augmented with the 1990 Census data that had been aggregated from the census tract to the health area level. New York City is divided into 352 health areas; the average health area contains between 15,000 and 25000 residents. The birth certificates identify a mother's residence by health area; thus area specific variables can be used to control for health area characteristics. Race and ethnic specific poverty rates, and labor force participation rates proxy for command over resources. Other area characteristics include homicides per capita, number of drug-related deaths, and reported cases of syphilis per capita.

Creation of Exposure Measures

The data on exposure to illicit substances during pregnancy derive from two sources: the New York City birth certificate and the ICD-9 codes from discharge abstracts collated by the Health and Hospitals Corporation institutions in their computerized data base.[7] The birth certificates contain information on prenatal substance abuse, which is based upon a combination of self-reports to physicians and positive toxicology screens applied at delivery. An individual certificate can record up to five separate exposures. Dichotomous indicators exist for the use of more than ½ pack of tobacco per day, more than 2 drinks of alcohol per week, exposure to heroin, cocaine,

[7] The details of the merging of exposure measures from birth certificates with exposure measures from discharge data as described by Joyce et al. (1996) appear in the Appendix.

methadone, marijuana, sedatives, tranquilizers and anticonvulsants, and to other unknown drugs. For the purposes of this analysis, the infant is considered exposed if either the maternal or the infant discharge record contained evidence of exposure or exposure is indicated on the birth certificate. There is no distinction however, as to how the identification of use is obtained on either, the birth certificate or the discharge abstract. Protocols outlining selective criteria for urine toxicology screen usually vary greatly from hospital to hospital thus, the reliability of the data may also vary among institutions.

Of the 75597 observations in the data set, 5446 women, or 7.2 percent, were identified as having been exposed to illicit substances during pregnancy. Among those, 1.8 percent were exposed to cocaine, 3.2 percent to opiates and 1.9 percents to cocaine plus opiates. The rates of exposure to marijuana and other or unspecified drugs were relatively lower, 0.3 percent and 0.1 percent respectively.

In this sample of low-income, high-risk women who delivered at public hospitals, these estimates most likely represent an underestimation of actual use. Several anonymous screening studies indicated a markedly higher rate (10% to 20%) of illicit drug use among poor, minority, inner-city obstetric population (Frank et al. 1988; Gillogley et al. 1990; Matera et al. 1990; McCalla et al.1991; Schulman et al. 1993).

The low rate of substance abuse in this study sample reflects the limitations of the screens used to capture exposure. First, significant underreporting was likely to have occurred. Self-report to identify drug use during pregnancy can be highly unreliable and may underestimate use by as much as 65 percent (Zuckerman et al. 1989). Supplementing birth certificate data with ICD-9 codes reduces underreporting, yet it is unlikely to capture the full extent of substance abuse.

Second, the reliability of urine toxicology is limited by the rapid clearance of most substances (ACOG 1994). Urine screening reveals only the results of cocaine use within 24 to 72 hours, opiates use for 2 to 4 days, and marijuana use over 7 to 30 days, leading to negative results for women who abstain from use a few days before delivery or testing (Evans and Gillogley 1991).

Finally, using information based on clinicians' diagnostic evaluation to identify maternal substance use may classify only those newborns that have symptoms severe enough to diagnose and miss newborns that are exposed but show no symptoms. The misclassification of drug-exposed newborns as unexposed may overstate the effect of drug use on newborns. Nonetheless, birth certificate and hospital discharge summaries each, capture exposure missed by the other source and increase the reliability of exposure information compared to any one source used alone.

Description of Newborn Cost

The primary measure of newborn costs is the expected revenue for each discharge based on the New York Prospective Hospital Reimbursement Methodology (NYPHRM IV), an all payer reimbursement system in effect in New York State between 1988 and 1996. Under this system hospitals are reimbursed for impatient service based upon the patient's diagnostic classification i.e., diagnosis related groups (DRG) rather than based upon length of stay and charges. The New York State prospective payment system uses over 800 DRGs to assess reimbursement and recognizes 39 DRGs for newborns. Each DRG is assigned a relative case weight or service intensity weight (SIW). Relative resource use is converted into cost by multiplying the SIW by case-mix neutral payment rate that represents the average cost per discharge in a particular hospital.

The reliability of SIWs to serve as basis for payment depends on their accuracy as a measure of relative resource utilization. The SIWs were first developed by the New York State Department of Health in 1979 and have been updated in 1983, 1985, and 1989. The SIWs are based on a one-third sampling of each category and type of hospital in the State, and thus, represents the largest sample of discharges used in a DRG system in the country (New York State Department of Health 1991).

The information for SIW cost comes from in-depth financial review of each sample hospital. Non-comparable cost elements among hospitals such as malpractice insurance costs, depreciation and interest, and physician salaries are excluded in deriving SIW values. Costs are adjusted for geographic price differentials such as labor costs for comparability within the sample. Cases entailing extreme long lengths of stay (outliers) as well as cases with exceptionally high costs (cost outlier) are also excluded from SIW calculations. The SIW value for each DRG is then obtained by dividing the average cost per case of each DRG by the average cost per case of the sample. The SIW represent the average use of resources of patients in that DRG, compared to the average use of resources of all patients. A DRG with expected resource consumption equal to that of the average of all DRGs is assigned a SIW of 1.000. For example, if DRG 1 has a SIW of 0.5000 and DRG 2 has a SIW of 2.000 then DRG 2 requires four times the resources of DRG 1 and two times the resources of the average of all DRGs. The SIWs range from a high of 35.9324 for a newborn weighing less than 750 grams discharged alive, to 0.1376 for false labor.

Assuming that the SIWs are an accurate measure of resource utilization, the per-case payment rate becomes the link between reimbursement and cost. The main source of financial data for the case payment rate calculation is the Institutional Cost Report (ICR) supplemented by patient discharge data and a variety of surveys on claims and cost. Non-comparable, hospital specific cost are excluded from the calculation as are short-stay and long-stay cases and cases with exceptional costs. Adjustments are made for local area wages, graduate medical education, case-mix "creep" and other factors.

The case payment rates are established separately for groups of hospitals based on a geographic area, urban/nonurban location, and teaching status. Hospitals with similar characteristics are considered to comprise a "peer group." Once costs are standardized, each institution is assigned a cost per discharge based on its own operating costs, and an average cost per discharge based on the hospital group operating cost is computed for the group. The case payment rate is a weighted average of hospital-specific cost per discharge (45 percent) and peer group cost (55 percent). To calculate the actual hospital reimbursement additional adjustments have to be made for such items as capital cost, bad debt and charity care, excess physician malpractice, and financially distressed facility allowance.

The expected reimbursement under the DRG system appears to be a good measure of newborn resource utilization for several reasons. First, the case payment rates are derived primarily from the assessments of institutional costs not charges. Second, under NYPHRM IV the hospital has relatively little control over the rate of reimbursement. Case payment rates are set prospectively and apply to all discharges regardless of the payer and cannot be raised or lowered by the institution. Third, this form of reimbursement eliminates the incentives inherent in fee-for-service system to increase revenues by providing additional hospital services. Moreover, because it applies to all payers, it minimizes cost shifting from less generous to more generous payers.

Another measure of newborn costs in this analysis considers the routine costs in newborn nursery. Each of the 11 facilities recognize two types of nurseries: a regular nursery for uncomplicated deliveries and a neonatal intensive care nursery (NICU) or premature care nursery for more specialized care. The routine costs per day are obtained from institutional cost reports from each hospital and include nursing costs, pharmacy, laundry, and housekeeping. Excluded in the costs are ancillary costs such as radiology and laboratory. Although incomplete, the costs per day multiplied by the acute care length of stay provide an alternative measure of resource consumption by the newborn that is not based on DRGs.

Two additional measures of costs are the acute care length of stay and service intensity weights. Unlike hospital charges that are positively correlated to length of stay, under the prospective payment methodology such as NYPHRM IV the reimbursement is constant over a certain range of lengths of stay providing strong incentives for hospitals to minimize length of stay. Thus, the estimates of the length of stay associated with illicit drug use should reflect efficient use of hospital resources since there is no financial incentive to extend the medically necessary length of stay. The service intensity weights represent the expected resource utilization associated with a particular DRG. Since SIWs are invariant across hospitals, the estimates of SIWs associated with illicit drug use should reflect a good measure of the severity of illness and of the relative resource consumption by the newborn.

Treatment of missing data on expected revenue

Clearly, the expected reimbursement under NYPHRM IV offers a reasonable measure of newborn cost per discharge. An inspection of the data however, revealed that some infants had expected revenues and thus costs of less than or equal to zero. In the sample of 5446 newborns who were identified as exposed to illicit drugs, 810 observations had an expected revenue of zero, and five observations had a negative expected revenue, of -$32.46. Stratification by payer for infant cost per discharge disclosed that the five observations with negative costs and 722 observations with zero costs were infants insured by Medicaid, 42 infants were uninsured, and other payers insured the remaining 44.

Furthermore, the 815 observations were not confined to one hospital; each of the 11 municipal hospitals had several. As shown in Table 3, Harlem, Lincoln, and Woodhull hospitals had the largest absolute number of deliveries with a negative or zero infant expected revenue. At Coney Island hospital nearly thirty percent of newborns delivered in that period had expected revenue of zero.

As noted by Joyce et al. (1996), officials at Health and Hospitals Corporation could not come up with an explanation for these revenue figures. Except for uninsured infants for whom hospitals may possibly not collect any revenues, for the other over 90 percent of infants insured by Medicaid or other insurance, the hospitals were likely to collect reimbursements. Certainly, zero or negative expected revenue did not reflect the cost or the resource utilization by newborns.

Under the New York Prospective Hospital Reimbursement Methodology (NYPHRM IV) a payment the hospital receives is calculated as the product of two components: service intensity weights assigned to each DRG, a factor invariant across hospitals, and the case payment rate, a standardized amount adjusted for certain hospital specific factors (NYPHRM 1991). Therefore, if the DRG designations and the corresponding service intensity weights were correct, using the case payment rates for the individual hospitals the expected reimbursement can be easily imputed.

Tables 4 presents the observations with expected revenue of less than or equal to zero by DRG. Except for the 36 observations in DRG 470, which could belong to more than one major diagnostic category (ungroupable) and have no SIWs assigned to them, each of the other observations had a mean service intensity weight comparable to that designated by New York State Department of Health. A further check into the data indicated that the mean acute length of stay associated with each DRG also corresponds to that assigned by the NYS Department of Health i.e., it was within the Non-Medicare high and low trimpoints.

According to the NYS Department of Health the reimbursement for what is referred to as a normal inlier stay is straight forward and it is calculated as follows: (Discharge case payment rate * SIW)+(capital cost per discharge).[8] This formula however, does not include the regional bad debt and charity care percentage add-on, which is approximately between 2.2 and 6.5 percent of the basic reimbursement. Also, no consideration is given in the above calculation to the long stay, short stay, and high cost outlier payments. An examination of the data revealed that among the cases with zero or negative expected revenue, 24 infants had acute care length of stay longer than the Non-

[8] The information regarding hospital reimbursement, Medicaid Case Payment rates, and the New York State DRGs with their assigned SIWs was obtained through personal communication with John W. Gahan Jr., Assistant Director, Bureau of Primary and Acute Care Reimbursement, NYS Department of Health.

Medicare high trimpoint. For those observations the expected revenue should be higher than what the above formula suggests.

Before attempting to impute the expected revenue it is of interest to see whether the observations with negative or zero expected revenue differed significantly form those with positive reimbursement. A comparison of selected characteristics is shown in Table 5. There are several statistically significant differences between the two groups and some are more important than others. Certainly, the mean cost of $12,079 was a more appropriate measure of resource consumption by a newborn exposed to illicit drugs than zero or negative costs. Moreover, the mean total cost from nurseries is higher for the observations with zero or negative revenue than for those with positive revenue, $6550 versus $5198, which verifies the magnitude of resource utilization by exposed infants.

The two groups differed significantly in several other respects. First, although the mean number of prenatal care visits was similar for both, a greater proportion of women received prenatal care in the group with zero or negative expected revenue. Second, the observations with negative or zero expected revenue had a higher proportion of cocaine users whereas those with positive expected revenue had higher proportions of opiate and cocaine plus opiate users. Finally, perhaps the most noteworthy differences between the two groups are the years in which the observations occurred. While the proportion of cases with positive revenue was similar in 1990 and 1991, and considerably lower in 1992, the cases with negative or zero revenue came disproportionally from 1992.

Given that 95 percent of the cases were from 1992 and nearly 90 percent of newborns were insured by Medicaid the substitution can now be greatly simplified by using the 1992 Medicaid discharge case payment rates and the 1992 capital cost payment rates. Although the reimbursement by other payers might differ from the Medicaid reimbursement, according to the NYS Department of Health these differences are generally minimal. Since the case payment rates and the capital cost payments are set twice a year by NYS Department of Health the mean of the two rate settings is used.

Table 6 displays the mean Medicaid discharge case payment rates and mean capital cost per discharge for the years 1990-1992. An inspection of the figures in the table reveals that for any DRG an expected revenue of less than $1100 is too low to be a believable cost. For example, 0.2128 is the lowest SIW in the data and it belongs to DRG 629, normal vaginal delivery without complications and newborn with normal diagnosis. Multiplied by the 1992 mean case payment rate for Coney Island hospital plus the capital cost per discharge it yields the lowest possible cost per discharge of $1373. A further investigation of the data showed that 179 observation had an expected revenue of less than $1100, 70 percent of which (125) were infants classified as uninsured, 17 percent (31) were infants covered by Medicaid, and 13 percent (23) were insured by other payers. Hence altogether 994 observations had an expected revenue that seems too low.

To preserve the large number of observations the infant expected revenue was imputed for observations with costs less than $1100 using the service intensity weights in the data, the mean 1992 Medicaid discharge case payment rates, and the 1992 mean capital cost per discharge according to the formula noted earlier. Observations that lacked data on SIW were eliminated reducing the number of observations of infants who were identified as exposed to illicit drugs from 5446 to 5409. The mean expected revenue after substitution was $12,248 – only slightly higher than the mean displayed in Table 4 which contains all observations with positive revenue including those less than $1100.

The missing data on infant expected revenue was imputed in a similar manner for the randomly chosen sample of newborns who were classified as unexposed. In a random sample of 7026 mother/infant pairs, 1032 infants had an expected revenue of zero, and 48 had an expected revenue of -$32.46. Except of the 48 observations with negative cost which occurred in 1990, all observations with zero cost (95%) came from the 1992 data. Stratification by payer for infant discharge data disclosed that the 48 observations with negative costs and 924 observations with zero costs were infants insured by Medicaid, 56 infants were uninsured, and 30 were insured by other payers. The mean cost of discharge for infants with positive expected revenue was $3134. A closer look at the data revealed that 500 cases had costs of less than $1100. Of these, 66 percent (335) were to infants classified as uninsured, 18 percent (93) were infants covered by Medicaid, and other payers insured the remaining 16 percent (80).

Following the earlier formula the infant expected revenue was imputed for observations with costs less than $1100 using the service intensity weights in the data, the mean 1992 Medicaid discharge case payment rates, and the mean 1992 capital cost per discharge. The 12 observations with missing DRG classification as well as 22 observations classified as DRG 470 (ungroupable) without the information on SIWs were eliminated, reducing the number of observations in the random sample of unexposed mother/infant pairs to 6992. The mean expected revenue after substitution is $3237.

The sensitivity of the parameter estimates to the imputed values of expected revenue will be tested in two ways. First, the cost regression will be re-estimated using only positive expected revenue in the data thus, eliminating the observations with negative or zero revenue. Although, this will reduce the sample to 4631 observations, it will test the sensitivity of the estimates to the inclusion of the low values (below $1100) of the expected revenue. Second, using the same sample the length of stay regression will be re-estimated. Since the length of stay was not imputed, this will test the sensitivity of the parameter estimates to the smaller sample that might have been used had the substitution not been performed.

V. Results

A. Descriptive Statistics

Table 7 displays definitions of the dependent and independent variables used in the analysis. Summary statistics of mother/infant pairs stratified by prenatal care categories are presented separately for the sample of women who were identified as exposed to illicit drugs, (Table 8), and a random sample of unexposed women, (Table 9). The descriptive statistics of the pooled sample by type of exposure are presented in Table 10. Of the 5409 women exposed to illicit drugs, 1789 (33%) did not receive any prenatal care and 1061 (20%) had an unknown number of visits. It is important to note, however, that women in the *unknown care* category had a mean number of 5.35 prenatal care visits and their birth outcomes differed significantly from those in the *no care* category, which underscores the distinct nature of these categories. Table 8 shows that among exposed women, those without prenatal care had worse birth outcomes than women in the other prenatal care categories, with the exception of the *adequate plus* category. The most notable differences in birth outcomes were between *no care* and *inadequate* care categories. The outcomes improved further with *intermediate* care but the marginal differences were small.

The rates of exposure to cocaine alone or opiates alone did not vary significantly among women in the different prenatal care categories, but the rate of exposure to cocaine plus opiates was significantly higher among women who had *no care* or *inadequate* care compared with women in the higher care categories. Women who obtained *inadequate* prenatal care had infants with significantly higher mean birth weight than those with *no care* (2808 grams versus 2527 grams). The rate of low-birth-weight infants among exposed women who received *inadequate* prenatal care was half of that among women with *no care* (27.4% versus 43.9%). Significant differences are also seen in the rate of very low birth weight (2.34% among women with *inadequate* care versus 8.44% among those with *no care*) and in gestational age (38.51 weeks for infants whose mothers had *inadequate* care compared with 36.07 weeks for infants whose mothers had *no care*). Infant death rate was four times as high in the *no care* category as in the *inadequate* care category.

As expected, the outcomes in the *adequate plus* prenatal care category were only slightly better and some cases worse than outcomes for women who had *no care*. More than 38 percent of women in this category had a low birth weight (LBW) infant and nearly 58 percent experienced a preterm delivery. Four percent of women who obtained *adequate plus* care had multiple births and 21 percent had birth by cesarean section. These findings are consistent with studies that report that women who initiated prenatal care earliest and who had greater than expected utilization experience complication, rates of low birth weight, and preterm deliveries in excess of almost all other women (Kotelchuck 1994b). The association between high utilization of care and poor birth outcomes among women exposed to illicit drugs may reflect adverse selection. Exposed women who anticipated a complicated pregnancy and birth may have been more likely to initiate prenatal care earlier and follow a more intense schedule of visits. The mean number of prenatal care visits in the *adequate plus* category was more than double the number of visits in the *inadequate* care category (11.91 versus 5.02).

As shown in Tables 8 and 9. the differences in outcomes among prenatal care categories among unexposed women are not as striking as those for exposed women. The distribution of women among the care categories differed between exposed and unexposed women. Of the random sample of 6992 unexposed women, 594 (8.5%) had no prenatal care and 897 (12.8%) had unknown care. Unexposed women in the *no care* category had far better outcomes than women exposed to illicit drugs in higher care categories. For unexposed women, the most notable differences in outcomes were between the *no care* and *intermediate* care categories. Women who received *intermediate* prenatal care had infants with significantly higher mean birth weights than women with *no care* (3307 grams versus 3112 grams). The rate of LBW among women with *intermediate* care was less than half of that among women with no care (5.82% versus 14.50%). The gestational age was also significantly higher for infants born to women who received *intermediate* care compared to infants whose mothers had no care (40.17 weeks versus 38.50 weeks). The infant death rate was ten times higher for infants whose mothers had *no care* compared with infants whose mothers had *intermediate* care.

Table 9 also illustrates that among unexposed women, those who chose *adequate plus* prenatal care had worse outcomes than women with *no care*. The rates of LBW, preterm delivery, birth by cesarean section, and infant death were highest in the *adequate plus* category. This may be because women who received extra prenatal care visits were in a high-risk group. In both, Table 8 and Table 9, the outcomes in the *adequate plus* category underscore the importance of this category of the APNCU Index. The *adequate plus* category provides a means to directly estimate the number of women receiving more than the ACOG-recommended number of visits, adjusted for the timing of care initiation

(Kotelchuck 1994a). It is important to isolate this large group of high-risk women because they have a disproportionate number of complicated pregnancies and LBW infants. An important issue for these women may be quality and efficacy of prenatal care rather than additional visits (Kotelchuck 1994a, 1994b).

The sample characteristics by exposure are shown in Table 10. Women who use illicit drugs during pregnancy tend to be older, African American, and born in United States. More than 90 percent of exposed women were unmarried compared with 66 percent unexposed women. Users were more likely than nonusers to have less than a high school education, be unemployed, and live in poor high-crime neighborhoods. Significant differences are also seen in a number of obstetrical risk factors. Drug users were more likely than nonusers to have experienced previous fetal loss, have a fourth or higher order birth, and have sexually transmitted diseases (STD).

What is especially striking is the high rates of tobacco and alcohol use among exposed women. The reported rates of tobacco and alcohol use were significantly higher among all women exposed to illicit drugs compared with unexposed women but the difference was most marked for women exposed to cocaine plus opiates. Nearly 64 percent of women exposed to cocaine plus opiates admitted to smoking at least a half-pack of cigarettes per day during pregnancy and 23 percent reported having at least two drinks per week. Similar rates have been reported in the literature. Feldman et al.(1992) reported that 70 percent of drug users were also cigarette smokers. McCalla et al. (1991) reported that 73 percent of cocaine users admitted to cigarette smoking compared with 14 percent of nonusers. Gillogley et al. (1990) have found that 37 percent of drug users reported alcohol use, compared with 10 percent of nonusers.

Finally, as noted in previous studies, drug use was strongly associated with underutilization of prenatal care. Between 31 and 41 percent women exposed to illicit drugs had no prenatal care compared with 8.5 percent of unexposed women. Nearly 20 percent of users had unknown care. Women exposed to cocaine plus opiates had a mean number of three prenatal visits compared with eight visits for unexposed women. Studies consistently show that late or no prenatal care is common among substance abusers. McCalla et al. (1991) reported that 51 percent of cocaine users had no prenatal care compared to 8.8 percent of nonusers.

Table 10 also highlights the differences in birth outcomes by exposure. The mean gestational age at delivery and mean birth weight were significantly lower for infants exposed to illicit drugs than for unexposed infants. The mean birth weight of unexposed infants was nearly 600 grams greater than the birth weight of infants exposed to cocaine and nearly 650 grams more than infants exposed to cocaine plus opiates. The rates of low birth weight and very low birth weight varied in a similar way. Infants exposed to cocaine were more than four times as likely to be born less than 2500 grams and nearly five times as likely to be of very low birth weight (less than 1500 gram) than unexposed infants. The rate of preterm delivery among women exposed to cocaine plus opiates was nearly three times that of unexposed women (35.66% versus 11.70%). Infants exposed to cocaine plus opiates were nearly five times as likely to be admitted to intensive care than unexposed infants. The outcomes of infants exposed to marijuana and to other or unspecified drugs were also different than those of unexposed infants, but the differences were less striking than differences associated with cocaine, opiates or cocaine plus opiates.

Previous studies report similar consequences of use of illicit drugs. McCalla et al (1991) reported that infants of cocaine users had a mean birth weight of 2,560 grams compared with 3,151 grams of unexposed infants. The frequency of low birth weight was 40 percent among cocaine users compared with 12 percent among nonusers. In a study by Gillogley et al. (1990), the mean birth weight of infants exposed to cocaine was 2,682 grams compared to 3,165 grams of unexposed infants. Those exposed to multiple drugs had even lower mean birth weight, 2,575 grams. In a study from New York municipal hospital, Bateman et al. (1993) reported that infants exposed to cocaine had a mean birth weigth of 2,713 grams, mean gestational age was 38 weeks, and the rate of low birth weight was 30 percent.

Hence, the characteristics of the sample of women exposed to illicit drugs and their birth outcomes are consistent with those reported in the literature. The vast differences in socioeconomic, demographic, and obstetrical risk factors as well as the differences in birth outcomes between women exposed to illicit drugs and unexposed women underscore the need for separate multivariate regressions.

B. Bivariate Results

Infant costs

Table 11 displays mean cost, length of stay, costs of newborn nurseries, and service intensity weights (SIW) of infants who were identified as prenatally exposed to illicit drugs by categories of prenatal care. The illicit drug categories include cocaine, opiates, opiates plus cocaine, marijuana, and other or unspecified drugs. The results in Table 11 group together all infants regardless of the type of exposure. Tables 11A – 11C show mean cost, length of stay, nursery cost, and service intensity weights separately for infants exposed to cocaine, opiates, and opiates plus cocaine. Both the arithmetic and geometric means are displayed. The geometric mean is less sensitive to outliers, and the natural logarithm of the cost measures has a distribution that is closer to normal. As shown in Table 11, mean cost per discharge of infant exposed to any drug whose mother had not received prenatal care was $15,523 in 1991 dollars, the geometric mean was $8,489. The cost decreased substantially with the receipt of any prenatal care. Infants whose mothers received *inadequate* care had an average cost of $9,599 in 1991 dollars and a geometric mean cost of $6,030. The average cost of newborn prenatally exposed to illicit drugs decreased only slightly when the mother obtained *intermediate* prenatal care ($9,536), and increased again in the *adequate* and *adequate plus* categories which may reflect adverse selection. Women whose prenatal care utilization was unknown had infants with mean cost significantly lower ($11,489) than women who had no care which indicates that although undocumented, these women may have received prenatal care.

The differences of length of stay, nursery cost, and SIW were consistent with cost differences. The mean length of stay for infants exposed to illicit drugs born to mothers with no prenatal care was 22.98 days, 16.72 days when mothers had *inadequate* care, and 15.92 days when mothers obtained *intermediate* prenatal care. The geometric mean length of stay was significantly lower, 12.08 days with receipt of any prenatal care. The mean and geometric mean of length of stay for infants whose mothers had *unknown care* was lower (19.02 and 13.7 days respectively) than for infants whose mothers had *no care*.

The mean nursery cost decreased dramatically from $6480 to $4279 with the receipt of any prenatal care. The geometric mean decreased from $3593 in the *no care* category to $2424 in the *intermediate* prenatal care category. The mean service intensity weights (SIW) was significantly lower in the *intermediate* prenatal care category than in the *no care* category, (1.7248 versus 2.9225), as was the geometric mean of SIW, (1.0833 versus 1.6178). The large discrepancy between the arithmetic and geometric mean in all the categories underscores the skewed distribution of the variables.

It is of particular interest to see how these costs were affected by the various exposures. A comparison of Tables 11A, 11B, and 11C reveals that infants who were identified as prenatally exposed to opiates plus cocaine and whose mothers had no prenatal care incurred the highest mean cost, mean length of stay, and mean SIW among the three groups of exposed infants. The mean cost of $18,858 (Table 11C) was substantially higher than the group mean, $15,523 (Table 11). However, the mean nursery cost and the geometric mean nursery cost were significantly higher for newborns exposed to cocaine (Table 11A) whose mothers had no prenatal care, than newborns exposed to opiates (Table 11B), or infants exposed to opiates plus cocaine (Table 11C), in the same care category. The average differences were similar for length of stay, mean nursery cost, and service intensity weights; all seem to decrease with the receipt of any prenatal care.

Finally, Table 13 displays infant cost, length of stay, and service intensity weights by type of exposure regardless of prenatal care utilization. Unexposed infants had a mean cost of discharge of $3,237 in 1991 dollars and a geometric mean of $1,891. The mean length of stay and the geometric mean were 5.06 days and 3.60 days respectively. Infants exposed to cocaine plus opiates had an average cost of $15,342 in 1991 dollars, 4.7 times the average cost of unexposed infants. The geometric mean for that group was 4.9 times the geometric mean of unexposed infants. Infants exposed to opiates were second most costly to care for after delivery followed by infants exposed to cocaine.

Differences by length of stay were consistent with cost differences. The mean length of stay was 22.55 days for infants exposed to cocaine plus opiates, 19.62 days for infants exposed to opiates and 17.98 days for infants exposed to cocaine. The geometric means were considerably lower, but still nearly 4 times the geometric mean of unexposed infants.

Infants exposed to marijuana did not differ substantially from unexposed infants in terms of costs and length of stay. Although differences based on the geometric mean were statistically significant, the differences were quite small compared with differences associated with cocaine and opiates. Infants exposed to other or unspecified drugs were similar to those exposed to cocaine in terms of cost and length of stay. However, the small number of cases involved did not permit any specific conclusions, and they were ultimately dropped from subsequent analyses.

In summary, mean differences in costs and length of stay varied substantially by type of exposure. Women exposed to cocaine plus opiates had newborns that required the most care and had the longest stays in the hospital. This is consistent with the findings of Joyce et al. (1995) and Phibbs et al. (1991) who reported that cocaine in combination with other drugs produced larger increases in hospital costs and lengths of stay than did cocaine or opiates alone. However, for infants exposed to cocaine or opiate alone the magnitude of the differences is larger in this sample than in the other two studies. As Joyce et al. (1995) have shown, when exposure is based on screens obtained from discharge abstracts it is often associated with larger increases in costs and length of stay compared to screens of exposure based on universal toxicology analysis.

Maternal costs

Maternal cost and length of stay by categories of prenatal care are displayed in Table 14. The figures reveal that delivery costs for women exposed to illicit drugs who received prenatal care did not differ significantly from delivery cost for exposed women with no care. Table 15 illustrates maternal costs and length of stay by exposure. The differences in delivery costs associated with exposure were small but significant for cocaine, opiate, and cocaine plus opiate users. Delivery costs for women exposed to marijuana or other drugs were not significantly different from unexposed women. Overall, women exposed to illicit drugs did not seem to experience more complications during delivery that lead to substantial cost differentials compared to unexposed women. Thus, higher treatment costs associated with exposure were primarily driven by differences in newborn costs.

C. Multivariate Results

The empirical analysis emphasizes the total effect of illicit substances on newborn costs (equation 11) and the total and direct effects of utilization of prenatal care (equations 12 and 12a) on newborn costs. Separate regressions are fitted for the sample of infants prenatally exposed to illicit drugs and for a random sample of unexposed infants. As the summary statistics by prenatal care utilization illustrate (Tables 8-13), birth outcomes and newborn costs as well as maternal characteristics differed significantly between exposed and unexposed mother/infant pairs. By fitting separate regressions, the coefficients of prenatal care categories are allowed to vary between the two groups. Moreover, in preliminary regressions the hypothesis that slope coefficients are the same for the sample of exposed and unexposed infants was tested and rejected.[9] Tables 16-19 present the results from log linear regressions of four outcomes of infants exposed to illicit drugs: newborn costs per discharge (Table 16), acute care length of stay (Table 17), newborn nursery costs (Table 18) and service intensity weights (SIW, Table 20). The primary measure of cost is newborn cost per discharge derived from expected reimbursement under NYPHRM IV. Acute length of stay measures the medically necessary length of stay associated with delivery. The other two measures of cost, newborn nursery costs and SIW are presented as an alternative measure of resource consumption by the newborn. Because much of the cost associated with stays of drug-exposed infants is in neonatal intensive care units (NICU) or premature care nursery, the

[9] A Chow test based on OLS estimates reveals statistically significant differences in the slope coefficients for exposed and unexposed sample. The F-statistics of 11.73 (df=44,∞) is significant at better than 1 percent level.

newborn nursery costs although incomplete, provide a relative measure of costs for the main component of newborn resource use. Similarly, the SIW reflect average use of resources across New York State hospitals. Since the resource consumption equal to that of the average of all DRGs is normalized to one, coefficients on prenatal care from the regressions of SIW measure the relative change in resource use associated with the receipt of prenatal care.

Tables 16-19 present the results from three specifications. All three columns include controls for year of birth and hospital of delivery. The first column in each table has additional controls for socio-eonomic, demographic, and obstetric characteristics that can reasonably be treated as exogenous. This is a specification of equation 11 of the empirical model and the coefficients from column 1 measure the total effect of exposure on costs. The purpose here is to assess the sensitivity of the coefficients on exposure when endogenous variables such as prenatal care, participation in WIC, infant health at delivery, and other covariates are added to the regressions. Column 2 includes a full set of control variables including the measures of prenatal care utilization, WIC participation, as well as indicators for prenatal risk factors such as gestational diabetes, hypertension, anemia, and STD. The coefficients on prenatal care in column 2 measure the total effect of prenatal care on newborn costs. Column 3 adds measures of newborn health at delivery. Birth weight and its square, an indicator of preterm delivery as well as an indicator for unknown gestational age proxy for infant health at delivery. The coefficients on prenatal care in column 3 measure the direct effect of care on infant costs not operating through birth weight. Finally, all of the dependent variables are in logarithmic form. Thus, coefficients on categorical variables reflect changes in the natural logarithm of the dependent variable associated with the indicator relative to the omitted category. It is important to note that since the regressions are analyzed separately for exposed and unexposed infants, the omitted category for illicit drugs in Tables 16-19 is marijuana.

Because women exposed to marijuana were selected as the reference group to permit comparison to users of other illicit drugs, it is useful to consider whether marijuana exposure adversely effects pregnancy outcomes. While some studies have reported a significant effect of marijuana use during pregnancy on birth weight and length (Zuckerman et al. 1989), other studies have found that there was no significant relationship between prenatal marijuana use and infant size at birth (Fried 1991; Day and Richardson 1991). A small number of studies reported a reduction (0.8 weeks) in the gestational age of infants of mothers who used marijuana during pregnancy six or more times per week compared to nonusers (Fried et al. 1991). Other investigators have not found a significant relationship between prenatal marijuana use and gestational age or preterm delivery (Day and Richardson 1991).

In this sample, women who used marijuana during pregnancy differed from women who did not (Table 10). They were more likely to be black, older, unmarried, less educated, use tobacco and alcohol, and have a low birth weight infant. The differences in the length of gestation, the rate of preterm deliveries, and the mean number of prenatal visits were small but significant. However, for newborns exposed to marijuana, the mean costs did not differ significantly from those of unexposed infants (Table 13). Therefore the costs of exposure to cocaine, opiates, and cocaine plus opiates can reasonably be compared with the cost of exposure to marijuana. Thus, in the regressions of exposed infants, the effect of exposure on costs is relative to the effect of exposure to marijuana on cost. To compute percent changes take the anti-log of the coefficient, subtract it from one, and multiply by 100 [percent change = $(e^{\beta}-1)*100$].

In Table 16, the coefficients on substances in column 1 indicate that exposure to opiates was associated with a 259 percent increase $\{(e^{1.278}-1)*100\}$ in newborn cost per discharge relative to infants exposed to marijuana. This was nearly double the rise in costs associated with cocaine only and slightly lower than the increase in costs associated with exposure to opiates plus cocaine.

The coefficients on prenatal care in column 2 suggest that the receipt of *inadequate* care had the largest total effect on infant cost and was associated with a 25 percent reduction $[(e^{-.287}-1)*100]$ in cost per discharge of exposed newborns relative to *no care*, the omitted category. The receipt of *adequate plus* care was associated with the smallest reduction in cost per discharge, 11 percent.

As expected, the impact of prenatal care fell considerably with the inclusion of infant health. *Inadequate* care had a small but significant direct effect and was associated with a 6.6 percent reduction in cost per discharge of exposed newborns relative to *no care*. It is important to note that the magnitude of the coefficients on illicit drugs fell only slightly when other covariates were included in columns 2 and 3. This shows that controlling for birth weight had little impact on the effects of illicit drug use on cost, and that the effect of prenatal care on newborn cost was small compared to the cost associated with maternal exposure.

The coefficients on the socioeconomic and demographic covariates in Table 16 were relatively consistent in sign with expectations, but most were insignificant. The cost of discharge was 11 percent higher for black newborns compared to Hispanic, but the difference diminished when birth weight was included in the regression. The cost of discharge for newborns whose mothers completed college was 23 percent lower compared to those whose mothers had less than a high school education, however that too worked primarily through birth weight. Deliveries by cesarean section were associated with a 26 percent increase in cost and sexually transmitted diseases (STD) were associated with an increase in newborn costs of 20 percent, both were invariant to the inclusion of newborn health.

Differences in length of stay associated with exposure are shown in Table 17. Infants exposed to cocaine had stays that were 123 percent longer $[(e^{.802} - 1)*100]$ than infants exposed to marijuana. The relative increase in length of stay associated with exposure to cocaine was greater than the increase in newborn costs. For opiates and cocaine plus opiates the relative increases in length of stay were smaller than the relative increases in cost. The coefficients on prenatal care in column 2 suggest that *intermediate* care had the largest effect and reduced the length of stay by 26 percent $[(e^{-.302} - 1)*100]$ compared to *no care*. As in Table 16, the magnitude of the coefficients on exposure fell only slightly when prenatal care and birth weight were included in the regressions.

Tables 18 and 19 show results from regression analyses of newborn nursery costs and service intensity weights (SIW) as the dependent variables respectively. The coefficients on illicit drugs from the regression of nursery costs were only slightly lower than those from the cost per discharge regression. The coefficients on illicit substances in the SIW regression however, were larger than the coefficient from the cost per discharge regression. Both, *intermediate* and *adequate* prenatal care seemed to reduce nursery cost

25 percent, which was only a slightly larger effect than *inadequate* care (22%). In the SIW regression both, *inadequate* and *intermediate* care had the same effect (27%). As in earlier regressions, Tables 18 and 19 show that the coefficients on illicit drugs decreased only slightly when covariates and birth weight were included in the regressions.

In sum, Tables 16-19 show that even after adjustment for a relatively large set of potentially confounding variables, effects of opiates and cocaine on newborn costs and length of stay are substantial. The coefficients on prenatal care indicate that the increase in cost per discharge associated with exposure can be reduced at most 25 percent with the receipt of *inadequate* care. The increase in length of stay can be reduced at most 26 percent with the receipt of *intermediate* prenatal care.

A comparison with cost regressions of the random sample of unexposed infants reveals that the beneficial effect of prenatal care had a much smaller impact among infants classified as unexposed than among infants exposed to illicit drugs. Tables 20-23 present the results from log linear regressions of four outcomes of the random sample of unexposed infants. All three specifications include controls for year of birth and hospital of delivery. Column 1 in each table has controls for socio-economic, demographic, and obstetric characteristics. Column 2 has a full set of control variables; the coefficients on prenatal care measure the total effect of prenatal care on newborn costs. Column 3 adds measures of newborn health on delivery; the coefficients on prenatal care measure the direct effect of care on infant costs not operating through birth weight.

In Table 20, the coefficients of prenatal care in column 2 suggest that the receipt of *intermediate* care reduced infant cost per discharge approximately 10 percent [$(e^{-.101} - 1)*100$] relative to *no care*, the omitted category. The coefficients on *inadequate* and *adequate* care were smaller but significant. The receipt of *adequate plus* care raised newborn cost per discharge nearly 14 percent [$e^{.128} - 1)*100$]. A plausible explanation for the positive coefficient on *adequate plus* care is adverse selection. Women with greater likelihood of complicated pregnancy received more intense prenatal care biasing downward the true effect of care.

Results in column 3 reveal that the coefficients on prenatal care fell considerably and became insignificant when infant health at delivery was included in the regression. The coefficients on the socioeconomic and demographic covariates in Table 20 were mostly consistent with expectations but of insignificant magnitude. The cost of discharge was seven percent higher for black infants compared to Hispanic. The coefficient on high school education, although small, remained significant in all three specifications. Deliveries by cesarean section and STD were associated with nearly 25 percent increase in cost per discharge and both were invariant to the inclusion of newborn health.

The results were similar with length of stay as the dependent variable (Table 21). Newborns whose mothers received *intermediate* care had length of stays approximately 13 percent shorter than infants whose mothers had no prenatal care. The coefficients on *inadequate* and *adequate* categories were smaller but significant. The coefficient on *adequate plus* was positive but insignificant. When birth weight was included in the regression in column 3, the coefficients on prenatal care fell substantially, yet those on *intermediate* and *adequate* care remained significant.

The results from regressions with nursery cost and service intensity weights (SIW) as dependent variables are shown in Tables 22 and 23 respectively. *Intermediate* and *adequate* care reduced nursery costs between 12 and 15 percent and both coefficients remained significant when infant health was included in the regression. The coefficient on *adequate plus* was positive and insignificant. As in the previous regression, *intermediate* care had the largest effect on SIW; it reduced resource consumption nearly 12 percent. *Adequate plus* care increased resource use approximately 15 percent, which corresponded to the increase in cost per discharge (Table 20).

These results indicate that prenatal care utilization reduced newborn costs for both exposed and unexposed infants. The data also show that prenatal care had a greater effect on newborn costs of drug-exposed infants than on newborn costs of unexposed infants. Furthermore, exposed infants benefited the most from less extensive prenatal care services than unexposed infants (*inadequate* versus *intermediate*). For both groups, the magnitude of the coefficients on prenatal care fell significantly with the inclusion of infant health on delivery as proxied by birth weight and prematurity. Most important, in the sample of exposed infants, the effect of illicit substances on costs remained substantial even after adjustment for a relatively large set of confounding variables.

Finally, the cost regressions were re-estimated using a pooled sample, which consisted of exposed infants and a random sample of unexposed infants. The objective here was to assess the magnitude of costs of exposure relative to unexposed infants, to compute the expected increase in length of stay relative to unexposed infants, and to estimate cost saving from prenatal care. Tables 24-27 present the results from log linear regressions of four outcomes, each with three specifications. The coefficients on substances in column 1 of Table 24 indicate that exposure to opiates was associated with a 290 percent increase $[(e^{1.362} - 1)*100]$ in newborn cost per discharge relative to unexposed infants. This increase was approximately 31 percent larger than when exposure to opiates is compared with exposure to marijuana (Table 16) indicating that there was a slight increase in costs associated with newborn exposure to marijuana relative to unexposed infants. Exposure to opiates plus cocaine was associated with the highest increase (330%) in newborn costs compared to unexposed infants.

Prenatal care seemed to have a smaller effect on costs in the regressions using the pooled sample than in the regressions of exposed infants (Tables 16-19). The coefficients on prenatal care suggest that receipt of *intermediate* care had the largest impact and reduced cost nearly 20 percent; *inadequate* care was associated with approximately 18 percent lower cost per discharge compared to *no care*.

As expected, the coefficients on prenatal care decreased substantially when measures of newborn health were included in column 3 as do the coefficients on illicit drugs. Coefficients on opiates and opiates plus cocaine were still quite large indicating an increase of nearly 200 percent holding constant birth weight and preterm delivery. The coefficient on cocaine however, decreased nearly 40 percent from .837 to .541. Consequently, approximately 40 percent of the total costs associated with exposure to only cocaine were indirect, that is they operated through adverse birth outcomes.

The coefficients on the socioeconomic and demographic covariates in Table 24 were generally consistent in sign with expectations but most were of insignificant magnitude. Similar to the earlier regression of exposed and unexposed infants, deliveries by cesarean section were associated with 26 percent increase in cost and STD were associated with an increase in newborn cost of 20 percent, both invariant to inclusion of health on delivery.

The impact on length of stay followed a similar pattern (Table 25). Infants exposed to cocaine had lengths of stay that were 190 percent longer [$(e^{1.071}-1)*100$] than unexposed infants. *Intermediate* prenatal care seemed to shorten length of stay 24 percent relative to *no care*. The other coefficients on prenatal care were smaller but significant. The magnitude of the coefficients on illicit substances fell only slightly when additional covariates were added in the length of stay regression. However, the coefficients on prenatal care remained significant even when infant health was included in column 3, indicating a strong direct effect on length of stay.

One way to gauge the magnitude of the estimates of the effect of prenatal care is to apply the relevant coefficients to increases in cost associated with drug use. The coefficients from the cost and length of stay equations (Tables 24 and 25) were used to assign a dollar figure to the increase in costs, to compute the increase in length of stay, and to estimate savings from the level of prenatal care with the greatest impact. The relative changes in newborn cost and length of stay were evaluated at their respective geometric means for unexposed newborns (Table 13). The results are presented in Table 28. The top panel displays figures for newborn cost and the bottom panel for length of stay. The percentage increase is obtained by taking the antilog of the coefficient, subtracting one, and multiplying by 100. Thus, the 118 percent increase in newborn cost associated with exposure to cocaine is derived from the coefficient on cocaine (.781), in column 2 of Table 24. The absolute increase, $2,231, represents a 118 percent increase in the geometric mean of newborn cost. The geometric mean of newborn cost is $1,891. The expected cost per discharge for a newborn exposed to cocaine is $4,122, the sum of $2,231 and $1,891. Intermediate prenatal care reduced the increase in cost nearly 20 percent and the increase in length of stay approximately 24 percent. To obtain the expected cost per discharge with *intermediate* prenatal care, the absolute increase is multiplied by 20 percent and the result is subtracted from the expected cost [4122-(2231*0.2)]. Thus, the expected cost for infants exposed to cocaine born to women who received *intermediate* prenatal care were $446 lower than those for infants whose mothers had no prenatal care.

The largest increase in cost was associated with exposure to opiates plus cocaine (Table 28). Infants exposed to both substances cost $7,734 in 1991 dollars, $5,843 above the mean. *Intermediate* prenatal care reduced cost by $1,169 to $6,565 dollars. The direct effect was also large; the increase associated with opiates plus cocaine was $4,084 dollars. The direct effect of prenatal care was less than four percent: therefore for opiates and opiates plus cocaine exposure the direct cost remained large.

Changes in length of stay correlated highly with changes in costs (Table 28, lower panel). Infants exposed to opiates plus cocaine had stays of 9.40 days longer than unexposed infants. Exposure to cocaine was associated with an increase of 6.12 days over unexposed infants. Infants exposed to opiates stayed 7.13 days longer than unexposed infants. *Intermediate* prenatal care decreased expected length of stay between 1.53 to 2.26 days. The direct effects of exposure remained large and the direct effect of prenatal care on expected length of stay was approximately 0.6 days.

To summarize, even after adjustment for socioeconomic and demographic characteristics as well as prenatal care and infant health, effects of illicit drugs remained a prominent component of newborn costs. *Intermediate* prenatal care seemed to reduce the cost per discharge approximately 20 percent and length of stay nearly 25 percent. The coefficients on prenatal care in the pooled regressions were smaller than the coefficients on prenatal care in regressions of exposed infants and larger than the coefficients on prenatal care in regressions of unexposed infants. This underscores the importance of separate regressions for exposed and unexposed infants. It also shows that using the pooled sample to obtain estimates on the effect of prenatal care may obscure the group with the greatest benefit.

In addition to the different effect of prenatal care on the costs of exposed and unexposed infants, the effect of prenatal care may also differ by exposure. To explore the differential effect the model was re-estimated with plausible interactions.

Differences by Exposure

To test whether the effect of prenatal care on newborn costs differed by exposure, the model was re-estimated using the pooled sample of exposed and unexposed infants. The equations of newborn costs and length of stay in columns 2 and 3 of Tables 24 and 25 were re-estimated but the coefficients on prenatal care were allowed to vary by exposure. Specifically, each measure of prenatal care was interacted with each measure of illicit drug use. The reference categories were *no care* and unexposed. Total costs were from specifications that excluded measures of birth outcomes. Estimates of direct costs included newborn health at delivery as measured by birth weight and prematurity. Coefficients for *unknown*, *inadequate*, *intermediate*, *adequate*, and *adequate plus* categories reflect the relative differences in costs, and length of stay as compared to exposed infants in the *no care* category relative to unexposed infants in the *no care* category.

For example, using *no care* and unexposed as reference categories, and allowing exposure and prenatal care to have both direct and indirect effects, a simple linear model for newborn costs with interaction terms may specified as follows:

$$C = \alpha_0 + \alpha_1'X + \alpha_2 D_1 + \alpha_3 D_2 + \alpha_4 D_3 + \alpha_5 D_4 + \alpha_6 P_1 + \alpha_7 P_2 + \alpha_8 P_3 + \alpha_9 P_4 + \alpha_{10} P_5 +$$

$$\alpha_{11}(D_1{*}P_1) + \ldots\ldots + \alpha_{15}(D_1{*}P_5) + \alpha_{16}(D_2{*}P_1) + \ldots\ldots + \alpha_{20}(D_2{*}P_5) + \alpha_{21}(D_3 P_1) + \ldots\ldots$$

$$+ \alpha_{25}(D_3{*}P_5) + \alpha_{26}(D_4{*}P_1) + \ldots\ldots \alpha_{30}(D_4{*}P_5)$$

where X is a vector of demographic and socioeconomic characteristics, D_1, D_2, D_3, D_4 are cocaine, opiate, opiates + cocaine, and marijuana respectively, and P_1, P_2, P_3, P_4, P_5 are prenatal care categories, *unknown, inadequate, intermediate, adequate, and adequate plus* respectively. The results of the regressions with interaction terms are displayed in Table 29 and Table 30.

Table 29 shows the differential impact of prenatal care on newborn cost relative to the effect of no prenatal care on cost for the same exposure category. The coefficients of *no care* reflect the increase in cost for infants exposed to illicit drugs whose mothers had no prenatal care relative to costs of unexposed infants whose mothers had no prenatal care. For example, an infant exposed to cocaine in the *no care* category incurred 188 percent higher cost than the cost of an unexposed infant in the *no care* category $[(e^{(1.058)}-1)*100]$. Thus, the coefficient on newborn cost of exposure to cocaine in the *inadequate* category, -0.423, indicates that the incremental cost associated with exposure to cocaine for an infant whose mother had *inadequate* care was 88.7 percent $[(e^{(1.058-.423)}-1)*100]$ greater than for unexposed infants in the *no care* category and those costs were 34.5 percent $[(e^{(-.423)}-1)*100]$ lower than the costs for infants exposed to cocaine in the *no care* category. The differences in coefficients on newborn costs for cocaine exposure were statistically significant for each prenatal care category, although *intermediate* and *adequate* care prenatal care reduced the incremental costs of cocaine exposure less than *inadequate* prenatal care. *Adequate plus* prenatal care also reduced the incremental costs approximately 34 percent.

These differences carry over to direct cost for cocaine exposure. The incremental direct cost for a newborn exposed to cocaine whose mother received *inadequate* prenatal care was 58 percent higher [$e^{(.697-.236)}$-1)*100] than the cost of unexposed infant in the *no care* category. The incremental direct cost for infants exposed to cocaine in the *adequate plus* prenatal care category was 55 percent [$e^{(.697-.256)}$-1)*100] higher when compared with unexposed infants in the *no care* category.

The differences in coefficients on newborn total and direct cost among opiate users were insignificant across all categories of prenatal care. This was despite the fact that infants exposed to opiates whose mothers had no care incurred costs that were more than 300 percent higher [($e^{(1.400)}$-1)*100] than unexposed infants in the *no care* category. A significant difference was evident among infants exposed to opiates plus cocaine in the *adequate plus* category. The incremental total costs associated with exposure to opiates plus cocaine were 35.5 percent lower [($e^{(-.439)}$-1)*100] for infants whose mothers received *adequate plus* care than for infants exposed to opiates plus cocaine whose mothers had no prenatal care. Exposure to marijuana had a comparatively small impact, statistically insignificant across all prenatal care categories for both, costs and length of stay.

The incremental total length of stay for infants exposed to cocaine whose mothers obtained *intermediate* prenatal care was 30 percent shorter [($e^{(-.362)}$-1)*100] than infants exposed to cocaine in the *no care* category (Table 30). Similar differences were evident with respect to length of stay for infants exposed to cocaine in the *inadequate* and *adequate plus* prenatal care categories. The differential effect of prenatal care on infant total length of stay associated with exposures to opiates and opiates plus cocaine was insignificant, with the exception of the *adequate plus* category.

In summary, the coefficients on prenatal care categories interacted with illicit drug use show that for newborns exposed to cocaine *inadequate* prenatal care attenuates the effects of exposure on costs and length of stay approximately 28 to 35 percent compared to no prenatal care. The effects were similar in the *intermediate* and *adequate plus* categories. The differential impact was insignificant for newborns exposed to opiates, even though infants exposed to opiates in the *no care* category incurred significantly higher cost and lengths of stay than unexposed newborns in the *no care* category. The coefficients also show that infants exposed to opiates plus cocaine in the *no care* category incur the highest incremental costs compared to unexposed infants in that category, which was consistent with earlier results.

As previously noted, the screen for exposure in this study was not universal and it is likely that only symptomatic women and infants were screened or diagnosed as exposed to illicit drugs. By not including asymptomatic infants exposed to illicit drugs, the average effect of substance exposure on newborn costs may be overestimated. In the next section, therefore, the sensitivity of the parameter estimates to nonrandom screening and other specification biases will be assessed.

D. Sensitivity Analysis

1. Regressions using observations with positive revenue

To evaluate whether the substitution for missing data on expected revenue introduced a bias, the cost and length of stay regressions were re-estimated using only the observations with positive expected revenue. Since these observations also included the expected revenue values below $1,100, the estimates of costs of exposure may be lower. Moreover, because length of stay was not imputed, this will test the sensitivity of the estimates to the smaller sample. Table 31 presents selected coefficients from two outcomes, three specifications in each outcome. The top panel displays the results from regressions of exposed infants and the bottom panel shows the results from regressions of the pooled sample which includes exposed infants and a random sample of unexposed infants. Column 1 in each outcome table presents the coefficients of illicit substances from a regression of exogenous variables, thus total effect of exposure on newborn costs. Column 2 presents coefficients on substances and prenatal care from regressions that exclude newborn health at delivery – total effect of prenatal care. Column 3 presents the direct effect of prenatal care from regressions that include infant health at delivery as measured by birth weight and prematurity.

A comparison of the coefficients from the cost regressions in the top panel with those from the sample of exposed infants with imputed revenue in Table 16 reveals that the coefficients on prenatal care are smaller but the differences are minimal. Inadequate prenatal care, for example, reduced cost approximately 23 percent [$(e^{-.265}-1)*100$] (Table 31, top panel) compared with a reduction of 25 percent [$(e^{-.287}-1)*100$] in the sample with imputed revenue (Table 16, column 2). The coefficients on prenatal care in the length of stay regressions are insensitive to the smaller sample. As in the sample with imputed revenue, *inadequate* care had the greatest impact on cost and *intermediate* care had the greatest impact on length of stay. The increase in cost associated with cocaine was lower in the sample with positive revenue compared to the sample with imputed revenue. In both samples though, the coefficient on cocaine decreased nearly 35 percent when other covariates and infant health were included in the regression. The costs associated with opiates and opiates plus cocaine were nearly 30 percent higher in the sample with positive revenue than in the sample with imputed revenue. The costs also remained high when covariates and infant health were included. In the length of stay regression, the coefficient on cocaine was slightly lower in the sample with positive revenue (top panel, right) than in the sample with imputed revenue (Table 17). The effects of opiates and opiates plus cocaine on length of stay were similar in the two samples.

As expected, similar differences are evident in the bottom panel (Table 31) from regressions of the pooled sample with positive expected revenue. The impact of prenatal care in the cost regression was smaller in the pooled sample with positive revenue than in the pooled sample with imputed revenue (Table 24). Also, the category with the greatest impact here was *inadequate*, whereas in the pooled sample with imputed revenue *intermediate* care had the largest effect. The increase in cost associated with cocaine exposure in the bottom panel Table 31 was nearly 20 lower than that in the pooled sample with imputed revenue (Table 24). The coefficient on cocaine in the cost regression fell substantially (45%) when other covariates were included (Table 31, bottom panel column 3). The coefficients on opiates and opiates plus cocaine were slightly larger in the cost regression of the pooled sample with positive revenue than in the pooled sample with imputed revenue. The costs associated with opiates and opiates plus cocaine remained high even when other covariates and infant health were included (bottom panel, column 3). The coefficients in the length of stay regression (Table 31, bottom panel right) were similar to those of the pooled sample with imputed revenue (Table 25) with the exception of the coefficient on cocaine. The total increase in length of stay associated with exposure to cocaine was approximately 169 percent $[(e^{.990}-1)*100]$ in the sample with positive revenue (Table 31 bottom panel column 1) compared to 202 percent $[(e^{1.1071}-1)*100]$ in the pooled sample with imputed revenue (Table 25 column 1).

One way to explain the discrepancies is that infants exposed to cocaine comprised nearly half of the observation with zero revenue (Table 5). A check into the group exposed to cocaine revealed that 30 percent of infants had expected revenue of zero and four percent had revenues less than $1,100. Consequently, in the sample with imputed expected revenue, the effect of cocaine on cost was considerably higher than in the sample without substitution. At the same time, only 11 percent of infants exposed to opiates and 13 percent of infants exposed to opiates plus cocaine had an expected revenue of less than $1,100. For those observations the imputed revenue of $1,100 was most likely too low. Therefore, the effect of opiates and opiates plus cocaine on cost in the samples with imputed revenue was slightly lower than in the samples with positive revenue.

In comparison, the coefficients in the length of stay regressions were relatively insensitive to the smaller sample. This can be expected since length of stay was not imputed. The relatively small differences in the effect of cocaine on length of stay may be because the sample with positive revenue had a smaller proportion of cocaine users than the sample with imputed revenue.

2. <u>Changes in Prenatal Care Specifications</u>

To test the sensitivity of the prenatal care parameter estimates to changes in categories specifications, the cost and length of stay regressions were re-estimated with two often used indicators of adequacy of care, the trimester of initiation of prenatal care and the number of visits. The first model has four categories of prenatal care: women who had no visit, one to three visits, four or more visits, and an unknown number of visits. Similar specifications have been used in a number of studies on the effect of prenatal care on outcomes among women who use illicit drugs. (Racine et al. 1993; Joyce et al. 1995). The second model groups women according to the trimester of initiation of care and two additional categories: no care and unknown care. Although, the information on the month of pregnancy in which prenatal care began is routinely collected and available from birth certificates, this measure is self-reported and is often subject to errors. To minimize the error in the measure of timing of first prenatal visits, many studies have grouped the initiation of care by trimester (Forrest and Singh 1987).

Tables 32A and 32B present the coefficients on prenatal care from the two models. The coefficients are from specifications that exclude newborn health at delivery, thus report the total effect of prenatal care on cost and length of stay. Table 32A displays the coefficients of prenatal care using one to three visits and four or more visits as levels of care for newborns exposed to illicit drugs, a random sample of unexposed infants, and the pooled sample. The coefficients show that the receipt of one to three visits reduced the cost of exposure approximately 14 percent and reduced the length of stay associated with exposure nearly 13 percent (Table 32A columns 1 and 2). The impact of four or more visits in the exposed sample was comparable to that of *inadequate* care in the cost regression (Table 16 column 2) and that of *intermediate* care in the length of stay regression (Table 17 column 2). Thus, the category of four or more visits captured the largest impact of prenatal care on costs for the exposed sample. For the unexposed sample the coefficients on four or more visits were slightly smaller than the coefficients on *intermediate* care, which had the largest impact on cost and length of stay in this group (Tables 20 and 21, column 2). The coefficients of the pooled sample show that four or more visits reduced costs associated with exposure approximately 22 percent, which was slightly higher than the effect of *intermediate* prenatal care (20%) in Table 24. In the length of stay regression four or more visits had a smaller impact than *intermediate* prenatal care in Table 25. Overall, the category of one to three visits showed smaller effects on costs and length of stay than the *inadequate* category of the APNCU index. The category of four or more visits however, captured the largest impact of prenatal care on costs and length of stay, similar to that of the *inadequate* and *intermediate* categories in the APNCU index, especially for exposed infants.

The coefficients on prenatal care by trimester of initiation (holding the number of visits constant) are presented in Table 32B. Initiating care in the third trimester had the largest impact on cost and length of stay in each sample, but the effect was substantially smaller than that of *inadequate* and *intermediate* care categories of the APNCU index (Tables 16, 17, 20, 21, 24, and 25). When the number of visits was not held constant (results not shown) the effect of initiation of care in the third trimester was more similar to the effect of the *inadequate* care in the APNCU index.

To assess the marginal effect an additional visit, the cost and length of stay regressions for each sample were re-estimated using individual visits from the first to the ninth visit. The specifications exclude infant health at delivery thus the coefficients show the total effect of prenatal care compared to no prenatal care. The results are presented in

Table 32C. For newborns exposed to illicit drugs, obtaining just three visit decreased costs of exposure nearly 20 percent. Subsequent visits decreased costs further but the marginal benefit of an additional visit was small. The coefficients on prenatal visits in the unexposed sample were mostly insignificant and had the wrong signs up to the seventh visit, which reduced cost approximately eight percent and length of stay nearly 10 percent. The coefficients in the pooled sample also show that after the second or third visit, the marginal benefit of an additional visit was small.

Regardless of the specification, prenatal care was associated with a greater reduction of newborn costs among exposed women then among unexposed women. Since drug use jeopardizes the pregnancy, exposed women may have had more risk factors that were counteracted by prenatal care. For these women, early identification and amelioration of these risk factors may have had a considerable effect on costs. However, the estimates of the effect of care in Tables 32A and 32B are not significantly different from those obtained in earlier regressions using the APNCU index. In this sample of low-income women those who received prenatal care, initiated care late and obtained a small number of visits. Thus, taking into consideration the number and timing of prenatal visits did not substantially change the effect of prenatal care on costs. The APNCU index did however, separate women with distinct characteristics and very different birth outcomes. The poor birth outcomes of women who received *adequate plus* care that primarily reflected high-risk pregnancies were not captured in the other specifications of prenatal care thus, using the other specifications the true effect of prenatal care for women with high-risk pregnancies may be underestimated.

3. Impact on Birth Weight

As noted earlier, there have been relatively few studies on the costs associated with maternal substance abuse but considerable attention has been paid to the effect of drug use during pregnancy on birth weight and other birth outcomes. In this section, regression results of birth weight on exposure, prenatal care, and other prenatal characteristics of the mother are presented. The objective here is twofold. First, studies of prenatal care have suggested possible greater benefits for high-risk women (Greenberg 1983; Alexander and Cornelly 1987; Murray and Bernfield 1988). Thus, by fitting separate birth weight regressions for exposed and unexposed infants it is explored further whether the effect of prenatal care on birth weight varies between the two groups and is consistent with the effect of prenatal care on costs. Second, investigators have found a strong relationship between birth weight, complications, and newborn costs (Schwartz 1989). Thus, if effects of exposure on birth weight are similar to effects reported in other studies with more universal screens for exposure, then there is some evidence that underreporting of exposure based on discharge abstracts has not seriously biased the cost estimates.

Tables 33-35 present regression estimates with birth weight in grams as the dependent variable. Table 33 displays the results of four specification for newborns exposed to illicit substances. Column 1 includes controls for only hospital and year of delivery. Column 2 includes exogenous measures of socio-economic, demographic, and obstetric characteristics as well as neighborhood characteristics of the mother's residence. Column 3 adds measures of prenatal care, WIC, and prenatal risk factors. Column 4 adds gestation measures. As in the previous regressions of exposed infants, the coefficients on illicit substances reflect changes in the dependent variable associated with the indicator relative to infants exposed to marijuana. Therefore, the adjusted birth weight deficits associated with exposure (columns 3 and 4) from the sample of exposed infants may not be comparable to the literature. Of special interest here is the effect of prenatal care on birth weight. The coefficients in column 3 suggest that prenatal care had a substantial association with higher birth weight for exposed newborns. Infants born to women who received *inadequate* prenatal care were 238 grams heavier than infants whose mothers had no prenatal care. The coefficients in column 4 suggest that the association between birth weight and prenatal care remained significant even after taking length of gestation into account. When length of gestation was added to the regression the impact of *inadequate* prenatal care decreased 79 grams from 238 grams to 159 grams. These results imply that in addition to the effect through length of gestation, prenatal care may have large direct effects on birth weight among infants exposed to illicit drugs, for example, by improving maternal nutrition or mitigating certain complications and risks.

Table 34 presents the results of three specifications for the random sample of unexposed infants. In column 1 in addition to controls for hospital and year of delivery the right-hand-side variables include exogenous measures of socio-economic, demographic, obstetric and neighborhood characteristics. Column 2 includes measures of prenatal care and obstetric risk factors and column 3 adds gestation measures. It is important to note that in the sample of unexposed infants exposure to tobacco was associated with a birth weight deficit of 144 grams. The association persisted even when other covariates were included in the regression. This is consistent with the well-documented relationship between smoking during pregnancy and fetal growth retardation (Underwood et al. 1965; Meyer et al. 1976). The coefficients on prenatal care in column 2 suggest that infants born to women who received *intermediate* care were 142 grams heavier than infants whose mothers had no prenatal care. The coefficients fell considerably when gestation measures were included, yet they remained significant. These findings are comparable with the results reported by Showstack et al. 1984 who found that adequate prenatal care was associated with an increase of 197 grams in mean birth weight. The addition of the length of gestation was associated with halving the effect of prenatal care.

The results from separate birth weight regressions indicate that prenatal care was associated with increased birth weight for both exposed and unexposed infants. However, the estimated positive contribution of *inadequate* and *intermediate* care was greater in pregnancies complicated by illicit drug use than in pregnancies of unexposed women. As in the cost regressions, exposed infants benefited the most from less extensive prenatal care than unexposed infants. These findings were documented by several investigators who reportd that prenatal care had the greatest observed impact for socially disadvantaged women because of their high risk of delivery of low birth weight infant (Greenberg 1983; Showstack 1984; IOM 1985; Murray and Bernfield 1988).

Birth weight regression estimates from four specifications for the pooled sample of exposed and unexposed infants are presented in Table 35. Column 1 includes controls for hospital and year of delivery. In column 2 exogenous variables are added. Column (3) includes prenatal care variables and obstetrical risks, and column 4 includes gestation measures. The adjusted birth weight deficits associated with exposure (column 3 and 4) were within the estimates reported by several investigators who found mean reductions in birth weight of cocaine-exposed infants ranging from 300 to 600 grams (McCalla et al. 1992; Zuckerman et al. 1989; Chasnoff et al. 1989). However, the birth deficits associated with exposure in this sample were slightly higher than those reported in studies using urine analysis to detect exposure. In two studies conducted at New York City municipal hospitals researchers used universal urine toxicology screening to identify all birth for illicit drug use (McCalla et al. 1992; Bateman et al. 1993). In the McCalla study exposure to cocaine was associated with an adjusted birth deficit of 382 grams. After adjustment for gestation, the deficit was reduced to 77 grams. In the study by Bateman et al. (1993) cocaine alone was associated with a 125 grams deficit and cocaine plus opiates with a 237 grams deficit. Both results were from models that included gestational age. In the present study, the deficit associated with only cocaine was 407 grams and with cocaine plus opiates 449 grams. When gestation measures were added to the specification (column 4) the deficit associated with cocaine was 345 grams and with opiates plus cocaine 375 grams. The high birth weight deficits associated with exposure in this study suggest that the screen for drugs on discharge abstracts may be identifying a subset of newborns for whom exposure was more extensive and, thus, more detrimental to birth weight.

Joyce et al. (1995) compared costs and length of stay for patients for whom exposure was recorded on discharge abstracts, therefore known to clinicians, to those for whom exposure was captured by anonymous screen and remained undisclosed. For infants exposed to cocaine, or drugs other than cocaine, known exposure was associated with large and highly significant increases in costs and length of stay compared to unexposed infants; unknown exposure was not. There were no significant differences in costs between known and unknown exposures to cocaine plus other drugs. The authors also found that infants whose exposure to cocaine was recorded on discharge abstracts had smaller mean birth weights, greater rates of low birth weight, and mothers who had received less prenatal care than infants whose exposure was unknown. The Joyce study further showed that selective screening of women or infants for exposure to cocaine and other drugs as recorded on the discharge abstracts would bias upwards the estimated costs associated with exposure more than one hundred percent. Similarly, the estimates of birth deficits associated with exposure in the present study were two to three times higher than those in studies based on universal urine toxicology screens. Consequently, the cost impact of exposure may be significantly smaller than what estimates from discharge summaries suggest.

It is also important to note that the birth weight deficits reported above represented relative changes of between 11 and 14 percent as estimated from loglinear birth weight regressions and shown in Table 36. The specification in column 1 excludes gestational age thus reports total effects. Column 2 includes gestational measures. The relative changes in birth weight persisted when gestation measures were included (column 2). This is consistent with the large direct effects reported from newborn costs and length of stay regressions.

4. Pregnancy Outcomes and Changes in Prenatal Care Specifications

To further assess the sensitivity of the model to different specifications of prenatal care, three pregnancy outcomes were examined using a logistic regression model and adjusting for confounding variables. The adjusted odds ratios and confidence intervals by levels of prenatal care are presented in Tables 37A-37C for women exposed to illicit drugs and Tables 38A-38C for the pooled sample of exposed and unexposed women. Table 37A shows that exposed women with *inadequate* prenatal care were half as likely to have a LBW infant, nearly one-fourth as likely to have a VLBW infants, and nearly half as likely to deliver preterm compared with women who had no prenatal care. The odds did not improve with additional care and worsened with *adequate plus* care. Table 37B illustrates that women exposed to illicit drugs with four or more prenatal care visits were half as likely to have a LBW infant, one-third as likely to have a VLBW infant and half as likely to have a preterm delivery as women with no care. The effect of one to three visits was small for LBW infant and preterm delivery, but halved the odds of having a VLBW infant. Finally, Table 37C groups women by trimester of initiation of care holding the number of visits constant. Table 37C shows that exposed women who initiated care in the third trimester lowered their odds of having a LBW infant more than 30 percent, were half as likely to have a VLBW infant, and one-fourth as likely to deliver preterm compared with women who had no care.

For the pooled sample (Table 38A), the receipt of *intermediate* or *adequate* care lowered the odds of having a LBW infant more than 50 percent. Women who received *inadequate* or *intermediate* care were one-fourth as likely to have a VLBW infant. The receipt of *inadequate* care lowered the odds of having a preterm delivery nearly 50 percent and the receipt of *intermediate* care lowered those odds nearly two-thirds. Table 38B shows that obtaining four or more visits had the greatest impact on all three birth outcomes. As shown in Table 38C, initiating care in the third trimester lowered the odds of having a LBW infant less than 30 percent but lowered the odds of having a VLBW infant nearly 75 percent. The difference between this result and the result for exposed women in Table 37C may be because the rate of VLBW among exposed women was nearly 3.5 times as high as the rate among unexposed women (8% versus 1.6%).

It is also important to note that in both samples, initiation of care in the first trimester was associated with increased odds of having LBW, VLBW, and preterm delivery. This result is consistent with the hypothesis that women with a greater likelihood of experiencing complications in pregnancy initiate care early. The adverse selection was reflected in the specification by trimester and in the APNCU index in the *adequate plus* category but not in the specification of one to three and four or more visits.

5. Comparison to Urine Prevalence Study

A major concern with respect to data in this study is whether screens for illicit drug use based on discharge abstracts and birth certificates underestimate the prevalence due to underreporting. To evaluate whether the estimates of costs and the birth deficits associated with exposure are biased in this study, a sub-sample of births delivered at Kings County hospital, was analyzed and compared to the data in Joyce et al (1995) from the same site. Joyce et al. (1995) had used anonymous urine toxicology analysis of all birth as well as maternal self-reports to screen for exposure among deliveries at Kings County Medical Center between November 18, 1991 and April 11, 1992. To create a comparison sample from the data set of matched birth certificates and discharge abstracts all births delivered at Kings County Medical Center between November 1, 1991 and April 30, 1992 were extracted. Since the date of birth had been deleted from the files to protect confidentiality, all birth in November and April had to be included. The final sample of 1669 births had 390 more births than in the study by Joyce et al. (1995). To simplify comparison the exposure variables in the sample of birth certificates and discharge abstracts were categorized in a similar manner to those in the study by Joyce et al. (1995). It is important to note that the category cocaine plus other drugs used by Joyce et al. (1995), includes only cocaine plus opiates in the sample of matched birth certificates and discharge files. However, this is a minor difference since according to Joyce et al. (1996) opiates dominated the 'other drug' category in Joyce et al. (1995).

Table 39 presents summary statistics for the two samples by type of exposure. The upper panel is from urine prevalence study; the bottom panel is from merged birth certificates and discharge files study. What is immediately apparent is the difference in prevalence rate of exposure in the two samples. The bottom row of the lower panel indicates that of the 1669 birth, 5.9 percent ([(33+26+39)/1669]*100), had evidence of exposure to some illicit drug, which was considerably lower than 11.2 percent ([(51+34+58)/1279]*100), the prevalence rate based on urine analysis (top panel). Hence, screens from birth certificates and discharge abstracts missed nearly 50 percent of the exposure identified by urine toxicology.

There were other important differences between the two samples. Mean birth weight was the same among the unexposed but it was lower on average among exposed infants in the bottom panel. There were large differences in costs and length of stay between the two groups, especially among infants exposed to cocaine. Newborn costs among infants identified as exposed on birth certificates and discharge abstracts were more than three times higher than costs among infants whose exposure was ascertained with urine screen. The differences in geometric means were slightly smaller. The differences in length of stay were even more dramatic. Infants from matched birth certificates and discharge abstracts had length of stay four times longer than infants from the urine analysis study. The differences for infants exposed to cocaine plus other drugs were substantially smaller. The differences suggest that clinicians screened only those infants who were affected enough to show symptoms and that estimated costs and length of stay associated with exposure based on discharge abstracts were higher on average than costs based on universal toxicology screens (Joyce et al. 1995, 1996).

Table 40 compares the coefficients from loglinear regressions of newborn costs and length of stay of the sample from the urine prevalence study (taken from Table 2 in Joyce et al. 1995) with the coefficients of the sub-sample from matched birth certificates and discharge abstracts data. As shown in the top panel, the coefficients on cocaine plus other drugs were identical in the two studies for the total effect (1.34) and relatively close for the direct effect (0.95 versus 1.17). The coefficients on other drugs and on cocaine alone differed dramatically for the two groups. The coefficients in the length of stay regression (bottom panel) followed a similar pattern. Here however, the coefficients on cocaine plus other drugs also differed between the urine prevalence study and matched birth certificate and discharge abstract study (0.84 versus 1.11 for the total effect and 0.47 versus 1.01 for the direct effect).

Both, the urine prevalence study and birth certificate and discharge abstracts study indicated that infants exposed to cocaine plus other drugs were the most costly to care for. The percentage increase in costs was more than 280 percent $[(e^{1.34} - 1)*100]$ and when evaluated at the geometric mean of unexposed infants ($1,665) the predicted costs exceeded $6,300 in 1991-1992 dollars. The meaningful difference between the two types of screens for exposure was in the costs associated with exposure to cocaine. In the urine prevalence study the cost per discharge of treating newborns exposed to cocaine, $2,410, was only 45 percent higher than that for unexposed newborns. In the birth certificate and discharge abstract study however, the increase in costs associated with cocaine was nearly 200 percent for an estimated cost per discharge of $4945 in 1991-1992 dollars. The differences in length of stay were also substantial. Exposure to cocaine based on the screens in birth certificates and discharge abstracts was associated with nearly 300 percent increase in lengths of stay compared to 27 percent increase in stay in the study that used urine toxicology analysis to ascertain exposure. The unadjusted mean differences in Table 39 were even higher.

The large discrepancies in costs and length of stay between the two samples for infants exposed to cocaine indicate that the some of the exposed infants may have not been identified as exposed to cocaine in the merged birth certificate and discharge abstract data. First, the screens obtained from the discharge abstracts may have captured only infants with the most marked symptoms of withdrawal and other complications. Second, studies have shown that self-reported drug use significantly underestimates actual use. Normally, underreporting of illicit drug use tends to bias estimates of the effect downwards, or equal. This assumes that misclassification is random. A study by Kaestner et al. (1996) showed however, that underreporting leads to upward-biased estimates of the impact of illicit drug use on infant health. Their results suggest that costs of prenatal exposure based on hospital discharge data and birth certificates have been overestimated by a measurement error. The authors found that the probability of reporting drug use was significantly related to the frequency and intensity of use, and that relatively heavier users were more likely to report their use. Even with a random screen of urine samples, frequent users were more likely to test positive given the rapid clearance of cocaine. The Keastner study develops a method to correct for the non-random measurement error in a binary indicator of illicit drug use by using characteristics of the mother to predict probability of not reporting drug use. Using this predicted probability yielded more accurate estimates of the true impact of drug use on outcomes, similar to those obtained in studies with universal urine toxicology screens.

VI. Conclusion

This large population-based study of exposed and unexposed mother/infant pairs used prospective per case reimbursement as a measure of resource utilization by newborns to estimate costs associated with exposure and the cost savings for infants whose mothers obtained prenatal care. The results of this study show a significant association between prenatal care, improved pregnancy outcome, and lower newborn costs among women who use illicit drugs.

Using separate regressions for exposed and unexposed infants, this study demonstrates that prenatal care was associated with a greater reduction in newborn costs and a greater increase in birth weight among drug-exposed infants than among unexposed infants. Moreover, exposed infants benefited the most from less extensive care than unexposed infants. A single estimate of the effect of prenatal care obtained from a pooled sample (exposed and unexposed) obscures the group with the greater benefit.

Among substance-abusing women *inadequate* prenatal care, as defined by the APNCU index, was associated with 25-35 percent lower costs, 240 grams increased birth weight, and 50 percent lower odds of having a low birth weight (LBW) infant. However, higher levels of care were not associated with better outcomes, and the marginal effect of care was small beyond *inadequate* care. Even obtaining just three visits reduced costs associated with drug exposure nearly 20 percent, suggesting that the marginal product of care may be considerable at low levels of care. Seven visits reduced costs further (30 percent), however, a greater number of visits and higher categories of care, regardless of their specification, were associated with worse outcomes. The group receiving more than the ACOG-recommended number of visits were separately categorized (Adequate Plus) in the APNCU index. These women were identified as high-risk and experienced poor birth outcomes independent of utilization of prenatal care.

Despite the beneficial effect of prenatal care, the impact of exposure to illicit substances during pregnancy may not be eliminated solely by improving prenatal care. Even when factors that place pregnancy at risk such as smoking, limited prenatal care, and prior preterm birth were controlled for in the analysis, there remained a significant adverse effect of substance use on birth outcomes and costs. The finding that newborns exposed prenatally to cocaine plus opiates were more than three times as costly to care for after delivery than unexposed infants is in agreement with previously reported results. In this study, in which screening was not universal, the increase in newborn costs and length of stay associated with exposure to cocaine was only slightly less than the increases associated with opiates plus cocaine. However, studies that used universal toxicology screens to ascertain exposure, (for example, Phibbs et al. (1991) and Joyce et al (1995)) reported that increases in newborn costs associated with exposure to cocaine were significantly lower than those associated with polydrug use. These differences underscore the bias introduced by selective screening and self-reported use and indicate that caution must be exercised when interpreting the effect of exposure on outcomes and costs.

Another potential source of bias derives from self-selection, or the inclination of individuals who are in a greater position to benefit from an intervention to elect to use it. Drug-using women who obtain prenatal care may systematically differ from those who do not. They may be more concerned about their health, live in a less stressful environment, and use fewer drugs than those who do not seek prenatal care. The inclusion, in the multivariate regression, of factors that represented a tendency to self-select such as WIC, labor force participation, and marital status allowed this analysis to partially control for self-selection bias. However, many confounding factors were unknown or hard to measure. If these hard-to-measure characteristics were more prevalent among substance-using women who elected prenatal care than those who did not, then this analysis would be likely to attribute some of that effect to prenatal care.

The finding that exposed women obtained greater benefits from the introduction of prenatal care suggests that prenatal care for this group of women may have several effective components that are not relevant to women who do not use drugs, such as help with withdrawal and referral to drug treatment. Prenatal care may be an important mechanism for providing appropriate health education, which may help drug-using women abstain or decrease substance use during pregnancy (Abma and Mott 1991). Vega et al. (1993) report that prenatal care that began during the first trimester of pregnancy was associated with lower prevalence estimates for the use of most drugs. Thus, interventions designed solely to get pregnant substance using women into prenatal care might be cost-effective as a first step in identifying high-risk pregnancies and may ultimately increase the rate at which women return to care.

Although, the cost savings from prenatal care seem to be modest in this study, the study may have underestimated the potential cost savings by considering only short-term costs. Infants exposed prenatally to drugs are known to have higher rates of learning disability, cognitive impairments, and neurological problems (Finnegan and Kandall 1992; Zuckerman and Bresnahan 1991). If prenatal care can help exposed women reduce drug use it possibly may help reduce such complications in the future.

However, the results of this analysis also show that the deficits and costs associated with exposure may not be mitigated by prenatal care alone; without treatment of the addiction itself further improvements in pregnancy outcomes seem unlikely.

Therefore, in addition to programs that emphasize early enrollment in prenatal care, strategies for improving birth outcomes among substance abusing women should focus on reducing drug use, smoking, and other behaviors that have adverse consequences in pregnancy.

Several strategies have been employed to improve prenatal care compliance and reduce substance use by prenatal patients. In some programs, as an added incentive, patients are provided with lunch and transportation cost (McCalla et al. 1991). Others have suggested financial incentives on both compliance and birth outcomes (Fiscella 1995). Cash subsidies to medically indigent pregnant women have been suggested as incentive for use of prenatal care (Volpp 1994). Strategies like these would not only have substantial health benefits to pregnant drug-abusing women but they may produce significant cost-savings as well.

The effectiveness of prenatal care on substance abusing women needs to be further evaluated. Improved controls for life-styles and other correlates of drug use may improve the estimates of the effect of prenatal care on outcomes in this group. Better ascertainment of prenatal drug exposure using well-established biological markers will lead to more accurate estimates of cost of exposure (Ostrea and Welch 1991). These methods have advantages over urine testing and self-reporting because they provide a window longer than a few days. However, these methods too have limitation, thus validating the results of the biological markers with self-report may further increase to reliability of the assessment.

Appendix

A. Data Creation

Matching of Mother Infant Pairs

The matching process began with linkage of all mothers who delivered in an HHC facility between January 1, 1990 through December 31, 1992 to their infants. The Health and Hospitals Corporation used a scoring system based on a number of characteristics to match mothers and infants within a facility. The higher the score the more likely a successful match has been accomplished. Table A-1 displays the number of mother/infant pairs that were successfully matched in each of the three years. The match rate in 1990 was 62.8 percent, relatively low compared to 98.7 percent in 1992. The overall match rate in was 78.0 percent. The reason for the earlier low match rate was that the coding of the discharge data was inconsistent among the HHC facilities prior to August 1991. Thus the match rate varied by facility as well as by year. Subsequently, a more uniform coding system was developed which enabled HHC to achieve a higher match rate in 1992.

Table A-2 shows the number of successfully matched mother/infant pairs by HHC facility. In 1990, there were two outliers. Coney Island had no matches and Woodhull had few. To gauge the relative match rate of each facility, the numbers of successfully matched pairs were divided by total number of deliveries at the facility based on New York birth certificates. The results are presented in Table A-3. The match rates of Coney Island and Woodhull hospitals were considerably below the match rates of other facilities. Queens, Kings County, Metropolitan, Bellevue, and Bronx Municipal hospitals had match rates that exceeded 80 percent in each year.

Unfortunately, some observations were lost in the matching algorithm. The information about the infants who delivered with HHC facilities but could not be matched to mothers consists of birth weight and length of stay (LOS). Table A-4 displays mean LOS and birth weight by year for study and non-study infants. Differences in LOS between the two groups were approximately 0.8 days and this difference was statistically significant. Overall differences in mean birth weight were not statistically significant, nor were differences in 1990, the year of the largest number of unmatched infants.

In summary, non-study infants stayed longer and weighed less although the latter difference was less substantial. There was little that can be done about the lost cases or the selection bias they might or might not create. However, the effects of inconsistent match rates should be minimized when controls for year and facility are included in empirical specifications.

B. Creation of Exposure Measures

Creation of consistent exposure variables required identification of comparable drug classifications within each, the New York birth certificates and the and the ICD-9 codes from discharge abstracts followed by a coherent merging.

New York City Birth Certificates

An individual birth certificate can record up to five separate exposures that occurred during pregnancy. Dichotomous indicators exist for the following substances: tobacco, alcohol, heroin, cocaine, methadone, marijuana, sedatives, tranquilizers or anticonvulsants, other drugs or unknown exposures. For the purposes of this analysis sedatives, tranquilizers, anticonvulsants and other drugs were grouped into a single category, simply because the frequency of these exposures was very low. Ultimately they were dropped from the analysis because the numbers involved are very low and the unknown nature of the substance made it difficult to classify the impact. Heroin and methadone were combined into a single opiate category because their effect on the newborns has similar physiologic consequences. Once the exposures to single agents were separated from exposures to combinations, there were four exposure variables from the birth certificate data: cocaine only, opiates only, cocaine plus opiates, and marijuana.

Health and Hospital Corporation, PADBARS

Discharge data from all 11 acute care facilities in the New York City Health and Hospitals corporation were collated in a single computerized data base called PADBARS. The exposure variables from this data source, originated with the ICD-9 diagnostic codes from infant and maternal delivery records. To make use of the PADBARS data on exposures, maternal and infant health records had to be linked together. On each record, 15 diagnostic fields were searched for specific ICD-9 designations. Illicit substance exposure were initially divided into one of the following seven categories based on ICD-9 coding: cocaine, opiates, marijuana, alcohol, tobacco, other or unspecified. To generate congruence with the birth certificate data the HHC designations were simplified into cocaine only, opiates only, cocaine plus opiates, other drugs and unspecified. No marijuana exposures were detected in the HHC data.

Merging

With four drug classifications from the birth certificate data and five from the PADBARS data set the next procedure was to merge the exposure classifications in order to create a single set of exposure variables to use in the analysis. The merging algorithm followed a two-step process. First, cocaine exposures were merged from either source, opiate exposures were merged from either source, marijuana, etc. Next, pure cocaine or pure opiate exposure categories were established based on the merged variables. The final set of exposures included six combined exposure variables: cocaine without opiates, opiates without cocaine, cocaine plus opiates, marijuana, other drugs or unknown exposure.

Tables A-5a through A-5d depict the exposure rates for different drugs in the entire data set for the years 1990-1992based upon the HHC designations, the birth certificate designations, and the composite designations obtained after merging the two data sets. In general the HHC designations based on ICD-9 classifications were less able to identify cocaine exposure than the birth certificate data but more sensitive at ascertaining exposure to opiates. Table A-5d displays the concordance between the two data sets. It can be seen that over 80 percent of the cocaine exposures identified by the birth certificates were classified either as unexposed or as opiate exposures by the HHC and nearly half of the opiate exposures identified by the HHC classification were unexposed according to the birth certificates. These findings underscore the importance of the use of complementary information sources to improve the sensitivity of exposure classifications when using New York City data

C. Complications of Drug Use

Almost all drugs taken by pregnant women are known to cross the placenta and have some effect on the fetus. Although, a clear understanding of the complications associated with a specific substance is often hampered by the high incidence of multiple drug use as well as tobacco and alcohol use, it is useful to consider the effects of the drugs most frequently used by pregnant women - marijuana, opiates and cocaine.

Marijuana

The majority of women of childbearing age report that they have used marijuana at least once in their lifetime (NIDA 1991). The reported prevalence rate during pregnacy is between 10 and 30 percent (Day and Richardson 1991). Despite the high frequency use the impact of marijuana on health during pregnancy remains controversial. Evidence to date suggests that marijuana may adversely affects fetal well being. The use of marijuana during pregnancy has been associated with increased frequency of meconium-stained amniotic fluid and precipitous labor. Some studies also found a relationship between marijuana use and premature birth, especially among heavier users. Marijuana use during pregnancy was also associated with decreased infant birth weight and decreased length (Zuckerman et al. 1989). Marijuana can be detected in the urine for weeks, much longer than most other illicit substance. Given that marijuana is commonly used by multiple substance abusers, the presence of marijuana metabolites in the urine may often identify patients who are users of other substances. (Fried et al. 1983)

Cocaine

Obstetric complications attributed to cocaine use are numerous and extend throughout pregnancy. Spontaneous abortions and premature separation of the placenta (abruptio placentae) are the most frequently described. In addition, pregnant cocaine users have been shown to be at high risk for preterm labor and delivery. Poor nutrition during pregnancy potentially affects fetal growth, thus newborns exposed prenatally to cocaine are at increased risk for intrauterine growth retardation (IUGR), younger gestational age, smaller size at birth and meconium-stained amniotic fluid (Little et al. 1989; MacGregor et al. 1987; Neerhof et al. 1989). Infants exposed prenatally to cocaine are also at risk for neurobehavioral abnormalities and seizures (Chasnoff et al. 1989). Cocaine may be detectable in blood or urine for less than 12 hours but its water-soluble products may be recovered from urine for up to one week, depending on the sensitivity of testing methodology.

Opiates

The most consistently reported effects of prenatal opiate exposure on fetus are higher rates of stillbirth, intrauterine growth retardation, low birth weight, smaller head size, prematurity and long-term deficits in mental or neurological functioning (Finnegan et al. 1972). These finding are associated with both, heroin and methadone exposure. Most widely documented problem is neonatal abstinence syndrome, which can occur after either heroin or methadone exposure. Neonatal withdrawal symptoms may include sweating, stuffy nose, fever, seizures, dysfunction, respiratory distress, poor sucking reflex and poor soothability. The symptoms usually appear within a day or two after delivery, but they may not appear for as long as 10 days. Symptoms usually last for two weeks, but some infants show mild signs for as long as six months. Withdrawal begins later and lasts longer when the mother has been taking methadone than when she has been taking heroin (Finnegan and Kandall 1992).

Glossary

Abruptio placentae	Premature detachment of the placenta from the uterine wall.
ACOG	American College of Obstetricians and Gynecologists
Amniotic fluid	The fluid surrounding the fetus in the uterus.
APNCU Index	Adequacy of prenatal care utilization index. a two-factor index that combines the timing of initiation of care and the ratio of the actual number of visits to the ACOG-recommended number of visits (adjusted for gestation).
Diagnosis-Related Groups (DRG)	DRGs are patient illness categories that are clinically coherent and relatively homogeneous with respect to the hospital resources required to treat the illness. DRGs were used as the basis for reimbursement for all payers between 1983-1997.
Fetus	An unborn child from the end of the eighth week to the moment of birth.
Gestational age	Norms that have been established for the increase in size of the body and its constituent parts at each week of gestation and are based on weight, length, and head circumference.
Gestational period	The normal human gestational period is 280 days, or 40 weeks, calculated from the first day of the mother's last menstrual cycle.
ICD-9 Codes	International Classification of Diseases 9th Revision. Used to record a patient's diagnosis.
Intrauterine growth retardation (IUGR)	Problems that interfere with normal growth early in pregnancy inhibit cell division causing a decrease in total body cell number. As a result, the fetus may be growth retarded or small for weight, length, and head circumference.
Low birth weight (LBW)	Infant weighing less than 2,500 grams (5.5 lbs).
Malformation	Results from poor tissue formation caused by a single gene, chromosomal, or teratogenic disorders.

Meconium	The first stool of a newborn. The finding of meconium in the amniotic fluid is an indication of fetal distress.
Neonatal abstinence syndrome	Drug withdrawal in the newborn due to intake of drugs of the mother.
Neonate	The neonatal period is defined as the fist 28 days (4 weeks) of life.
Perinatal	Occurring near the time of birth.
Placenta	The organ attached to the wall of the uterus through which the fetus receives nourishment and oxygen, and passes off metabolic waste products.
Precipitous labor	Abrupt labor and delivery.
Premature birth	Birth happening before the proper time, as a premature infant.
Preterm delivery	Refers to delivery at less than 37 weeks gestation.
Service Intensity Weights (SIW)	A case weight assigned to a specific DRG. It represents the relative average resource consumption (cost) of patients in that DRG compared with the average cost of all DRGs.
Small for gestational age	If an infant's weight is less than the tenth percentile for a specific time of gestation.
Spontaneous abortion	Refers to the interruption of pregnancy usually between the fourth month and viability.
Stillbirth	Birth of a dead baby.
Teratology	The science dealing with malformation of fetuses.
Toxicology	The science concerned with poisons, their effects, and antidotes.
Very low birth weight (VLBW)	Infant weighing less than 1,500 grams (3.3 lbs).

Figure 1

Distribution of Expected Revenue

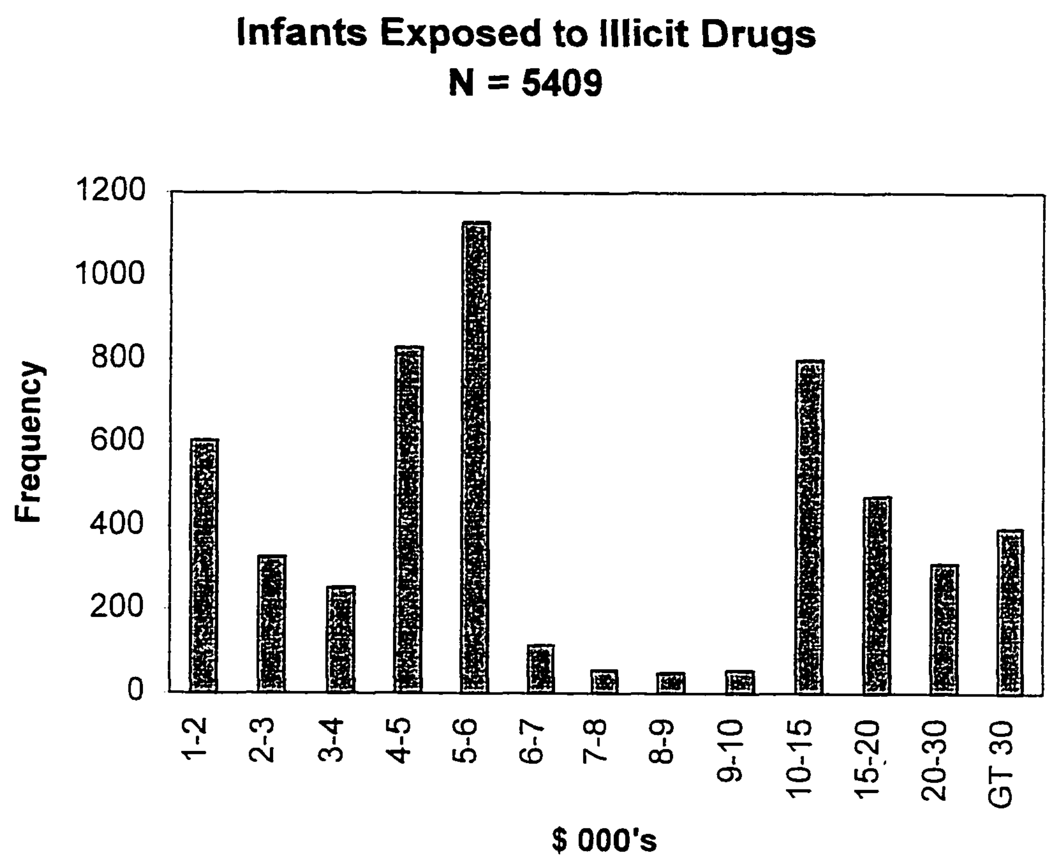


Figure 2

Distribution of Acute Care Length of Stay (Days)

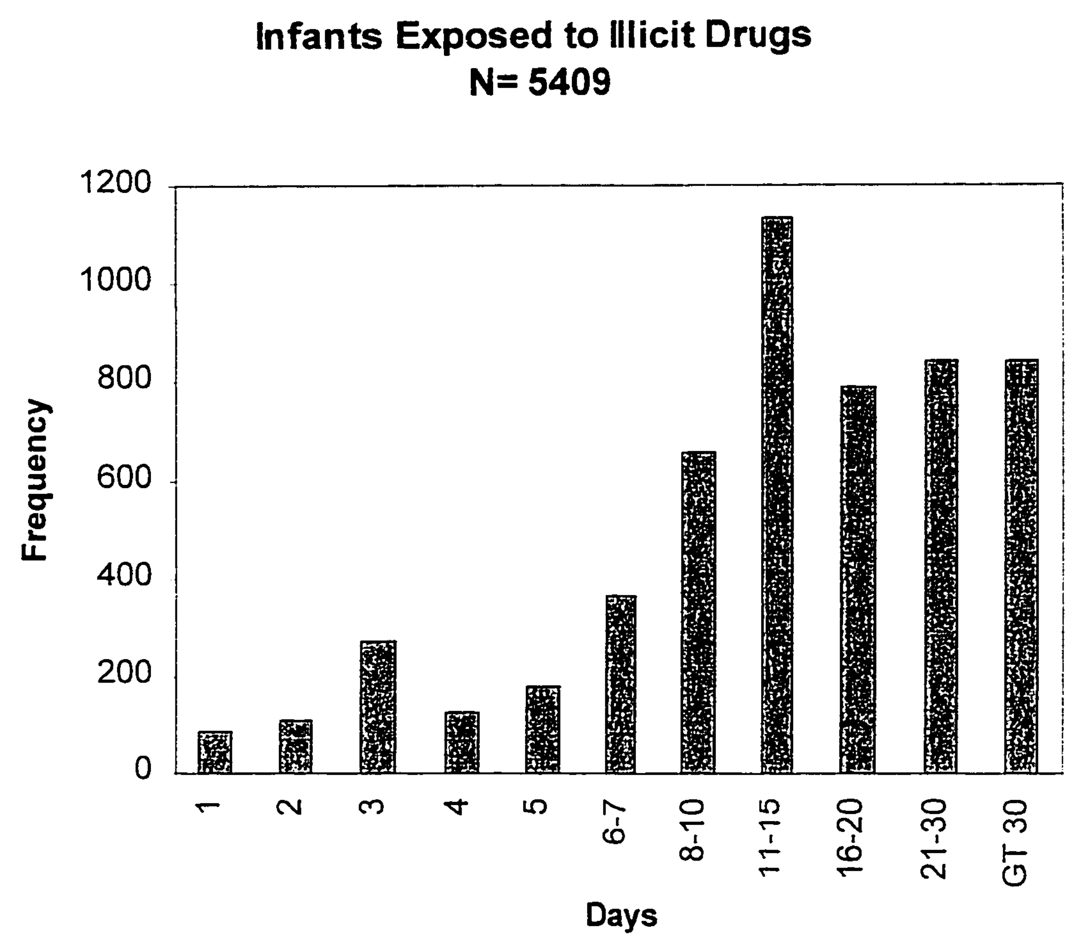


Table 1

Categories of the Summary Index by Initiation and Utilization of Prenatal Care (Kotelchuck 1994)

Month Prenatal Care Begun	Adequacy of Services Received			
	0-49%	50-79%	80-109%	110%
7-9 or none			Inadequate	
5-6				
3-4		Intermediate		
1-2				

Table 2

Distribution of Prenatal Care Utilization by Drug Exposure (percent)

Illicit Substances	Care Unknown	No Prenatal Care	Inadequate	Intermediate	Adequate	Adequate Plus
Cocaine N=1338	19.37	31.56	29.69	6.20	6.58	6.58
Opiates N=2394	20.97	31.12	26.15	7.56	7.68	6.52
Cocaine + Opiates N=1407	18.85	41.11	26.24	4.76	4.62	4.41
Marijuana N=201	11.94	13.43	40.30	12.44	14.43	7.46
Other N=69	17.56	24.64	31.88	15.94	7.2	4.34

Table 2A

Distribution of Prenatal Care Utilization by Kotelchuck APNCU Index of Women Who Were Identified as Exposed to Cocaine, New York City Municipal Hospitals 1990-1992 N=1338

	Adequacy of Services Received						
Month Prenatal Care Began	**< 49%**	**50-79%**	**80-109%**	**110%**	**No Care**	**Care Unknown**	**Total**
					31.5	19.4	50.9
7-9	2.9	2.3	3.0	3.3			11.5
5-6	1.8	3.6	2.9	4.9			13.2
3-4	3.3	3.5	3.5	4.1			14.4
1-2	1.6	2.8	3.0	2.6			10.0
Total	9.6	12.2	12.4	14.9	31.5	19.4	100.0

Table 2B

Distribution of Prenatal Care Utilization by Kotelchuck APNCU Index of Women Who Were Identified as Exposed to Opiates, New York City Municipal Hospitals 1990-1992 N=2394

Month Prenatal Care Began	Adequacy of Services Received <49%	50-79%	80-109%	110%	No Care	Care Unknown	Total
					31.3	20.9	52.2
7-9	1.2	2.2	1.7	2.9			8.0
5-6	1.8	3.6	2.9	5.3			13.6
3-4	2.2	3.8	4.9	4.3			15.2
1-2	2.2	3.8	2.8	2.2			11.0
Total	7.4	13.4	12.3	14.7	31.3	20.9	100.0

Table 2C

Distribution of Prenatal Care Utilization by Kotelchuck APNCU Index of Women Who Were Identified as Exposed to Opiates Plus Cocaine, New York City Municipal Hospitals 1990-1992 N=1407

Month Prenatal Care Began	Adequacy of Services Received						
	< 49%	50-79%	80-109%	110%	No Care	Care Unknown	Total
					41.1	18.8	59.9
7-9	1.3	3.5	2.9	2.6			10.3
5-6	1.8	2.8	2.8	3.2			10.6
3-4	3.4	2.5	2.9	2.9			11.7
1-2	1.9	2.3	1.7	1.6			7.5
Total	8.4	11.1	10.3	10.3	41.1	18.8	100.0

Table 2D

Distribution of Prenatal Care Utilization by Kotelchuck APNCU Index of a Random Sample of Unexposed Women, New York City Municipal Hospitals 1990-1992 N=6992

Month Prenatal Care Began	Adequacy of Services Received						
	<49%	50-79%	80-109%	110%	No Care	Care Unknown	Total
					8.5	12.8	21.3
7-9	1.1	2.4	3.5	4.3			11.3
5-6	1.4	4.5	6.1	7.4			19.4
3-4	2.0	9.6	13.2	6.8			31.6
1-2	1.6	5.4	5.9	3.5			16.4
Total	6.1	21.9	28.7	22.0	8.5	12.8	100.0

Table 3

Number and Percent of Deliveries of Infants Identified as Exposed to Illicit Drugs with Negative or Zero Revenue by Hospital, New York City Municipal Hospitals, 1990-1992 N=815

Hospital	Total Deliveries	Number of Deliveries with Negative or Zero Revenue	Percent of Total Deliveries
Bellevue	264	36	13.64
Harlem	1114	153	13.73
Metropolitan	503	47	9.34
Lincoln	1125	120	10.67
Bronx Municipal	246	68	27.64
North Central Bronx	435	56	12.87
Coney Island	147	42	28.57
Kings County	427	86	20.14
Woodhull	582	125	21.65
Queens	325	39	12.00
Elmhurst	278	42	15.11

Table 4

Infant Identified as Exposed to Illicit Drugs With Expected Revenue of Less Than or Equal to Zero by DRG With Their Mean Service Intensity Weights and the 1992 New York State Department of Health Designated Service Intensity Weights
N = 815

DRG	Diagnosis Related Group Name	Num of Cases	%	Mean SIW	NYS SIW
470	Ungroupable or can belong to more than one Major Diagnostic Category	36	4.4	--	--
602	Neonate. birthwt <750g. discharged alive	2	0.2	34.6865	35.9324
603	Neonate. birthwt <750g. died	2	0.2	8.3908	9.3058
604	Neonate. birthwt 750-999g. discharged alive	5	0.6	20.4671	22.4474
605	Neonate. birthwt 750-999g. died	2	0.2	16.2122	15.4618
607	Neonate. birthwt 1000-1499g. w/o signif OR proc. w mult major problems	20	3.2	10.8910	11.1178
608	Neonate. birthwt 1000-1499. died	2	0.2	15.1417	17.5119
609	Neonate. birthwt 1500-1999g. w signif OR proc. w multiple major problems	1	0.1	22.9778	25.3324
611	Neonate. birthwt 1500-1999g.w/o signif OR proc. w multiple major problems	26	3.2	5.7607	5.8293
612	Neonate. birthwt 1500-1999g. w/o signif OR proc. w major problems	25	3.1	4.5657	4.5657
613	Neonate. birthwt 1500-1999g. w/o signif OR proc. w major problems	1	0.1	3.4002	3.4002
614	Neonate. birthwt 1500-1999g w/o signif OR proc. w minor problems	2	0.2	2.0387	2.0387
615	Neonate. birthwt 2000-2499g. w signif OR proc. w multiple major problems	1	0.1	13.8130	13.8130
617	Neonate. birthwt 2000-2499g. w/o signif OR proc. w multiple major problems	38	4.7	3.3586	3.3586
618	Neonate. birthwt 2000-2499g. w/o signif OR proc. w major problems	92	11.3	1.9680	1.9672
619	Neonate. birthwt 2000-2499g. w/o signif OR proc. w minor problems	3	0.4	1.3131	1.3131
620	Neonate. birthwt 2000-24000g. w/o signif OR proc. w norm newborn diagnos.	11	1.4	0.3857	0.3857
622	Neonate. birthwt >2499g. w signif OR proc. w multiple major problems	2	0.2	7.6754	7.6754
624	Neonate. birthwt >2499g. w minor abdominal procedure	1	0.1	1.1680	1.1680
626	Neonate. birthwt >2499g. w/o signif OR proc. w multiple major problems	117	14.4	2.5946	2.5880
627	Neonate. birthwt >2499g. w/o signif OR proc. w major problems	328	40.3	0.7913	0.7899
628	Neonate. birthwt >2499g. w/o signif OR proc. w minor problems	8	1.0	0.5598	0.5598
629	Neonate. birthwt >2499g. w/o signif OR proc. w normal newborn diagnosis	75	9.2	0.2116	0.2128
630	Neonate. birthwt >2499g w/o signif OR proc. w other problems	6	0.7	0.5114	0.5114
637	Neonate. died within one day of birth. born here	4	0.5	0.5005	0.5005
639	Neonate. transferred <5 days of birth. born here	4	0.5	0.3289	0.3289

Table 5

Comparison of Means and Frequencies of Selected Characteristics of Drug-Exposed Sample With Expected Reimbursement of Less than or Equal to Zero and Those With Positive Expected Reimbursement, New York City Municipal Hospitals, 1990-1992

Characteristics	Positive Expected Revenue N=4631	Negative or Zero Expected Revenue N=815	T-statistics
Mean cost $	12079	0.00	41.30
Prenatal care			
Number of prenatal care visits	4.13	4.41	1.55
Care unknown	19.37	21.23	1.23
No prenatal care	42.29	34.58	4.01
Inadequate	33.66	38.32	1.79
Intermediate	8.06	10.44	1.67
Adequate	8.44	9.35	0.58
Adequate plus	7.55	7.32	0.36
Birth outcomes			
Birth weight (grams)	2677	2699	0.88
Low birth weight	35.75	35.75	1.03
Very low birth weight	5.59	4.79	0.98
Preterm <37 weeks	26.75	26.63	0.07
Gestational age (weeks)	37.01	37.18	1.08
Parity	2.34	2.59	3.55
Plural birth	1.86	1.60	0.54
Infant died	1.40	1.84	0.87
Illicit substances			
Cocaine	20.36	49.95	15.72
Opiates	47.61	25.77	12.85
Cocaine + opiates	27.29	18.53	5.80
Marijuana	3.45	5.03	1.94
Other drugs	0.09	0.25	0.11
Legal substances			
Tobacco	51.41	53.62	1.16
Alcohol	13.91	14.36	0.34
Demographic			
Mother's age (years)	27.92	28.75	4.32
Teens	4.28	4.17	O.13
Older than 34	10.56	13.50	2.29
White	5.81	5.03	0.93
Black	63.29	67.48	2.30
Hispanic	29.00	25.03	2.32
Background unknown	1.90	2.45	0.96
Born in USA	84.52	84.66	0.11

Table 5 con.

Comparison of Means and Frequencies of Selected Characteristics of Drug-Exposed Sample With Expected Reimbursement of Less than or Equal to Zero and Those With Positive Expected Reimbursement, New York City Municipal Hospitals, 1990-1992

Characteristics	Positive Expected Revenue N=4631	Negative or Zero Expected Revenue N=815	T-statistics
Socioeconomic			
Unmarried	89.92	90.92	0.88
Mother's education (years)	15.59	17.44	2.16
Worked during pregnancy	2.92	3.68	1.09
WIC	36.58	45.89	5.06
AFDC	5.40	10.80	4.75
Obstetric			
First birth	15.22	11.66	2.87
Fourth + birth	21.96	26.75	2.87
Cesarean section	15.61	14.61	0.73
Mother's total length of stay (days)	3.74	3.72	0.21
Mother's acute length of stay	4.06	3.70	3.55
Infant's total length of stay	19.37	19.80	0.59
Infant's acute length of stay	19.32	19.75	0.59
Infant needed NICU care	18.83	17.67	0.78
Total cost from nurseries ($)	5198	6550	3.11
Finance			
Unknown	0.00	0.12	2.38
Self pay	3.93	5.16	1.48
Medicaid	91.92	89.31	2.35
Blue Cross	1.12	0.86	0.74
Commercial	0.15	0.25	0.51
Other finance	2.87	4.30	1.89
Hospitals			
Bellevue	4.92	4.42	0.64
Harlem	20.75	18.77	1.29
Metropolitan	9.85	5.77	4.40
Lincoln	21.70	14.72	5.05
Bronx Municipal	3.84	8.34	4.46
North Central Bronx	8.18	6.87	1.35
Coney Island	2.27	5.15	3.58
Kings County	7.36	10.55	2.79
Woodhull	9.85	15.46	4.19
Queens	6.18	5.15	1.68
Elmhurst	5.10	5.15	0.07
Year			
1990	36.30	4.05	32.63
1991	38.09	1.23	45.43
1992	25.61	94.72	67.69

Table 6

Mean Medicaid Discharge Case Payment Rates and Mean Capital Cost Per Discharge, New York City Municipal Hospitals 1990-1992

Hospital	1990 Case Payment	1990 Capital Cost	1991 Case Payment	1991 Capital Cost	1992 Case Payment	1992 Capital Cost
Bellevue	5,195.82	492.87	5,425.50	869.72	5,525.68	625.69
Harlem	5,242.82	351.10	5,657.57	489.66	6,446.49	462.10
Metropolitan	6,112.11	299.83	6,717.21	271.10	6,250.29	384.67
Lincoln	4,672.10	431.47	6,245.99	682.85	5,066.12	448.38
Bronx Municipal	5,071.03	379.13	5,480.68	309.07	5,731.85	284.81
North Central Bronx	4,897.50	403.86	5,308.26	480.58	5,200.94	492.01
Coney Island	4,387.93	341.15	4,814.10	324.50	4,970.94	315.52
Kings County	5,064.60	177.95	5,953.10	245.69	5,298.65	475.59
Woodhull	5,443.55	953.18	6,120.45	958.04	3,893.83	903.62
Queens	4,984.42	309.65	5,328.54	325.20	5,650.56	400.13
Elmhurst	4,977.11	258.48	5,519.00	288.40	5,447.60	311.06

Source: Bureau of Primary and Acute Care Reimbursement, New York State Department. of Health

Table 7

Definitions of Dependent and Independent Variables Used in the Analysis

Variable	Definition
Birth outcomes	
Birth weight	Infant birth weight in grams
Gestational age	Gestation in weeks based on the difference between the date of birth and the date of the last menstrual period
Low birth weight	Birth weight < 2500 grams
Very low birth weight	Birth weight < 1500 grams
Preterm	A dichotomous variable that equals one if gestation < 37 weeks
Plural birth	A dichotomous variable that equals one if birth is plural
Obstetrical	
Prenatal visits	Number of prenatal care visits obtained during pregnancy
Parity	Number of previous live births
First birth	A dichotomous variable that equals one if first birth
Fourth + births	A dichotomous variable that equals one if the mother had four or more previous births
Fetal loss	A dichotomous variable that equals one if the mother experienced previous fetal loss
Sex	A dichotomous variable that equals one if male
Gestational hypertension	A dichotomous variable that equals one if the mother has gestational hypertension
Gestational diabetes	A dichotomous variable that equals one if the mother has gestational diabetes
STD	A dichotomous variable that equals one if the mother has sexually transmitted disease other than herpes
Anemia	A dichotomous variable that equals one if the mother has anemia
Cesarean section	A dichotomous variable that equals one if birth was a cesarean delivry
Prepregnancy weight	Weight before pregnancy (kg)
Weight gain	Pregnancy weight gain (kg)

Table 7 con.

Variable	Definition
Demographic	
Mother's race	Maternal race categorized as White non-Hispanic. Black non-Hispanic, and Hispanic.
Mother's age	Age of the mother at the time of delivery (years)
Age < 19	A dichotomous variable that equals one if the mother is less than 19 years old
Age > 35	A dichotomous variable that equals one if the mother is age 35 or over
Born in USA	A dichotomous variable that equals one if the mother was born in the mainland United States
Socioeconomic	
Unmarried	A dichotomous variable that equals one if the mother is unmarried
Mother's schooling	Mother's education in years of completed schooling
Less than high school	A dichotomous variable that equals one if the mother completed less than 12 years of schooling
High school	A dichotomous variable that equals one if the mother completed high school
Some college	A dichotomous variable that equals one if the mother completed some college
College	A dichotomous variable that equals one if the mother completed college or more
Employment	A dichotomous variable that equals one if the mother worked during pregnancy
Method of finance	Payment for mother's birth categorized as financed by Medicaid, self-pay or other third-party
WIC	A dichotomous variable that equals one if the mother participated in the Supplemental Nutrition Program for Women, Infants, and Children

Table 7 con.

Variable	Definition
Behavioral risks	
Smoking	A dichotomous variable that equals one if the woman smoked at least ½ pack of cigarettes per day during pregnancy
Alcohol	A dichotomous variable that equals one if the woman had 2 or more drinks per week during pregnancy
Cocaine	A dichotomous variable that equals one if the woman used cocaine during pregnancy
Heroin	A dichotomous variable that equals one if the woman used heroin during pregnancy
Marijuana	A dichotomous variable that equals one if the woman used marijuana during pregnancy
Cost measures	
Infant LOS	Infant's acute care length of stay (days)
Mother LOS	Mother's acute care length of stay (days)
Infant SIW	Infant's service intensity weights
Mother SIW	Mother's service intensity weights
Infant cost	Hospital expected revenue
Area measures	
LFPR	Labor force participation rate in census tract, 1990 census
FLFPR	Labor force participation rate of females in census tract, 1990 census
Poverty	Persons below poverty level in 1989 (%)in census tract, 1990 census
Homicide rate	Number of homicides per 100000 by health area in 1989
Drug death	Number of death due to drugs by health area
Total population	Total population by health area 1990 census

Table 8

Means and Frequencies of Selected Variables of Women Who Were Identified as Exposed to Illicit Drugs During Pregnancy and Their Infants by the Prenatal Care Utilization Index (Koteltchuck), New York City Municipal Hospitals, 1990-1992 * N=5409 (Percent unless otherwise stated)

Variable	No Prenatal Care N=1789	Care Unknown N=1061	Inadequate N=1497	Intermediate N=367	Adequate N=371	Adequate Plus N=324
Prenatal care						
Prenatal care visits	0.00	5.35[a]	5.02[a]	7.12[a]	9.71[a]	11.91[a]
Birth outcomes						
Birth weight (grams)	2527	2669[a]	2808[a]	2835[a]	2837[a]	2627[c]
Low birth weight	43.99	35.25[a]	27.42[a]	26.16	27.22	38.39
Moderately low birth weight	35.16	29.69[b]	25.02[a]	23.98[a]	22.91[a]	30.56
Very low birth weight	8.44	5.47[b]	2.34[a]	2.18[a]	4.31[b]	8.33
Preterm <37 weeks	27.95	24.69	22.41[b]	20.98[b]	23.18	56.79[a]
Gestational age (weeks)	36.07	36.35	38.51[a]	38.51[a]	38.01[a]	35.16[b]
Plural birth	1.73	1.41	1.67	1.63	1.89	4.01
Infant needed NICU	22.53	13.76[a]	19.80	12.53[a]	15.63[b]	17.59[c]
Infant died	2.40	1.89	0.60[a]	0.54[b]	0.54[b]	0.93[c]
Illicit substances						
Cocaine	23.59	24.41	26.56	22.62	23.72	27.16
Opiates	41.64	47.31[b]	41.87	49.32[b]	49.60[b]	48.15[c]
Cocaine + opiates	32.31	24.98[a]	24.68[a]	18.26[a]	17.52[a]	19.14[a]
Marijuana	1.51	2.26	5.42[a]	6.81[a]	7.82[a]	4.63[b]
Other drugs	0.95	1.04	1.47	3.00[c]	1.35	0.93
Legal substances						
Tobacco	51.70	46.56[b]	53.85	44.41[c]	55.53	62.35[b]
Alcohol	15.82	13.02[c]	13.78	12.81	10.51[b]	12.96
Demographic						
Mother's age unknown	0.67	0.09[c]	0.07[b]	0.27	0.00[b]	0.00[b]
Mother's age (years)	28.23	27.89	27.98	27.83	27.73	28.55
Teens age<19 years	3.41	3.49	5.55[b]	5.18	5.12	3.70
Adult age 19-34	85.41	85.45	83.21	85.83	84.10	84.88
Age 35 or older	11.18	11.03	11.24	8.99	10.78	11.42
White	6.93	4.54[b]	5.48	4.63	6.47	3.70[b]
Black	64.73	63.71	63.14	58.58[c]	60.11	72.84[b]
Hispanic	25.60	28.37	30.64[b]	34.88[b]	32.88[b]	22.53
Background unknown	2.74	3.39	0.74[a]	1.91	0.54[a]	0.93[b]
Born in USA	85.08	85.39	83.81	82.56	80.59[c]	87.96

* Comparison are paired t-tests of each prenatal care category to women with no prenatal care; [a] p<0.0001, [b] p<0.01, [c] p<0.05

Table 8 con.

Means and Frequencies of Selected Variables of Women Who Were Identified as Exposed to Illicit Drugs During Pregnancy and Their Infants by the Prenatal Care Utilization Index (Koteltchuck), New York City Municipal Hospitals, 1990-1992 * N=5409 (Percentage unless otherwise stated)

Variable	No Prenatal Care N=1789	Care Unknown N=1061	Inadequate N=1495	Intermediate N=367	Adequate N=371	Adequate Plus N=324
Socioeconomic						
Unmarried	92.06	90.29	90.37	85.83^b	86.25^b	86.11^b
Less than HS	52.54	50.80	54.38	56.68	51.21	47.87
High school	33.93	28.93^b	33.91	33.51	36.68	40.43^c
Some college	5.87	6.97	8.76^b	6.81	10.51^b	7.41
College or more	0.67	1.32	1.00	1.36	0.81	1.85
Education unknown	6.99	11.97^a	1.94^a	1.63^a	0.81^a	2.47^a
Worked during pregnancy	1.73	3.20^c	3.68^b	2.45	4.31^c	4.63^c
WIC	18.05	32.33^a	50.84^a	53.68^a	61.99^a	61.73^a
AFDC	5.93	3.20^b	6.02	8.45	9.70^c	12.35^b
Obstetric						
First birth	12.19	14.80	15.32^b	15.26	21.29^a	17.28^c
Fourth + birth	24.76	22.62	22.34	19.89^c	20.49	19.14^c
Parity	2.53	2.39	2.30^b	2.28^c	2.26^b	2.22^b
Parity unknown	5.93	6.13	4.48	7.90	5.93	7.72
Cesarean section	12.91	14.04	16.99^b	17.44^c	18.33^c	21.16^b
Previous fetal loss	2.40	2.07	1.94	2.18	2.43	2.16
Gestational diabetes	0.22	0.19	0.67	0.27	0.27	0.93
Gestational Hypertension	0.67	0.85	1.07	1.91	0.81	1.54
Anemia	2.07	3.49	3.34	1.63	2.96	2.47
STD	2.91	4.34	6.42^a	2.72	7.01^b	2.47
Prepregnancy weight (kg)	129.04	132.93^b	134.72^a	135.16^b	134.60^b	136.80^a
Prepregnancy weight unknown	61.49	68.14^b	43.75^a	49.86^a	36.39^a	27.16^a
Pregnancy weight gain (kg)	20.09	25.07^a	24.75^a	25.32^a	26.87^a	25.07^a
Pregnancy weight gain unknown	64.84	71.44^b	46.15^a	51.77^a	39.62^a	29.01^a
Area variables						
LFPR in census track	59.19	60.00^c	59.58	60.21	59.46	58.69
Female LFPR in census tract	51.54	51.66	52.33	52.35	52.21	51.54
Female LFPR in HA	45.73	46.62^b	46.64^b	44.92	47.29^b	48.04^a
Percent poor in census tract	22.20	21.18	20.88^c	21.69	20.96	21.44
Drug death rate in HA	29.53	27.14^b	26.95^b	26.94^b	25.38^b	30.68
Homicide rate in HA	53.56	51.77	50.14^b	51.51	49.25^b	50.54
Total population in Health Area	18858	27355	25087	19063	21549^a	19917

* Comparison are paired t-tests of each prenatal care category to women with no prenatal care;
^{a} $p<0.0001$, ^{b} $p<0.01$, ^{c} $p<0.05$

Table 8 con.

Means and Frequencies of Selected Variables of Women Who Were Identified as Exposed to Illicit Drugs During Pregnancy and Their Infants by the Prenatal Care Utilization Index (Koteltchuck), New York City Municipal Hospitals, 1990-1992 * N=5409 (Percentage unless otherwise stated)

Variable	No Prenatal Care N=1789	Care Unknown N=1061	Inadequate N=1495	Intermediate N=367	Adequate N=371	Adequate Plus N=324
Finance						
Self pay	5.14	4.34	4.15	2.18[b]	1.35[a]	2.47[b]
Medicaid	89.88	90.94	92.44[c]	94.28[b]	93.80[b]	93.52[c]
Blue Cross	1.06	1.13	1.07	1.36	1.08	0.93
Commercial	0.00	0.28	0.20	0.27	0.54	0.00
Other finance	3.91	3.30	2.14[b]	1.91[c]	3.23	3.09
Year						
1990	33.26	30.54	28.83[b]	29.97	28.03	38.58
1991	34.54	34.31	31.17[c]	28.61[c]	33.69	27.78[c]
1992	32.20	35.16	40.00[a]	41.42[b]	38.27[b]	33.64

* Comparison are paired t-tests of each prenatal care category to women with no prenatal care:
[a] $p<0.0001$, [b] $p<0.01$, [c] $p<0.05$

Table 9

Means and Frequencies of Selected Variables of a Random Sample of Unexposed Women and their Infants by the Prenatal Care Utilization Index (Koteltchuck), New York City Municipal Hospitals, 1990-1992* N=6992 (Percentage unless otherwise stated)

Variable	No Prenatal Care N=594	Care Unknown N=897	Inadequate N=2405	Intermediate N=1050	Adequate N=1329	Adequate Plus N=717
Prenatal care						
Prenatal care visits	0.00	8.02[a]	6.63[a]	8.19[a]	10.71[a]	12.73
Birth outcomes						
Birth weight (grams)	3112	3211[b]	3248[b]	3307[a]	3303[a]	3048
Low birth weight	14.50	10.18[c]	7.41[a]	5.82[a]	5.50[a]	16.90
Moderately low birth weight	10.96	7.94	6.74[b]	5.34[a]	4.74[a]	11.59
Very low birth weight	3.54	2.24	0.67[b]	0.48[a]	0.75[b]	5.31
Preterm <37 weeks	13.80	9.81[b]	8.90[b]	4.67[a]	7.07[a]	33.33[a]
Gestational age (weeks)	38.50	38.17	39.65[a]	40.17[a]	39.43[a]	36.92[a]
Plural birth	1.35	1.11	0.91	0.76	1.35	3.77[b]
Infant needed NICU	5.39	6.58	4.41	3.33	6.02	10.04
Infant died	1.18	1.34	0.21[c]	0.10[c]	0.23[c]	1.26
Legal substances						
Tobacco	7.41	7.80	6.44	4.38[c]	5.19	5.58
Alcohol	0.51	0.56	0.54	0.19	0.30	0.28
Demographic						
Mother's age unknown	0.00	0.33	0.04	0.00	0.00	0.00
Mother's age (years)	24.99	25.10	25.23	25.48	25.94	26.64
Teens age<19 years	19.36	19.40	18.75	16.38	14.45[b]	15.06[c]
Adult age 19-34	76.43	76.70	76.93	79.62	80.06	72.11
Age 35 or older	8.59	7.92	7.69	7.33	8.80	13.81[b]
White	13.64	11.59	13.43	9.90[c]	11.29	9.48[c]
Black	31.82	35.90	34.94	29.81	32.36	43.65[a]
Hispanic	52.36	50.17	48.44	57.52[c]	53.27	43.93[b]
Background unknown	2.19	2.34	3.16	2.76	3.09	2.93
Born in USA	41.58	42.36	32.14[a]	34.10[b]	31.15[a]	35.56[c]
Socioeconomic						
Unmarried	72.90	68.12[c]	67.11[b]	62.95[a]	63.36[a]	65.69[b]
Less than HS	43.77	44.37	45.70	42.48	41.99	40.17
High school	43.77	36.79[b]	40.33	43.62	41.91	43.10
Some college	6.40	10.48[b]	8.40	10.00[b]	11.36[b]	12.13[b]
College or more	0.67	2.68[b]	3.08[b]	1.81[c]	3.46[a]	2.79[b]
Education unknown	5.39	5.69	2.49[b]	2.10[b]	1.28[a]	1.81[b]
Worked during pregnancy	5.72	8.70[c]	8.11[c]	12.10[a]	14.82[a]	13.39[a]
WIC	15.49	40.80[a]	55.68[a]	57.14[a]	66.44[a]	67.36[a]
AFDC	2.53	1.11	1.25	2.19	2.18	3.49

* Comparison are paired t-tests of each prenatal care category to women with no prenatal care;
[a] $p<0.0001$, [b] $p<0.01$, [c] $p<0.05$

Table 9 con.

Means and Frequencies of Selected Variables of a Random Sample of Unexposed Women and Their Infants by the Prenatal Care Utilization Index (Koteltchuck), New York City Municipal Hospitals, 1990-1992 [a] N=6992 (Percentage unless otherwise stated)

Variable	No Prenatal Care N=594	Care Unknown N=897	Inadequate N=2405	Intermediate N=1050	Adequate N=1329	Adequate Plus N=717
Obstetric						
First birth	39.23	38.02	37.46	40.76	41.61	39.47
Fourth + birth	7.41	8.81	7.82	6.19	5.04	6.00
Parity	1.25	1.31	1.10	1.04	1.07	1.19
Parity unknown	6.73	3.68[c]	5.45	4.76	4.74	5.30
Cesarean section	12.63	16.50[c]	16.13[c]	15.05	18.08[b]	24.69[a]
Previous fetal loss	0.67	2.01[c]	1.58[c]	1.24	1.13	2.09[c]
Gestational diabetes	1.68	3.34[c]	2.45	2.10	2.86	6.56[a]
Gestational hypertension	1.18	2.23	1.46	1.90	1.88	3.07[c]
Anemia	0.67	1.11	2.45[a]	1.24	1.88	1.12
STD	0.17	1.23[b]	1.87[a]	1.43[b]	1.66[a]	1.12[c]
Prepregnancy weight (kg)	138.87	143.85	140.26	140.65	143.16	143.94
Prepregnancy weight unknown	83.50	63.55[a]	42.37[a]	39.90[a]	32.58[a]	33.75[a]
Pregnancy weight gain (kg)	22.48	31.30[a]	26.41	29.65[a]	29.58[a]	28.65[a]
Pregnancy weight gain unknown	84.85	66.00[a]	44.62[a]	41.71[a]	34.09[a]	35.84[a]
Area variables						
LFPR in census track	61.97	60.97	62.23	61.95	62.18	61.21
Female LFPR in census tract.	53.19	52.33	54.39	53.79	53.87	50.45
Female LFPR in HA	49.31	48.32[c]	50.47[b]	49.18	50.68[b]	50.45[c]
Percent poor in census tract	21.11	21.56	18.37[a]	19.37[c]	18.49[b]	19.80
Drug death rate in HA	18.13	18.43	16.61[c]	18.42	16.79	17.25
Homicide rate in HA	37.70	43.21[b]	38.11	41.50	37.67	37.43
Total population in HA	24360	24251	24480	23796	24585	24498
Finance						
Self pay	13.13	6.47[a]	5.57[a]	4.48[a]	4.44[a]	2.65[a]
Medicaid	82.66	88.41[b]	90.94[a]	90.00[a]	90.52[a]	90.38[a]
Blue Cross	2.53	2.90	2.66	3.62	3.69	4.18
Commercial	1.01	1.34	0.50	1.62	1.05	2.23
Other finance	0.67	0.89	0.33	0.29	0.30	0.56
Year						
1990	40.91	34.00[b]	27.98[a]	24.95[a]	23.33[a]	27.89[a]
1991	31.82	28.87	29.60	30.76	33.11	34.59
1992	27.27	37.12[a]	42.21[a]	44.29[a]	43.57[a]	37.52[a]

[•] Comparison are paired t-tests of each prenatal care category to women with no prenatal care;
[a] $p<0.0001$, [b] $p<0.01$, [c] $p<0.05$

Table 10

Means and Frequencies of Selected Characteristics of Women and Infants by Type of Exposure, Pooled Sample, New York City Municipal Hospitals, 1990-1992 * N=12401 (Percentage unless otherwise stated)

Variable	Unexposed N=6992	Cocaine N=1338	Opiates N=2394	Cocaine + Opiates N=1407	Marijuana N=201	Other or Unspecified N=69
Birth outcomes						
Birth weight (grams)	3231.09	2639.69[a]	2732.28[a]	2584.64[a]	2986.18[a]	2792.40[a]
Low birth weight	8.74	39.09[a]	31.24[a]	40.72[a]	16.92[b]	24.64[b]
Moderately low birth weight	7.16	31.17[a]	27.32[a]	34.18[a]	13.43[b]	17.39[c]
Very low birth weight	1.58	7.62[a]	3.84[a]	6.32[a]	3.48	7.25
Preterm <37 weeks	11.70	31.27[a]	30.27[a]	35.66[a]	17.53[c]	20.00
Gestational age (weeks)	39.12	37.00[a]	37.21[a]	36.52[a]	38.49[c]	38.50
Infant needed NICU	5.49	20.85[a]	14.62[a]	25.02[a]	8.96	10.14
Demographic						
Mother's age (years)	25.51	28.27[a]	28.06[a]	28.37[a]	24.20[b]	27.82[b]
Teens	17.33	2.77[a]	3.80[a]	2.77[a]	28.85[b]	8.69[c]
Older than 34	8.58	10.39[c]	11.36[a]	11.58[b]	6.97	11.59
White	11.87	4.93[a]	6.43[a]	4.98[a]	5.47[a]	8.69
Black	34.44	71.67[a]	60.28[a]	62.62[a]	65.17[a]	55.07[b]
Hispanic	50.81	20.70[a]	31.54[a]	30.56[a]	28.36[a]	33.33[b]
Background unknown	2.87	2.69	1.75[b]	1.85[c]	1.00[c]	2.90
Born in US	34.71	84.83[a]	84.79[a]	84.79[a]	80.10[a]	72.46[a]
Socioeconomic						
Unmarried	66.25	93.38[a]	87.17[a]	92.96[a]	89.55[a]	86.96[a]
Less than High School	43.61	49.25[a]	52.46[a]	55.65[a]	58.71[a]	43.48
Some college	9.68	8.15	7.27[b]	6.61[a]	7.46	10.14
College or more	2.67	1.27[a]	1.04[a]	0.85[a]	0.49[a]	0.00[a]
Education unknown	2.79	5.53[a]	5.64[a]	5.69[a]	1.99	7.24
Worked during pregnancy	10.39	2.69[a]	2.63[a]	2.91[a]	8.45	4.34[c]
WIC	53.82	44.47[a]	35.21[a]	34.33[a]	52.74	40.58[c]
Obstetric						
First birth	39.17	13.83[a]	14.62[a]	12.08[a]	36.82	23.18[b]
Fourth + birth	6.95	24.96[a]	22.80[a]	22.46[a]	8.46	23.19[a]
Parity unknown	5.07	2.09[a]	8.23[a]	5.26	6.96	1.45[c]
Cesarean section	16.96	14.28[c]	15.20[c]	16.99	12.94	26.09[c]
Previous fetal loss	1.47	2.62[c]	2.21[c]	1.71	1.99	2.89
STD	1.46	4.86[a]	3.05[a]	5.90[a]	6.97[a]	4.35[b]

* Comparison are paired t-tests of each exposure category to unexposed women;
[a] $p<0.0001$, [b] $p<0.01$, [c] $p<0.05$

Table 10 con.

Means and Frequencies of Selected Characteristics of Women and Infants by Type of Exposure, Pooled Sample, New York City Municipal Hospitals, 1990-1992 * N=12401 (Percentage unless otherwise stated)

Variable	Unexposed N=6992	Cocaine N=1338	Opiates N=2394	Cocaine + Opiates N=1407	Marijuana N=201	Other or Unspecified N=69
Legal substances						
Tobacco	6.06	56.58[a]	42.02[a]	63.68[a]	57.21[a]	31.88[a]
Alcohol	0.41	16.67[a]	7.48[a]	22.89[a]	13.93[a]	4.35
Prenatal care						
Number of prenatal care visits	7.87	4.11[a]	4.53[a]	3.16[a]	6.83[b]	4.34[a]
Care unknown	12.83	19.36[a]	20.97[a]	18.83[a]	11.94	15.94
No care	8.50	31.54[a]	31.12[a]	41.08[a]	13.43[c]	24.63[a]
Inadequate	34.40	29.75[b]	26.15[a]	26.59[a]	40.30	31.88
Intermediate	15.02	6.20[a]	7.56[a]	4.76[a]	12.44	15.94
Adequate	19.00	6.58[a]	7.69[a]	4.62[a]	14.43	7.25[b]
Adequate plus	10.25	6.58[a]	6.52[a]	4.40[a]	7.46	4.35[c]
Area variables						
Percent poor in census tract	19.33	21.82[a]	20.75[b]	22.18[a]	22.56[a]	21.89[a]
Female LFPR in census tract	53.74	52.21[a]	51.91[a]	51.57[a]	51.26[b]	52.50
Drug death rate in HA	17.35	29.14[a]	27.10[a]	29.00[a]	23.52[a]	25.97[b]
Homicide rate in HA	39.08	49.88[a]	52.26[a]	52.75[a]	49.44[a]	48.31[b]
Hospitals						
Bellevue	6.74	7.77	3.34[a]	4.83[b]	1.00[a]	13.04[c]
Harlem	7.55	25.56[a]	18.42[a]	19.26[a]	13.93[b]	15.90[c]
Metropolitan	6.75	7.10	8.56[b]	13.01[a]	8.96	1.45[b]
Lincoln	15.75	10.39[a]	25.19[a]	23.53[a]	14.93	15.94
Bronx Municipal	5.51	8.00[b]	3.34[a]	2.84[a]	7.46	5.79
North Central Bronx	12.46	6.05[a]	9.11[a]	7.75[a]	8.46	13.04
Coney Island	4.38	4.41	1.21[a]	2.70[b]	9.45[b]	2.90
Kings County	10.88	9.34	5.68[a]	9.45	14.43	4.34[b]
Woodhull	6.85	9.42[b]	10.99[a]	10.80[a]	13.93[b]	17.39[c]
Queens	8.52	5.38[a]	9.15	1.63[a]	2.99[a]	7.25
Elmhurst	14.62	6.58[a]	5.01[a]	4.19[a]	4.48[a]	2.90[a]
Year						
1990	28.50	16.37[a]	36.38[a]	36.96[a]	30.34	27.54
1991	31.05	15.78[a]	39.93[a]	37.46[a]	23.38[c]	40.58
1992	40.45	67.86[a]	23.68[a]	25.59[a]	46.27	31.88

* Comparison are paired t-tests of each exposure category to unexposed women;
[a] $p<0.0001$, [b] $p<0.01$, [c] $p<0.05$

Table 11

Cost, Length of Stay, and Service Intensity Weights (SIW) of Infants Who Were Identified As Prenatally Exposed to Illicit Drugs, by the Prenatal Care Utilization Index (Koteltchuck 1994), New York City Municipal Hospitals, 1990-1992 * N=5409

Variable	No Prenatal Care N=1789	Care Unknown N=1061	Inadequate N=1497	Intermediate N=367	Adequate N=371	Adequate Plus N=324
Mean Cost	15523	11489[a]	9599[a]	9536[a]	10929[a]	13474
Geometric Mean Cost	8489	6957[a]	6030[a]	6047[a]	6130[a]	7104[b]
Mean LOS	22.98	19.02[a]	16.72[a]	15.92[a]	17.42[a]	19.31[b]
Geometric Mean LOS	16.39	13.70[a]	12.08[a]	11.22[a]	11.52[a]	13.01[a]
Mean Nursery Cost	6480	5458[b]	4279[a]	4393[b]	4778[b]	6241
Geometric Mean Nursery Cost	3593	3236[b]	2650[a]	2424[a]	2645[a]	3508
Mean SIW	2.9225	2.2058[a]	1.7969[a]	1.7248[a]	1.9649[a]	2.7136
Geometric Mean SIW	1.6178	1.3438[a]	1.1029[a]	1.0833[a]	1.1010[a]	1.3533[b]

* Comparison are paired t-tests of each prenatal care category to women with no prenatal care;
[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p < 0.05$

Table 11A

Cost, Length of Stay, and Service Intensity Weights (SIW) of Infants Who Were Identified As Prenatally Exposed to Cocaine, by the Prenatal Care Utilization Index (Koteltchuck 1994), New York City Municipal Hospitals, 1990-1992 * N=1338

Variable	No Prenatal Care N=422	Care Unknown N=259	Inadequate N=398	Intermediate N=83	Adequate N=88	Adequate Plus N=88
Mean Cost	15038	9587^{b}	6861^{a}	9067^{c}	10387	11930
Geometric Mean Cost	6438	4628^{a}	3944^{a}	4105^{b}	4722^{c}	4865^{c}
Mean LOS	22.90	17.03^{a}	13.95^{a}	13.26^{a}	18.73	19.00
Geometric Mean LOS	15.18	12.43^{b}	9.77^{a}	8.67^{a}	10.91^{b}	11.59^{c}
Mean Nursery Cost	8708	5155^{b}	3951^{a}	6106	5850	7316
Geometric Mean Nursery Cost	4188	3361^{b}	2416^{a}	2540^{b}	2591^{b}	3394
Mean SIW	2.8921	1.9648^{b}	1.3870^{a}	1.7392^{c}	2.0498	2.5291
Geometric Mean SIW	1.2802	0.9547^{b}	0.7945^{a}	0.7710^{b}	0.9465^{c}	0.6188^{c}

* Comparison are paired t-tests of each prenatal care category to women with no prenatal care;
$^{a}p \leq 0.0001$, $^{b}p \leq 0.01$, $^{c}p < 0.05$

Table 11B

Cost, Length of Stay, and Service Intensity Weights (SIW) of Infants Who Were Identified As Prenatally Exposed to Opiates, by the Prenatal Care Utilization Index (Koteltchuck 1994), New York City Municipal Hospitals, 1990-1992 * N=2394

Variable	No Prenatal Care N=745	Care Unknown N=502	Inadequate N=626	Intermediate N=181	Adequate N=184	Adequate Plus N=156
Mean Cost	13684	11021[b]	10900[b]	9688[a]	12023	14703
Geometric Mean Cost	8604	7708[c]	7555[b]	7405[c]	7480[c]	9414
Mean LOS	21.79	19.57[c]	18.28[a]	17.06[a]	18.16[c]	19.38
Geometric Mean LOS	16.12	14.29[b]	13.87[b]	12.80[b]	12.94[b]	14.59
Mean Nursery Cost	5095	5336	4539	3729[b]	4844	5844
Geometric Mean Nursery Cost	3133	3197	2922	2465[b]	2951	3752[c]
Mean SIW	2.5189	2.1011[c]	2.0075[b]	1.7305[a]	2.1432	2.9471
Geometric Mean SIW	1.5999	1.4769	1.3498[a]	1.3364[b]	1.2969[b]	1.8221

* Comparison are paired t-tests of each prenatal care category to women with no prenatal care;
[a] $p \le 0.0001$, [b] $p \le 0.01$, [c] $p < 0.05$

Table 11C

Cost, Length of Stay, and Service Intensity Weights (SIW) of Infants Who Were Identified As Prenatally Exposed to Opiates Plus Cocaine, by the Prenatal Care Utilization Index (Koteltchuck 1994), New York City Municipal Hospitals, 1990-1992 * N=1407

Variable	No Prenatal Care N=578	Care Unknown N=265	Inadequate N=370	Intermediate N=67	Adequate N=65	Adequate Plus N=62
Mean Cost	18858	14658[c]	11711[a]	12492[c]	12460[c]	13320
Geometric Mean Cost	10721	9136[c]	8022[a]	8022[c]	8518[c]	7555[b]
Mean LOS	25.38	21.40[c]	19.81[a]	20.91	20.06[c]	21.76
Geometric Mean LOS	18.54	15.48[b]	15.18[a]	15.33	14.58[c]	14.57
Mean Nursery Cost	6929	5887	4946[b]	5594	4614[c]	6419
Geometric Mean Nursery Cost	3983	3498	3010[a]	2951[c]	2892[c]	3827
Mean SIW	3.5803	2.7115[b]	2.1662[a]	2.2279[b]	2.0256[a]	2.6682
Geometric Mean SIW	2.0896	1.7419[b]	1.4829[a]	1.4666[b]	1.5593[b]	1.3965[b]

* Comparison are paired t-tests of each prenatal care category to women with no prenatal care;
[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p < 0.05$

Table 12

Cost, Length of Stay, and Service Intensity Weights (SIW) of a Random Sample of Unexposed Infants by the Prenatal Care Utilization Index (Koteltchuck 1994), New York City Municipal Hospitals, 1990-1992 *   N=6992

Variable	No Prenatal Care N=594	Care Unknown N=897	Inadequate N=2405	Intermediate N=1050	Adequate N=1329	Adequate Plus N=717
Mean Cost	4082	3697	2744[c]	2419[b]	2475[b]	6230[b]
Geometric Mean Cost	1900	1933	1844	1772	1790	2322[a]
Mean LOS	5.83	5.69	4.65[b]	4.14[b]	4.29[b]	7.79[b]
Geometric Mean LOS	3.82	3.74	3.52[c]	3.28[a]	3.39[b]	4.26[c]
Mean Nursery Cost	1867	1958	1383[c]	1135[b]	1328[c]	3502[b]
Geometric Mean Nursery Cost	973	963	916	820[b]	889[b]	1196[b]
Mean SIW	0.7206	0.6213	0.4585[b]	0.3602[a]	0.4099[b]	1.1459[b]
Geometric Mean SIW	0.2815	0.2739	0.2603[c]	0.2433[a]	0.2527[b]	0.3430[b]

* Comparison are paired t-tests of each prenatal care category to women with no prenatal care;
[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p < 0.05$

Table 13

Infant Cost, Length of Stay and Service Intensity Weights (SIW) by Type Exposure, New York City Municipal Hospitals, 1990-1992 * N=12401

Variable	Unexposed N=6992	Cocaine N=1338	Opiates N=2394	Cocaine + Opiates N=1407	Marijuana N=201	Other or Unspecified N=69
Mean Cost	3237	10670[a]	12034[a]	15342[a]	4011	11191[a]
Geometric Mean Cost	1891	4908[a]	8047[a]	9293[a]	2102[c]	7138[a]
Mean LOS	5.06	17.98[a]	19.62[a]	22.55[a]	6.69	11.43[a]
Geometric Mean LOS	3.60	11.90[a]	14.58[a]	16.53[a]	4.34[b]	8.76[a]
Mean Nursery Cost	1664	6227[a]	4925[a]	6022[a]	1872	3522[b]
Geometric Mean Nursery Cost	935	3158[a]	3072[a]	3522[a]	1159[b]	2340[a]
Mean SIW	0.5481	2.1142[a]	2.2370[a]	2.8684[a]	0.6543	2.1473[b]
Geometric Mean SIW	0.2671	0.9778[a]	0.6761[a]	1.7593[a]	0.3054[c]	1.3558[a]

* Comparison are paired t-tests of each exposure category to unexposed infants;
[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p < 0.05$

Table 14

Cost, Length of Stay, and Service Intensity Weights (SIW) of Mothers Who Were Identified as Exposed to Illicit Drugs During Pregnancy, by Prenatal Care Utilization Index (Koteltchuck 1994), New York Municipal Hospitals, 1990-1992 * N=5409

Variable	No Prenatal Care N=1789	Care Unknown N=1061	Inadequate N=1497	Intermediate N=367	Adequate N=371	Adequate Plus N=324
Mean Cost	4242	4141[c]	4263	4153	4209	4285
Geometric Mean Cost	3994	3909	4024	3994	4013	4083
Mean LOS	3.96	3.97	4.02	3.69[c]	4.23	4.43
Geometric Mean LOS	3.40	3.43	3.52[c]	3.38	3.55	3.66[c]
Mean SIW	0.6799	0.6833	0.6840	0.6783	0.6903	0.7336[b]
Geometric Mean SIW	0.6438	0.6479	0.6468	0.6386	0.6496	0.6917[b]

* Comparison are paired t-tests of each prenatal care category to women with no prenatal care;
[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p < 0.05$

Table 15

Maternal Cost, Length of Stay and Service Intensity Weights (SIW) by Type Exposure, Pooled Sample, New York City Municipal Hospitals, 1990-1992 * N=12401

Variable	Unexposed N=6992	Cocaine N=1338	Opiates N=2394	Cocaine + Opiates N=1407	Marijuana N=201	Other or Unspecified N=69
Mean Cost	3848	4221[a]	4198[a]	4299[a]	3962	3950
Geometric Mean Cost	3666	3996[a]	3995[a]	4061[a]	3786	3802
Mean LOS	3.70	3.98[c]	3.99[a]	4.07[a]	3.86	4.23
Geometric Mean LOS	3.29	3.41[c]	3.47[a]	3.50[a]	3.42	3.60
Mean SIW	0.6609	0.6795	0.6779[c]	0.7084[a]	0.6449	0.7220
Geometric Mean SIW	0.6234	0.6375[c]	0.6455[a]	0.6678[a]	0.6130	0.6742

* Comparison are paired t-tests of each exposure category to unexposed women;
[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p < 0.05$

Table 16

Loglinear Regressions on Newborn Cost per Discharge of Infants Who Were Identified As Prenatally Exposed to Illicit Drugs, New York City Municipal Hospital System, 1990-1992*

	(1)	(2)	(3)
Substances [q]			
Cocaine	0.753[a]	0.694[a]	0.509[a]
	(0.070)	(0.070)	(0.057)
Opiate	1.278[a]	1.219[a]	1.103[a]
	(0.069)	(0.068)	(0.056)
Opiate + Cocaine	1.392[a]	1.310[a]	1.118[a]
	(0.070)	(0.070)	(0.058)
Alcohol	0.040	0.030	-0.047
	(0.037)	(0.037)	(0.030)
Tobacco	0.034	0.034	-0.006
	(0.027)	(0.027)	(0.022)
Prenatal Care			
Inadequate		-0.287[a]	-0.064[c]
		(0.033)	(0.028)
Intermediate		-0.272[a]	-0.056
		(0.053)	(0.044)
Adequate		-0.239[a]	-0.032
		(0.053)	(0.044)
Adequate plus		-0.113[c]	-0.077[d]
		(0.056)	(0.047)
Care unknown		-0.149[a]	-0.050[d]
		(0.037)	(0.030)
WIC		-0.092[b]	-0.046[c]
		(0.028)	(0.023)
Demographic			
Teens	-0.144[c]	-0.146[c]	-0.104[c]
	(0.065)	(0.065)	(0.053)
Older Than 34	-0.021	-0.023	-0.048
	(0.040)	(0.039)	(0.032)
White non-Hispanic	-0.056	-0.060	0.048
	(0.084)	(0.083)	(0.068)
Puerto Rican	0.034	0.047	0.062
	(0.069)	(0.068)	(0.056)
Dominican	-0.090	-0.077	0.009
	(0.110)	(0.109)	(0.089)
Black non-Hispanic	0.115	0.109[d]	0.046
	(0.070)	(0.066)	(0.054)
Born in US	-0.013	-0.016	0.009
	(0.039)	(0.038)	(0.031)

Table 16 con.

	(1)	(2)	(3)
Socioeconomic			
Unmarried	0.081[c]	0.062	0.075[c]
	(0.042)	(0.041)	(0.033)
High school	0.019	0.062	0.022
	(0.028)	(0.028)	(0.022)
Some college	0.042	0.063	0.029
	(0.049)	(0.048)	(0.039)
College +	-0.233[c]	-0.259[c]	-0.104
	(0.123)	(0.151)	(0.099)
Education unknown	0.084	0.031	0.011
	(0.060)	(0.060)	(0.049)
Obstetrics			
First birth	-0.038	-0.025	-0.059[c]
	(0.037)	(0.037)	(0.030)
Fourth + birth	0.014	0.004	0.016
	(0.031)	(0.030)	(0.025)
Parity unknown	0.002	-0.019	-0.002
	(0.056)	(0.056)	(0.046)
Male infant	-0.027	-0.026	0.032
	(0.024)	(0.024)	(0.020)
Plural birth	0.698[a]	0.687[a]	0.005
	(0.092)	(0.092)	(0.076)
Cesarean section	0.215[a]	0.233[a]	0.101[b]
	(0.034)	(0.034)	(0.028)
Previous fetal loss	0.159	0.139	0.049
	(0.084)	(0.083)	(0.068)
Infant died after delivery	0.006	-0.075	-1.673[a]
	(0.103)	(0.102)	(0.095)
Gestational diabetes		-0.288	0.029
		(0.194)	(0.159)
Gestational hypertention		0.063	0.204[c]
		(0.126)	(0.103)
Anemia		0.032	0.021
		(0.075)	(0.062)
STD		0.156[b]	0.185[b]
		(0.060)	(0.049)

Table 16 con.

	(1)	(2)	(3)
Birth outcomes			
Birth weight (grams)			-0.002[a] (0.000)
Birth weight squared			0.000[a] (0.000)
Preterm delivery			0.118[a] (0.025)
Gestation unknown			0.069[c] (0.032)
N	5340	5340	5331
Adjusted R-squared	0.1547	0.1724	0.4473

* Standard errors are in parentheses. All regressions include controls for hospital of delivery and year of birth.

[q] For all dummy variables yes=1; omitted categories are: marijuana for illicit substances, women 20-34 for mother's age, Hispanics other than Puerto Ricans and Dominicans for race/ethnicity, less than high school for mother's schooling, 1 to 3 previous live births for parity, no care for prenatal care, and deliveries with known gestation after the 37[th] week for preterm births.

[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p<0.05$, [d] $p<0.10$

Table 17

Loglinear Regressions on Newborn Acute Length of Stay of Infants Who Were Identified As Prenatally Exposed to Illicit Drugs, New York City Municipal Hospital System, 1990-1992 *

	(1)	(2)	(3)
Substances [q]			
Cocaine	0.802[a]	0.728[a]	0.612[a]
	(0.061)	(0.061)	(0.056)
Opiate	1.068[a]	0.997[a]	0.916[a]
	(0.060)	(0.059)	(0.055)
Opiate + Cocaine	1.161[a]	1.062[a]	0.938[a]
	(0.061)	(0.061)	(0.057)
Alcohol	0.083[b]	0.070[c]	0.023
	(0.032)	(0.032)	(0.029)
Tobacco	0.009	0.012	-0.011
	(0.023)	(0.023)	(0.021)
Prenatal Care			
Inadequate		-0.265[a]	-0.126[a]
		(0.029)	(0.028)
Intermediate		-0.302[a]	-0.165[b]
		(0.046)	(0.043)
Adequate		-0.284[a]	-0.152[b]
		(0.046)	(0.043)
Adequate plus		-0.213[a]	-0.199[a]
		(0.049)	(0.046)
Care unknown		-0.115[a]	-0.069[c]
		(0.032)	(0.030)
WIC		-0.120[b]	-0.090[a]
		(0.024)	(0.022)
Demographic			
Teens	-0.307[a]	-0.311[a]	-0.296[a]
	(0.057)	(0.056)	(0.052)
Older Than 34	0.109[b]	0.105[b]	0.088[a]
	(0.035)	(0.034)	(0.032)
White non-Hispanic	-0.039	-0.044	0.020
	(0.074)	(0.072)	(0.067)
Puerto Rican	0.028	-0.043	0.052
	(0.060)	(0.059)	(0.055)
Dominican	-0.098	-0.079	-0.028
	(0.097)	(0.095)	(0.088)
Black non-Hispanic	-0.001	-0.008	-0.047
	(0.059)	(0.057)	(0.053)
Born in US	0.022	0.018	0.031
	(0.034)	(0.033)	(0.031)

Table 17 con.

	(1)	(2)	(3)
Socioeconomic			
Unmarried	0.140[a]	0.116[a]	0.119[a]
	(0.036)	(0.036)	(0.033)
High school	0.011	0.021	0.019
	(0.024)	(0.024)	(0.022)
Some college	-0.001	0.020	0.005
	(0.043)	(0.042)	(0.039)
College +	-0.320[b]	-0.294[b]	-0.202[c]
	(0.107)	(0.105)	(0.098)
Education unknown	0.107[c]	0.044	0.020
	(0.053)	(0.052)	(0.048)
Obstetrics			
First birth	-0.120[b]	-0.103[b]	-0.119[a]
	(0.033)	(0.032)	(0.030)
Fourth + birth	0.098[b]	0.087[b]	0.095[a]
	(0.027)	(0.026)	(0.024)
Parity unknown	0.015	-0.005	0.003
	(0.049)	(0.048)	(0.045)
Male infant	-0.024	-0.024	0.013
	(0.021)	(0.029)	(0.019)
Plural birth	0.190[c]	0.186[c]	-0.184[c]
	(0.081)	(0.080)	(0.075)
Cesarean section	0.127[a]	0.151[a]	0.082[b]
	(0.030)	(0.029)	(0.027)
Previous fetal loss	0.066	0.049	-0.003
	(0.073)	(0.072)	(0.067)
Infant died after delivery	-1.815[a]	-1.903[a]	-2.670[a]
	(0.090)	(0.089)	(0.094)
Gestational diabetes		-0.393[c]	-0.191
		(0.169)	(0.157)
Gestational hypertention		0.045	0.141
		(0.110)	(0.102)
Anemia		0.003	-0.008
		(0.066)	(0.061)
STD		0.125[b]	0.144[b]
		(0.054	(0.048)

Table 17 con.

	(1)	(2)	(3)
Birth outcomes			
Birth weight (grams)			-0.001[a] (0.000)
Birth weight squared			0.000[a] (0.000)
Preterm delivery			0.132[a] (0.025)
Gestation unknown			0.109[b] (0.032)
N	5340	5340	5331
Adjusted R-squared	0.2023	0.2278	0.3319

* Standard errors are in parentheses. All regressions include controls for hospital of delivery and year of birth.

[q] For all dummy variables yes=1; omitted categories are: marijuana for illicit substances, women 20-34 for mother's age, Hispanics other than Puerto Ricans and Dominicans for race/ethnicity, less than high school for mother's schooling, 1 to 3 previous live births for parity, no care for prenatal care, and deliveries with known gestation after the 37[th] week for preterm births.

Table 18

Loglinear Regressions on Newborn Nursery Cost of Infants Who Were Identified As Prenatally Exposed to Illicit Drugs, New York City Municipal Hospital System, 1990-1992 *

	(1)	(2)	(3)
Substances [q]			
Cocaine	0.719[a]	0.641[a]	0.517[a]
	(0.074)	(0.073)	(0.066)
Opiate	0.895[a]	0.819[a]	0.745[a]
	(0.072)	(0.071)	(0.065)
Opiate + Cocaine	1.005[a]	0.903[a]	0.775[a]
	(0.074)	(0.073)	(0.066)
Alcohol	0.076[c]	0.064[d]	0.002
	(0.039)	(0.038)	(0.034)
Tobacco	0.022	0.028	0.007
	(0.028)	(0.028)	(0.025)
Prenatal Care			
Inadequate		-0.261[a]	-0.088[b]
		(0.035)	(0.033)
Intermediate		-0.284[a]	-0.124[b]
		(0.055)	(0.051)
Adequate		-0.287[a]	-0.125[b]
		(0.055)	(0.051)
Adequate plus		-0.097[d]	0.077
		(0.059)	(0.054)
Care unknown		-0.097[b]	-0.038
		(0.038)	(0.035)
WIC		-0.148[a]	-0.116[a]
		(0.029)	(0.026)
Demographic			
Teens	-0.355[a]	-0.358[a]	-0.337[a]
	(0.069)	(0.068)	(0.061)
Older Than 34	0.107[b]	0.101[c]	0.072[d]
	(0.042)	(0.041)	(0.037)
White non-Hispanic	-0.006	-0.011	0.072
	(0.089)	(0.088)	(0.079)
Puerto Rican	0.112	0.125[d]	0.138[c]
	(0.072)	(0.071)	(0.064)
Dominican	-0.153	-0.138	-0.091
	(0.114)	(0.112)	(0.102)
Black non-Hispanic	0.027	0.019	-0.026
	(0.070)	(0.069)	(0.062)
Born in US	0.047	0.040	0.066[d]
	(0.041)	(0.040)	(0.036)

Table 18 con.

	(1)	(2)	(3)
Socioeconomic			
Unmarried	0.145[b]	0.124[b]	0.137[b]
	(0.043)	(0.043)	0.039
High school	-0.025	-0.018	-0.011
	(0.029)	(0.029)	(0.026)
Some college	0.002	0.026	0.003
	(0.051)	(0.050)	(0.045)
College +	-0.397[b]	-0.382[b]	-0.250[c]
	(0.127)	(0.125)	(0.113)
Education unknown	0.129[c]	0.063	0.040
	(0.063)	(0.063)	(0.057)
Obstetrics			
First birth	-0.040	-0.025	-0.054
	(0.039)	(0.039)	(0.035
Fourth + birth	0.089[b]	0.082[b]	0.090[b]
	(0.032)	(0.032)	(0.029)
Parity unknown	0.036	0.011	0.028
	(0.059)	(0.058)	(0.029)
Male infant	-0.014	-0.016	0.022
	(0.025)	(0.025)	(0.023)
Plural birth	0.261[b]	0.249[c]	-0.188[c]
	(0.103)	(0.102)	(0.094)
Cesarean section	0.190[a]	0.216[a]	0.113[b]
	(0.036)	(0.036)	(0.033)
Previous fetal loss	0.056	0.037	-0.020
	(0.089)	(0.088)	(0.079)
Infant died after delivery	-1.168[a]	-1.252[a]	-2.479[a]
	(0.127)	(0.126)	(0.129)
Gestational diabetes		-0.689[b]	-0.466[c]
		(0.207)	(0.187)
Gestational hypertention		0.150	0.234[d]
		(0.135)	(0.122)
Anemia		-0.068	0.234
		(0.078)	(0.122)
STD		0.060	0.091
		(0.062)	(0.057)

Table 18 con.

	(1)	(2)	(3)
Birth outcomes			
Birth weight (grams)			-0.002[a] (0.000)
Birth weight squared			0.000[a] (0.000)
Preterm delivery			0.138[a] (0.029)
Gestation unknown			0.136[b] (0.038)
N	5014	5014	5007
Adjusted R-squared	0.1801	0.2019	0.3459

* Standard errors are in parentheses. All regressions include controls for hospital of delivery and year of birth.

[q] For all dummy variables yes=1; omitted categories are: marijuana for illicit substances, women 20-34 for mother's age, Hispanics other than Puerto Ricans and Dominicans for race/ethnicity, less than high school for mother's schooling, 1 to 3 previous live births for parity, no care for prenatal care, and deliveries with known gestation after the 37[th] week for preterm births.
[a] p<0.0001, [b] p<0.01, [c] p<0.05, [d] p<0.10

Table 19

Loglinear Regressions on Newborn Service Intensity Weights of Infants Who Were Identified As Prenatally Exposed to Illicit Drugs, New York City Municipal Hospital System, 1990-1992 *

	(1)	(2)	(3)
Substances [q]			
Cocaine	1.067[a]	0.998[a]	0.791[a]
	(0.073)	(0.072)	(0.058)
Opiate	1.548[a]	1.479[a]	1.343[a]
	(0.071)	(0.071)	(0.057)
Opiate + Cocaine	1.707[a]	1.611[a]	1.393[a]
	(0.073)	(0.073)	(0.058)
Alcohol	0.061	0.049	-0.037
	(0.038)	(0.038)	(0.030)
Tobacco	-0.006	-0.004	-0.047
	(0.028)	(0.028)	(0.022)
Prenatal Care			
Inadequate		-0.319[a]	-0.075[b]
		(0.034)	(0.029)
Intermediate		-0.320[a]	-0.083[d]
		(0.055)	(0.044)
Adequate		-0.292[a]	-0.055
		(0.055)	(0.045)
Adequate plus		-0.147[b]	-0.109[c]
		(0.058)	(0.047)
Care unknown		-0.174[a]	-0.072[c]
		(0.038)	(0.031)
WIC		-0.107[b]	-0.055[b]
		(0.029)	(0.023)
Demographic			
Teens	-0.172[b]	-0.173[b]	-0.129[b]
	(0.067)	(0.067)	(0.054)
Older Than 34	0.015	0.013	-0.017
	(0.041)	(0.041)	(0.033)
White non-Hispanic	-0.076	-0.083	0.036
	(0.087)	(0.086)	0.069
Puerto Rican	0.032	0.046	0.056
	(0.072)	(0.070)	(0.057)
Dominican	-0.164	-0.151	-0.031
	(0.115)	(0.113)	(0.091)
Black non-Hispanic	0.126[d]	0.118[d]	0.046
	(0.069)	0.068	(0.055)
Born in US	-0.015	-0.019	0.005
	(0.040)	(0.040)	(0.032)

Table 19 con.

	(1)	(2)	(3)
Socioeconomic			
Unmarried	0.078[d]	0.057	0.069[c]
	(0.043)	(0.042)	(0.034)
High school	0.011	0.019	0.016
	(0.029)	(0.029)	(0.023)
Some college	0.054	0.077	0.042
	(0.051)	(0.050)	(0.040)
College +	-0.307[b]	-0.281[c]	-0.114
	(0.127)	(0.125)	(0.100)
Education unknown	0.055	-0.006	-0.034
	(0.062)	(0.062)	(0.050)
Obstetrics			
First birth	-0.043	-0.026	-0.061[c]
	(0.039)	(0.038)	(0.031)
Fourth + birth	-0.021	-0.031	-0.015
	(0.032)	(0.031)	(0.025)
Parity unknown	0.000	-0.025	-0.007
	(0.058)	(0.058)	(0.046)
Male infant	-0.042[d]	-0.040	0.026
	(0.025)	(0.025)	(0.020)
Plural birth	0.649[a]	0.639[a]	-0.087
	(0.096)	0.095	(0.078)
Cesarean section	0.235[a]	0.258[a]	0.122[a]
	(0.035)	(0.035)	(0.028)
Previous fetal loss	0.126	0.105	0.006
	(0.087)	(0.096)	(0.069)
Infant died after delivery	0.044	-0.047	-1.675[a]
	(0.107)	()0.106	(0.096)
Gestational diabetes		-0.265	0.101
		(0.201)	(0.161)
Gestational hypertention		-0.014	0.153
		(0.131)	(0.105)
Anemia		0.022	0.007
		(0.078)	(0.062)
STD		0.126[c]	0.156[b]
		(0.062)	(0.050)

Table 19 con.

	(1)	(2)	(3)
Birth outcomes			
Birth weight (grams)			-0.002[a] (0.000)
Birth weight squared			0.000[a] (0.000)
Preterm delivery			0.150[a] (0.026)
Gestation unknown			0.089[b] (0.033)
N	5335	5335	5326
Adjusted R-squared	0.1634	0.1843	0.4764

* Standard errors are in parentheses. All regressions include controls for hospital of delivery and year of birth.

[q] For all dummy variables yes=1; omitted categories are: marijuana for illicit substances, women 20-34 for mother's age, Hispanics other than Puerto Ricans and Dominicans for race/ethnicity, less than high school for mother's schooling, 1 to 3 previous live births for parity, no care for prenatal care, and deliveries with known gestation after the 37th week for preterm births.
[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p < 0.05$, [d] $p < 0.10$

Table 20

Loglinear Regressions on Newborn Cost per Discharge of a Random Sample of Unexposed Infants New York City Municipal Hospital System, 1990-1992*

	(1)	(2)	(3)
Substances[a]			
Tobacco	0.036	0.035	-0.024
	(0.032)	(0.032)	(0.024)
Alcohol	-0.068	-0.068	-0.018
	(0.116)	(0.115)	(0.086)
Prenatal Care			
Inadequate		-0.061[c]	0.032
		(0.029)	(0.022)
Intermediate		-0.101[b]	0.011
		(0.032)	(0.024)
Adequate		-0.090[b]	0.016
		(0.032)	(0.024)
Adequate plus		0.128[b]	0.039
		(0.035)	(0.027)
Care unknown		-0.007	0.028
		(0.033)	(0.026)
WIC		-0.059[b]	-0.023[d]
		(0.016)	(0.012)
Demographic			
Teens	-0.010	-0.012	-0.034[c]
	(0.022)	(0.022)	(0.016)
Older Than 34	0.038	0.015	0.020
	(0.027)	(0.027)	(0.020)
White non-Hispanic	-0.027	-0.030	-0.008
	(0.032)	(0.032)	(0.024)
Puerto Rican	-0.008	-0.012	-0.009
	(0.026)	(0.026)	(0.019)
Dominican	-0.025	-0.023	-0.003
	(0.025)	(0.025)	(0.019)
Black non-Hispanic	0.078[b]	0.067[b]	0.017
	0.023	(0.023)	(0.017)
Born in US	0.026	0.023	0.004
	(0.019)	(0.019)	(0.014)

Table 20 con.

	(1)	(2)	(3)
Socioeconomic			
Unmarried	0.019	0.017	-0.011
	(0.016)	(0.016)	(0.012)
High school	-0.055[b]	-0.054[b]	-0.031[c]
	(0.017)	(0.017)	(0.013)
Some college	0.047[d]	0.044[d]	0.014
	(0.027)	(0.026)	(0.035)
College +	-0.093[c]	-0.088[d]	-0.042
	(0.047)	(0.047)	(0.034)
Education unknown	-0.009	-0.024	-0.086[c]
	(0.046)	(0.046)	(0.034)
Obstetrics			
First birth	0.035[c]	0.034[c]	0.022[d]
	(0.017)	(0.017)	(0.012)
Fourth + birth	0.056[d]	0.056[d]	0.054[c]
	(0.030)	(0.030[d])	(0.022)
Parity unknown	0.012	0.003	-0.014
	(0.035)	(0.035)	(0.026)
Male infant	-0.016	-0.016	0.016
	(0.014)	(0.014)	(0.010)
Plural birth	0.427[a]	0.396[a]	-0.065
	(0.064)	(0.064)	(0.048)
Cesarean section	0.239[a]	0.228[a]	0.112[a]
	(0.019)	(0.019)	(0.014)
Previous fetal loss	0.126[c]	0.125[c]	0.080[d]
	(0.061)	(0.060)	0.045
Infant died after delivery	1.189[a]	1.137[a]	-1.887[a]
	(0.107)	(0.106)	(0.090)
Gestational diabetes		0.120[b]	0.173[a]
		(0.043)	(0.032)
Gestational hypertension		0.165[b]	0.049
		(0.054)	(0.040)
Anemia		0.022	0.018
		(0.057)	(0.042)
STD		0.221[b]	0.223[a]
		(0.061)	0.045

Table 20 con.

	(1)	(2)	(3)
Birth outcomes			
Birth weight (grams)			-0.003[a] (0.000)
Birth weight squared			0.000[a] (0.000)
Preterm delivery			0.180[a] (0.019)
Gestation unknown			0.013 (0.026)
N	6983	6983	6983
Adjusted R-squared	0.0983	0.1131	0.5109

* Standard errors are in parentheses. All regressions include controls for hospital of delivery and year of birth.

[q] For all dummy variables yes=1; omitted categories are : women 20-34 for mother's age, Hispanics other than Puerto Ricans and Dominicans for race/ethnicity, less than high school for mother's schooling, 1 to 3 previous live births for parity, no care for prenatal care, and deliveries with known gestation after the 37[th] week for preterm births.
[a] p≤ 0.0001, [b] p≤0.01, [c] p<0.05, [d] p<0.10

Table 21

Loglinear Regressions on Newborn Acute length of Stay of a Random Sample of Unexposed Infants New York City Municipal Hospital System, 1990-1992*

	(1)	(2)	(3)
Substances			
Tobacco	0.063[c]	0.058[d]	0.016
	(0.031)	(0.030)	(0.026)
Alcohol	-0.073	-0.074	-0.043
	(0.110)	(0.109)	(0.094)
Prenatal Care			
Inadequate		-0.100[b]	-0.035
		(0.027)	(0.024)
Intermediate		-0.144[a]	-0.064[c]
		(0.030)	(0.027)
Adequate		-0.129[a]	-0.054[c]
		(0.030)	(0.026)
Adequate plus		0.042	-0.027
		(0.033)	(0.029)
Care unknown		-0.021	0.004
		(0.031)	(0.028)
WIC		-0.068[a]	-0.042[b]
		(0.016)	(0.013)
Demographic			
Teens	-0.007	-0.012	-0.028
	(0.021)	(0.020)	(0.018)
Older Than 34	0.079[b]	0.065[c]	0.068[b]
	(0.025)	(0.025)	(0.022)
White non-Hispanic	-0.003	-0.006	0.009
	(0.030)	(0.030)	(0.026)
Puerto Rican	0.004	0.002	0.003
	(0.024)	(0.024)	(0.021)
Dominican	0.012	0.016	0.029
	(0.024)	(0.024)	(0.020)
Black non-Hispanic	0.098[a]	0.087[a]	0.053[b]
	(0.022)	(0.025)	(0.019)
Born in US	0.019	0.013	0.000
	(0.018)	(0.018)	(0.015)

Table 21 con.

	(1)	(2)	(3)
Socioeconomic			
Unmarried	0.020	0.017	-0.002
	(0.015)	(0.015)	(0.013)
High school	-0.054[b]	-0.051[b]	-0.034[c]
	(0.016)	(0.016)	(0.014)
Some college	0.049[d]	0.050[c]	0.030
	(0.025)	(0.025)	(0.022)
College +	-0.128[b]	-0.121[c]	-0.088
	(0.044)	(0.044)	(0.038)
Education unknown	0.063	0.041	-0.001
	(0.043)	(0.043)	(0.037)
Obstetrics			
First birth	0.049[b]	0.049[b]	0.040[b]
	(0.015)	(0.015)	(0.013)
Fourth + birth	0.085[b]	0.082[b]	0.079[b]
	(0.028)	(0.028)	(0.024)
Parity unknown	0.004	-0.007	-0.018
	(0.033)	(0.033)	0.029
Male infant	0.010	0.009	0.031[b]
	(0.013)	(0.013)	(0.012)
Plural birth	0.349[a]	0.323[a]	-0.001
	(0.060)	(0.060)	(0.053)
Cesarean section	0.638[a]	0.632[a]	0.552[a]
	(0.018)	(0.018)	(0.016)
Previous fetal loss	0.097[d]	0.096[d]	0.065
	(0.057)	(0.057)	(0.049)
Infant died after delivery	-0.455[a]	-0.515[a]	-2.604[a]
	(0.101)	(0.101)	(0.100)
Gestational diabetes		0.003	0.043
		(0.041)	(0.035)
Gestational hypertension		0.123[c]	0.041
		(0.051)	(0.044)
Anemia		0.048	0.043
		(0.054)	(0.046)
STD		0.241[a]	0.243[a]
		(0.057)	(0.050)

Table 21 con.

	(1)	(2)	(3)
Birth outcomes			
Birth weight (grams)			-0.002[a] (0.000)
Birth weight squared			0.000[a] (0.000)
Preterm delivery			0.168[a] (0.021)
Gestation unknown			0.008 (0.029)
N	6983	6983	6983
Adjusted R-squared	0.1808	0.1937	0.3926

* Standard errors are in parentheses. All regressions include controls for hospital of delivery and year of birth.

[q] For all dummy variables yes=1; omitted categories are: women 20-34 for mother's age, Hispanics other than Puerto Ricans and Dominicans for race/ethnicity, less than high school for mother's schooling, 1 to 3 previous live births for parity, no care for prenatal care, and deliveries with known gestation after the 37[th] week for preterm births.
[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p < 0.05$, [d] $p < 0.10$

Table 22

Loglinear Regressions on Newborn Nursery Costs of a Random Sample of Unexposed Infants New York City Municipal Hospital System, 1990-1992*

	(1)	(2)	(3)
Substances			
Tobacco	0.042	0.037	-0.004
	(0.035)	(0.035)	(0.030)
Alcohol	-0.016	-0.019	0.011
	(0.124)	(0.123)	(0.107)
Prenatal Care			
Inadequate		-0.101[b]	-0.034
		(0.031)	(0.028)
Intermediate		-0.152[a]	-0.065[c]
		(0.035)	(0.028)
Adequate		-0.139[a]	-0.051[d]
		(0.034)	(0.030)
Adequate plus		0.062	-0.016
		(0.039)	(0.034)
Care unknown		-0.027	-0.005
		(0.036)	(0.032)
WIC		-0.078[a]	-0.046[b]
		(0.018)	(0.016)
Demographic			
Teens	-0.016	-0.021	-0.030
	(0.024)	(0.023)	(0.020)
Older Than 34	0.092[b]	0.073[c]	0.072[b]
	(0.029)	(0.029)	(0.025)
White non-Hispanic	-0.009	-0.013	0.011
	(0.035)	(0.035)	(0.030)
Puerto Rican	0.034	0.034	0.030
	(0.028)	(0.028)	(0.024)
Dominican	0.026	0.028	0.039
	(0.027)	(0.027)	(0.023)
Black non-Hispanic	0.107[a]	0.096[b]	0.063[b]
	(0.025)	(0.025)	(0.022)
Born in US	0.014	0.008	-0.012
	(0.020)	(0.020)	(0.018)

Table 22 con.

	(1)	(2)	(3)
Socioeconomic			
Unmarried	0.028	0.025	-0.000
	(0.017)	(0.017)	(0.015)
High school	-0.057[b]	-0.054[b]	-0.042[b]
	(0.018)	(0.018)	(0.016)
Some college	0.031	0.033	0.011
	(0.029)	(0.029)	(0.025)
College +	-0.158[b]	-0.148[b]	-0.117[b]
	(0.051)	(0.051)	(0.025)
Education unknown	0.103[c]	0.080	0.024
	(0.051)	(0.051)	(0.044)
Obstetrics			
First birth	0.060[b]	0.060[b]	0.052[b]
	(0.018)	(0.018)	(0.015)
Fourth + birth	0.096[b]	0.094[b]	0.089[b]
	(0.033)	(0.033)	(0.029)
Parity unknown	0.034	0.021	0.002
	(0.038)	(0.038)	(0.033)
Male infant	0.011	0.009	0.032[d]
	(0.015)	(0.015)	(0.013)
Plural birth	0.279[a]	0.247[b]	-0.109[d]
	(0.071)	(0.071)	()0.062
Cesarean section	0.674[a]	0.667[a]	0.576[a]
	(0.021)	(0.021)	(0.019)
Previous fetal loss	0.131[c]	0.131[c]	0.090
	(0.066)	(0.066)	(0.057)
Infant died after delivery	-0.040	-0.116	-2.802[a]
	(0.140)	(0.139)	(0.137)
Gestational diabetes		0.004	0.055
		(0.047)	(0.041)
Gestational hypertension		0.147[c]	0.055
		(0.047	(0.053)
Anemia		-0.005	0.025
		(0.063)	(0.055)
STD		0.245[a]	0.246[a]
		(0.066)	(0.057)

Table 22 con.

	(1)	(2)	(3)
Birth outcomes			
Birth weight (grams)			-0.003[a]
			(0.000)
Birth weight squared			0.000[a]
			(0.000)
Preterm delivery			0.185[a]
			(0.025)
Gestation unknown			0.025
			(0.034)
N	6755	6755	6755
Adjusted R-squared	0.2727	0.2836	0.4567

* Standard errors are in parentheses. All regressions include controls for hospital of delivery and year of birth.

[q] For all dummy variables yes=1; omitted categories are: women 20-34 for mother's age, Hispanics other than Puerto Ricans and Dominicans for race/ethnicity, less than high school for mother's schooling, 1 to 3 previous live births for parity, no care for prenatal care, and deliveries with known gestation after the 37th week for preterm births.
[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p < 0.05$, [d] $p < 0.10$

Table 23

Loglinear Regressions on Newborn Service Intensity Weights of a Random Sample of Unexposed Infants New York City Municipal Hospital System, 1990-1992*

	(1)	(2)	(3)
Substances			
Tobacco	0.052	0.050	-0.022
	(0.037)	(0.037)	(0.027)
Alcohol	-0.090	-0.092	-0.032
	(0.134)	(0.132)	(0.098)
Prenatal Care			
Inadequate		-0.076[c]	0.028
		(0.033)	(0.025)
Intermediate		-0.128[b]	0.001
		(0.037)	(0.028)
Adequate		-0.103[b]	0.018
		(0.036)	(0.027)
Adequate plus		0.140[b]	0.033
		(0.041)	(0.031)
Care unknown		-0.028	0.014
		(0.038)	(0.029)
WIC		-0.075[a]	-0.034[c]
		(0.019)	(0.014)
Demographic			
Teens	-0.004	-0.005	-0.030
	(0.025)	(0.025)	(0.018)
Older Than 34	0.059[d]	0.029	0.036
	(0.031)	(0.031)	(0.023)
White non-Hispanic	-0.044	-0.047	-0.019
	(0.037)	(0.031)	(0.027)
Puerto Rican	-0.009	-0.014	-0.012
	(0.030)	(0.030)	(0.022)
Dominican	-0.019	-0.016	0.010
	(0.029)	(0.029)	(0.021)
Black non-Hispanic	0.081[b]	0.068[b]	0.014
	(0.027)	(0.026)	(0.019)
Born in US	0.031	0.029	0.006
	(0.022)	(0.022)	(0.016)

Table 23 con.

	(1)	(2)	(3)
Socioeconomic			
Unmarried	0.024 (0.019)	0.022 (0.018)	-0.010 (0.014)
High school	-0.053[b] (0.020)	-0.052[b] (0.020)	-0.029[c] (0.014)
Some college	0.061 (0.031)	0.058 (0.030)	0.021 (0.022)
College +	-0.096[d] (0.031)	-0.091[d] (0.054)	-0.038 (0.040)
Education unknown	-0.017 (0.053)	-0.036 (0.053)	-0.106[b] (0.040)
Obstetrics			
First birth	0.049[b] (0.019)	0.047[b] (0.019)	0.034[b] (0.014)
Fourth + birth	0.046 (0.035)	0.046 (0.035)	0.043[d] (0.025)
Parity unknown	0.033 (0.041)	0.021 (0.041)	-0.003 (0.030)
Male infant	-0.013 (0.016)	-0.013 (0.016)	0.025[c] (0.012)
Plural birth	0.498[a] (0.074)	0.462[a] (0.073)	-0.079 (0.055)
Cesarean section	0.277[a] (0.022)	0.264[a] (0.022)	0.133[a] (0.017)
Previous fetal loss	0.136[d] (0.070)	0.137[c] (0.069)	0.085[d] (0.051)
Infant died after delivery	1.611[a] (0.123)	1.550[a] (0.122)	-1.948[a] (0.104)
Gestational diabetes		0.195[a] (0.050)	0.256[a] (0.037)
Gestational hypertension		0.176[b] (0.062)	0.038 (0.046)
Anemia		0.009 (0.066)	0.016 (0.048)
STD		0.267[a] (0.070)	0.268[a] (0.052)

Table 23 con.

	(1)	(2)	(3)
Birth outcomes			
Birth weight (grams)			-0.004[a] (0.000)
Birth weight squared			0.000[a] (0.000)
Preterm delivery			0.213[a] (0.022)
Gestation unknown			0.017 (0.030)
N	6975	6975	6975
Adjusted R-squared	0.0659	0.0823	0.4950

* Standard errors are in parentheses. All regressions include controls for hospital of delivery and year of birth.

[q] For all dummy variables yes=1; omitted categories are: women 20-34 for mother's age, Hispanics other than Puerto Ricans and Dominicans for race/ethnicity, less than high school for mother's schooling, 1 to 3 previous live births for parity, no care for prenatal care, and deliveries with known gestation after the 37th week for preterm births.
[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p < 0.05$, [d] $p < 0.10$

Table 24

Loglinear Regressions on Newborn Cost per Discharge of a Pooled Sample of Exposed and Unexposed Infants, New York City Municipal Hospital System, 1990-1992*

	(1)	(2)	(3)
Substances[q]			
Cocaine	0.837[a]	0.781[a]	0.541[a]
	(0.026)	(0.026)	(0.021)
Opiate	1.362[a]	1.313[a]	1.136[a]
	(0.216)	(0.022)	(0.017)
Opiate + Cocaine	1.478[a]	1.409[a]	1.153[a]
	(0.026)	(0.027)	(0.022)
Marijuana	0.038	0.028	0.003
	(0.055)	(0.054)	(0.043)
Alcohol	0.018	0.011	-0.067[b]
	(0.030)	(0.030)	(0.023)
Tobacco	0.041[c]	0.037[d]	-0.007
	(0.019)	(0.019)	(0.015)
Prenatal Care			
Inadequate		-0.200[a]	-0.024
		(0.021)	(0.017)
Intermediate		-0.221[a]	-0.038[d]
		(0.027)	(0.022)
Adequate		-0.204[a]	-0.028
		(0.026)	(0.021)
Adequate plus		-0.009	-0.007
		(0.030)	(0.024)
Care unknown		-0.122[a]	-0.038[c]
		(0.024)	(0.019)
WIC		-0.081[a]	-0.037[b]
		(0.015)	(0.012)
Demographic			
Teens	-0.028	-0.028	-0.042[c]
	(0.023)	(0.023)	(0.018)
Older Than 34	0.009	-0.003	-0.012
	(0.023)	(0.023)	(0.018)
White non-Hispanic	-0.036	-0.043	0.010
	(0.033)	(0.033)	(0.026)
Puerto Rican	0.008	0.006	0.012
	(0.025)	(0.025)	(0.020)
Dominican	-0.033	-0.027	0.002
	(0.029)	()0.029	(0.023)
Black non-Hispanic	0.094[a]	0.082[b]	0.022
	(0.024)	(0.024)	(0.019)
Born in US	0.009	0.004	0.000
	(0.018)	(0.018)	(0.014)

Table 24 con.

	(1)	(2)	(3)
Socioeconomic			
Unmarried	0.036[c]	0.029[d]	0.014
	(0.017)	(0.017)	(0.013)
High school	-0.025	-0.021	-0.013
	(0.015)	(0.015)	(0.012)
Some college	0.048[d]	0.054[c]	0.020
	(0.025)	(0.025)	(0.020)
College +	-0.129[b]	-0.116[c]	-0.047
	(0.050)	(0.049)	(0.039)
Education unknown	0.026	-0.008	-0.048[d]
	(0.036)	(0.036)	(0.029)
Obstetrics			
First birth	0.016	0.016	-0.006
	(0.017)	(0.017)	(0.013)
Fourth + birth	0.033	0.026	0.030[d]
	(0.021)	(0.021)	(0.016)
Parity unknown	0.014	-0.004	-0.005
	(0.032)	(0.032)	(0.025)
Male infant	-0.020	-0.020	0.023[c]
	(0.013)	(0.018)	(0.010)
Plural birth	0.577[a]	0.548[a]	-0.034
	(0.055)	(0.055)	(0.044)
Cesarean section	0.232[a]	0.233[a]	0.118[a]
	(0.018)	(0.018)	(0.014)
Previous fetal loss	0.151[b]	0.145[b]	0.064
	(0.051)	(0.050)	(0.044)
Infant died after delivery	0.419[a]	0.317[a]	-1.717[a]
	(0.074)	(0.070)	(0.064)
Gestational diabetes		0.085[d]	0.164[a]
		(0.050)	(0.040)
Gestational hypertension		0.133[c]	0.102[c]
		(0.056)	(0.044)
Anemia		0.026	0.017
		(0.047)	(0.037)
STD		0.166[a]	0.188[a]
		(0.041)	(0.037)

Table 24 con.

	(1)	(2)	(3)
Birth outcomes			
Birth weight (grams)			-0.002[a] (0.000)
Birth weight squared			0.000[a] (0.000)
Preterm delivery			0.148[a] (0.016)
Gestation unknown			0.057[b] (0.021)
N	12331	12331	12331
Adjusted R-squared	0.4725	0.4811	0.6740

* Standard errors are in parentheses. All regressions include controls for hospital of delivery and year of birth.

[q] For all dummy variables yes=1; omitted categories are: unexposed for illicit substances, women 20-34 for mother's age, Hispanics other than Puerto Ricans and Dominicans for race/ethnicity, less than high school for mother's schooling, 1 to 3 previous live births for parity, no care for prenatal care, and deliveries with known gestation after the 37[th] week for preterm births.

[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p < 0.05$, [d] $p < 0.10$

Table 25

Loglinear Regressions on Newborn Acute Care Length of Stay of a Pooled Sample of Exposed and Unexposed Infants, New York City Municipal Hospital System, 1990-1992*

	(1)	(2)	(3)
Substances [q]			
Cocaine	1.071[a]	0.994[a]	0.838[a]
	(0.024)	(0.024)	(0.023)
Opiate	1.281[a]	1.210[a]	1.091[a]
	(0.019)	(0.020)	(0.018)
Opiate + Cocaine	1.380[a]	1.285[a]	1.118[a]
	(0.024)	(0.025)	(0.023)
Marijuana	0.119[c]	0.105[c]	0.088[d]
	(0.050)	(0.050)	(0.045)
Alcohol	0.064[c]	0.053[d]	0.006
	(0.027)	(0.027)	(0.025)
Tobacco	0.045[c]	0.042[c]	0.013
	(0.018)	(0.017)	(0.016)
Prenatal Care			
Inadequate		-0.226[a]	-0.112[a]
		(0.019)	(0.018)
Intermediate		-0.275[a]	-0.155[a]
		(0.024)	(0.023)
Adequate		-0.262[a]	-0.145[a]
		(0.024)	(0.022)
Adequate plus		-0.110[a]	-0.118[a]
		(0.027)	(0.025)
Care unknown		-0.115[a]	-0.067[b]
		(0.022)	(0.020)
WIC		-0.108[a]	-0.079[a]
		(0.014)	(0.012)
Demographic			
Teens	-0.066[b]	-0.070[b]	-0.080[a]
	(0.022)	(0.021)	(0.019)
Older Than 34	0.092[a]	0.082[a]	0.077[a]
	(0.021)	(0.021)	(0.019)
White non-Hispanic	0.015	0.004	0.042
	(0.030)	(0.030)	(0.027)
Puerto Rican	0.060[b]	0.061[b]	0.065[b]
	(0.023)	(0.023)	(0.021)
Dominican	0.000	0.007	0.029
	(0.027)	(0.026)	(0.024)
Black non-Hispanic	0.089[a]	0.076[b]	0.040[c]
	(0.022)	(0.022)	(0.020)
Born in US	0.014	0.005	0.001
	(0.017)	(0.026)	(0.015)

Table 25 con.

	(1)	(2)	(3)
Socioeconomic			
Unmarried	0.054[b]	0.045[b]	0.033[c]
	(0.016)	(0.015)	(0.014)
High school	-0.021	-0.015	-0.011
	(0.014)	(0.014)	(0.013)
Some college	0.040[d]	0.051[c]	0.030
	(0.023)	(0.023)	(0.021)
College +	-0.161[b]	-0.148[b]	-0.104[c]
	(0.046)	(0.046)	(0.041)
Education unknown	0.073[c]	0.023	-0.002
	(0.034)	(0.033)	(0.030)
Obstetrics			
First birth	0.012	0.016	0.001
	(0.015)	(0.015)	(0.014)
Fourth + birth	0.116[a]	0.106[a]	0.108[a]
	(0.019)	(0.019)	(0.017)
Parity unknown	0.006	-0.014	-0.016
	(0.029)	(0.029)	(0.026)
Male infant	0.002	0.002	0.030[b]
	(0.012)	(0.012)	(0.011)
Plural birth	0.241[a]	0.227[a]	-0.137[b]
	(0.051)	(0.050)	(0.046)
Cesarean section	0.424[a]	0.429[a]	0.362[a]
	(0.017)	(0.016)	(0.015)
Previous fetal loss	0.084[d]	0.077[d]	0.029
	(0.047)	(0.046)	(0.042)
Infant died after delivery	-1.338[a]	-1.409[a]	-2.645[a]
	(0.068)	(0.068)	(0.068)
Gestational diabetes		-0.022	0.035
		(0.046)	(0.042)
Gestational hypertension		0.128[b]	0.109[c]
		(0.051)	(0.047)
Anemia		-0.002	-0.009
		(0.043)	(0.039)
STD		0.147[a]	0.158[a]
		(0.038)	(0.035)

Table 25 con.

	(1)	(2)	(3)
Birth outcomes			
Birth weight (grams)			-0.001[a] (0.000)
Birth weight squared			0.000[a] (0.000)
Preterm delivery			0.149[a] (0.017)
Gestation unknown			0.062[b] (0.022)
N	12314	12314	12314
Adjusted R-squared	0.5222	0.5343	0.6126

* Standard errors are in parentheses. All regressions include controls for hospital of delivery and year of birth.

[q] For all dummy variables yes=1; omitted categories are: unexposed for illicit substances, women 20-34 for mother's age, Hispanics other than Puerto Ricans and Dominicans for race/ethnicity, less than high school for mother's schooling, 1 to 3 previous live births for parity, no care for prenatal care, and deliveries with known gestation after the 37th week for preterm births.

[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p < 0.05$, [d] $p < 0.10$

Table 26

Loglinear Regressions on Newborn Nursery Costs of a Pooled Sample of Exposed and Unexposed Infants, New York City Municipal Hospital System, 1990-1992*

	(1)	(2)	(3)
Substances[q]			
Cocaine	1.044[a]	0.965[a]	0.780[a]
	(0.028)	(0.029)	(0.026)
Opiate	1.173[a]	1.101[a]	0.964[a]
	(0.023)	(0.023)	(0.021)
Opiate + Cocaine	1.293[a]	1.196[a]	0.996[a]
	(0.029)	(0.029)	(0.027)
Marijuana	0.157[b]	0.143[c]	0.112[c]
	(0.059)	(0.058)	(0.025)
Alcohol	0.059[d]	0.049	-0.015
	(0.032)	(0.032)	(0.028)
Tobacco	0.049[c]	0.046[c]	0.017
	(0.021)	(0.020)	(0.018)
Prenatal Care			
Inadequate		-0.217[a]	-0.081[a]
		(0.022)	(0.021)
Intermediate		-0.266[a]	-0.126[a]
		(0.028)	(0.026)
Adequate		-0.262[a]	-0.118[a]
		(0.028)	(0.026)
Adequate plus		-0.058[d]	-0.057[d]
		(0.032)	(0.029)
Care unknown		-0.111[a]	-0.057[c]
		(0.026)	(0.023)
WIC		-0.124[a]	-0.088[a]
		(0.016)	(0.014)
Demographic			
Teens	-0.089[b]	-0.093[b]	-0.095[a]
	(0.025)	(0.025)	(0.022)
Older Than 34	0.095[b]	0.082[b]	0.067[b]
	(0.025)	(0.025)	(0.022)
White non-Hispanic	0.029	0.017	0.063[c]
	(0.035)	(0.035)	(0.031)
Puerto Rican	0.114[a]	0.115[a]	0.115[a]
	(0.027)	(0.027)	(0.024)
Dominican	0.005	0.011	0.027
	(0.031)	(0.030)	(0.027)
Black non-Hispanic	0.105[a]	0.092[b]	0.052[c]
	(0.026)	(0.025)	(0.023)
Born in US	0.008	-0.000	-0.004
	(0.019)	(0.019)	(0.017)

Table 26 con.

	(1)	(2)	(3)
Socioeconomic			
Unmarried	0.061[b]	0.053[b]	0.039[c]
	(0.018)	(0.018)	(0.016)
High school	-0.040[c]	-0.035[c]	-0.028[d]
	(0.016)	(0.016)	(0.015)
Some college	0.026	0.035	0.010
	(0.027)	(0.027)	(0.024)
College +	-0.203[b]	-0.190[b]	-0.138[b]
	(0.053)	(0.053)	(0.047)
Education unknown	0.102[b]	0.052	0.018
	(0.040)	(0.039)	(0.035)
Obstetrics			
First birth	0.044[c]	0.047[b]	0.030[d]
	(0.018)	(0.018)	(0.016)
Fourth + birth	0.110[a]	0.103[a]	0.105[a]
	(0.022)	(0.022)	(0.020)
Parity unknown	0.037	0.016	0.011
	(0.034)	(0.034)	(0.030)
Male infant	0.005	0.003	0.034[b]
	(0.014)	(0.014)	(0.012)
Plural birth	0.254[a]	0.232[b]	-0.169[b]
	(0.062)	(0.061)	(0.055)
Cesarean section	0.476[a]	0.480[a]	0.392[a]
	(0.020)	(0.019)	(0.018)
Previous fetal loss	0.092[d]	0.084	0.022
	(0.055)	(0.054)	(0.049)
Infant died after delivery	-0.739[a]	-0.813[a]	-2.542[a]
	(0.095)	(0.094)	(0.092)
Gestational diabetes		-0.048	0.016
		(0.053)	(0.048)
Gestational hypertension		0.167[b]	0.138[c]
		(0.061)	(0.055)
Anemia		-0.062	-0.058
		(0.050)	(0.045)
STD		0.118[b]	0.136[b]
		(0.044)	(0.040)

Table 26 con.

	(1)	(2)	(3)
Birth outcomes			
Birth weight (grams)			-0.002[a] (0.000)
Birth weight squared			0.000[a] (0.000)
Preterm delivery			0.157[a] (0.019)
Gestation unknown			0.089[b] (0.025)
N	11762	11762	11762
Adjusted R-squared	0.4474	0.4593	0.5649

* Standard errors are in parentheses. All regressions include controls for hospital of delivery and year of birth.

[q] For all dummy variables yes=1; omitted categories are: unexposed for illicit substances, women 20-34 for mother's age, Hispanics other than Puerto Ricans and Dominicans for race/ethnicity, less than high school for mother's schooling, 1 to 3 previous live births for parity, no care for prenatal care, and deliveries with known gestation after the 37th week for preterm births.

[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p < 0.05$, [d] $p < 0.10$

Table 27

Loglinear Regressions on Newborn Service Intensity Weights of a Pooled Sample of Exposed and Unexposed Infants, New York City Municipal Hospital System, 1990-1992*

	(1)	(2)	(3)
Substances [q]			
Cocaine	1.194[a]	1.133[a]	0.857[a]
	(0.028)	(0.029)	(0.023)
Opiate	1.655[a]	1.598[a]	1.393[a]
	(0.023)	(0.023)	(0.019)
Opiate + Cocaine	1.811[a]	1.732[a]	1.439
	(0.029)	(0.029)	(0.023)
Marijuana	0.061	0.050	0.019
	(0.059)	(0.059)	(0.046)
Alcohol	0.032	0.023	-0.062[c]
	(0.032)	(0.032)	(0.025)
Tobacco	0.014	0.010	-0.039[c]
	(0.021)	(0.021)	(0.016)
Prenatal Care			
Inadequate		-0.228[a]	-0.032[d]
		(0.023)	(0.018)
Intermediate		-0.259[a]	-0.053[c]
		(0.029)	(0.023)
Adequate		-0.233[a]	-0.033
		(0.028)	(0.023)
Adequate plus		-0.015	-0.016
		(0.032)	(0.026)
Care unknown		-0.137[a]	-0.043[c]
		(0.026)	(0.020)
WIC		-0.096[a]	-0.047[b]
		(0.016)	(0.013)
Demographic			
Teens	-0.032	-0.032	-0.047[c]
	(0.025)	(0.025)	(0.020)
Older Than 34	0.043[d]	0.027	0.016
	(0.025)	(0.025)	(0.020)
White non-Hispanic	-0.073[c]	-0.083[c]	-0.017
	(0.036)	(0.035)	(0.028)
Puerto Rican	0.001	-0.002	0.003
	(0.027)	(0.027)	(0.021)
Dominican	-0.046	0.040	0.000
	(0.031)	(0.031)	(0.024)
Black non-Hispanic	0.094[b]	0.080[b]	0.017
	(0.026)	(0.026)	(0.020)
Born in US	0.018	0.014	0.006
	(0.020)	(0.020)	(0.015)

Table 27 con.

	(1)	(2)	(3)
Socioeconomic			
Unmarried	0.038[c]	0.032[d]	0.013
	(0.018)	(0.018)	(0.014)
High school	-0.026	-0.021	-0.014
	(0.017)	(0.017)	(0.013)
Some college	0.062[c]	0.069[c]	0.031
	(0.027)	(0.027)	(0.021)
College +	-0.133[c]	-0.120[c]	-0.043
	()0.054	(0.053)	(0.042)
Education unknown	0.017	-0.026	-0.069[c]
	(0.040)	(0.039)	(0.031)
Obstetrics			
First birth	0.026	0.028	0.002
	(0.018)	(0.018)	(0.014)
Fourth + birth	0.012	0.006	0.010
	(0.023)	(0.022)	(0.017)
Parity unknown	0.029	0.010	0.004
	(0.035)	(0.034)	(0.027)
Male infant	-0.026[d]	-0.026[d]	0.025[c]
	(0.014)	(0.014)	(0.011)
Plural birth	0.586[a]	0.564[a]	-0.096[c]
	(0.060)	(0.059)	(0.047)
Cesarean section	0.260[a]	0.259[a]	0.138[a]
	(0.020)	(0.020)	(0.035)
Previous fetal loss	0.145[b]	0.137[c]	0.051
	(0.055)	(0.020)	(0.043)
Infant died after delivery	0.589[a]	0.524[a]	-1.744[a]
	(0.080)	(0.080)	(0.069)
Gestational diabetes		0.151[b]	0.245[a]
		(0.054)	(0.043)
Gestational hypertension		0.122[c]	0.067[d]
		(0.061)	(0.047)
Anemia		0.010	0.004
		(0.050)	(0.039)
STD		0.160	0.178
		(0.045)	(0.039)

Table 27 con.

	(1)	(2)	(3)
Birth outcomes			
Birth weight (grams)			-0.003[a] (0.000)
Birth weight squared			0.000[a] (0.000)
Preterm delivery			0.185[a] (0.017)
Gestation unknown			0.068[b] (0.022)
N	12301	12301	12301
Adjusted R-squared	0.5181	0.5272	0.7100

* Standard errors are in parentheses. All regressions include controls for hospital of delivery and year of birth.

[q] For all dummy variables yes=1; omitted categories are: unexposed for illicit substances, women 20-34 for mother's age, Hispanics other than Puerto Ricans and Dominicans for race/ethnicity, less than high school for mother's schooling, 1 to 3 previous live births for parity, no care for prenatal care, and deliveries with known gestation after the 37th week for preterm births.

[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p<0.05$, [d] $p<0.10$

Table 28

Total and Direct Increments in Costs and Length of Stay Associated with Prenatal Exposure to Illicit Substances and the Effect of Prenatal Care Based on Multivariate Regressions of the Pooled Sample Evaluated at the Geometric Mean of Unexposed Infants. New York Municipal Hospital System 1990-1992 [a]

Newborn Cost								
	Total Effect				Direct Effect			
Substances	Percentage increase	Absolute increase	Expected cost	Expected cost with prenatal care	Percentage increase	Absolute increase	Expected cost	Expected cost with prenatal care
Cocaine	118	$2,231	$4,122	$3,676	72	$1,361	$3,252	$3,198
Opiates	271	$5,124	$7,095	$5,990	211	$3,990	$5,881	$5,721
Opiates + Cocaine	309	$5,843	$7,734	$6,565	216	$4,084	$5,975	$5,811
Marijuana	3	$57	$1,947	$1,936	0.3	$6	$1,897	$1,897

Length of Stay								
	Total Effect				Direct Effect			
Substances	Percentage increase	Absolute increase	Expected LOS	Expected LOS with prenatal care	Percentage increase	Absolute increase	Expected LOS	Expected LOS with prenatal care
Cocaine	170	6.12	9.72	8.25	131	4.71	8.31	7.88
Opiates	198	7.13	10.73	9.02	197	7.09	10.69	10.05
Opiates + Cocaine	261	9.40	13.00	10.74	206	7.41	11.01	10.41
Marijuana	5	0.18	3.78	3.73	5	0.18	3.78	3.77

[a] Percentage increases are from coefficients in tables 24 and 25, columns 2 and 3. Absolute increases are evaluated at the geometric mean for unexposed newborn cost $1,891 in 1991 dollars and length of stay 3.60 days. Intermediate prenatal care reduces the increase in newborn total cost 20%, direct cost by 3.7%; intermediate prenatal care reduces the increase in total length of stay by 24%, direct length of stay by 8.6%.

Table 29

Coefficients on Prenatal Care Categories Interacted with Illicit Drug Use from Loglinear Regressions of Newborn Costs, New York Municipal Hospital System, 1990-1992 * N=12332

	No Care	Unknown	Inadequate	Intermediate	Adequate	Adequate Plus
			TOTAL	**COST**		
Substances						
Cocaine	1.058^{a}	-0.319^{a}	-0.423^{a}	-0.329^{b}	-0.196^{c}	-0.412^{a}
	(0.050)	(0.015)	(0.062)	(0.097)	(0.094)	(0.096)
Opiates	1.400^{a}	-0.112^{c}	-0.086	-0.065	-0.089	-0.052
	(0.042)	(0.058)	(0.053)	(0.072)	(0.071)	(0.077)
Opiate +Cocaine	1.562^{a}	-0.127	-0.224^{b}	-0.157	-0.122	-0.439^{a}
	(0.046)	(0.068)	(0.060)	(0.103)	(0.104)	(0.107)
Marijuana	0.118	-0.052	-0.113	-0.038	-0.231	0.061
	(0.117)	(0.212)	(0.168)	(0.210)	(0.202)	(0.243)

	No Care	Unknown	Inadequate	Intermediate	Adequate	Adequate Plus
			DIRECT	**COST**		
Substances						
Cocaine	0.697^{a}	-0.185^{a}	-0.236^{a}	-0.199^{b}	-0.111	-0.256^{b}
	(0.039)	(0.056)	(0.049)	(0.077)	(0.075)	(0.076)
Opiates	1.181^{a}	-0.076	-0.028	0.011	-0.055	-0.099
	(0.034)	(0.046)	(0.042)	(0.057)	(0.056)	(0.061)
Opiates +Cocaine	1.208^{a}	-0.035	-0.069	-0.065	0.034	-0.275^{b}
	(0.037)	(0.054)	(0.048)	(0.082)	(0.083)	(0.085)
Marijuana	-0.123	0.089	0.183	0.181	-0.036	0.222
	(0.116)	(0.168)	(0.134)	(0.166)	(0.160)	(0.193)

* Coefficients are from models in which measures of prenatal care are interacted with measures of illicit drug use. The coefficients for No Care reflect the increase in costs for infants in the No Care category exposed to illicit drugs relative to infants unexposed in the No Care category. The coefficients of the other prenatal care categories show the differential impact of prenatal care on cost for different exposures relative to the impact of No Care on cost for that exposure. Thus, the coefficient on newborn cost of inadequate care and exposure to cocaine in the top panel, -0.423, indicates that infants exposed to cocaine whose mothers obtained inadequate prenatal care had costs 88.7 percent $[(e^{(1.058-.423)}-1)*100]$ greater than infants unexposed whose mothers had no care. This increase was 34.5 percent less than for infants exposed to cocaine whose mothers had no care $[(e^{(-.423)}-1)*100]$. Standard errors are in parentheses.
[a] p<0.0001, [b] p<0.01, [c] p<0.05

Table 30

Coefficients on Prenatal Care Categories Interacted with Illicit Drug Use from Loglinear Regressions of Newborn Acute Care Length of Stay, New York Municipal Hospital System, 1990-1992 * N=12332

	TOTAL LOS					
	No Care	**Unknown**	**Inadequate**	**Intermediate**	**Adequate**	**Adequate Plus**
Substances						
Cocaine	1.210[a]	-0.185[b]	-0.345[a]	-0.362[a]	-0.135	-0.349[a]
	(0.071)	(0.065)	(0.057)	(0.089)	(0.086)	(0.088)
Opiates	1.298[a]	-0.119	-0.062	-0.051	-0.111	-0.168[c]
	(0.053)	(0.054)	(0.048)	(0.066)	(0.065)	(0.071)
Opiate +Cocaine	1.388[a]	-0.131	-0.108	-0.029	-0.105	-0.308[b]
	(0.063)	(0.062)	(0.055)	(0.095)	(0.096)	(0.099)
Marijuana	0.339[b]	-0.290	-0.260	-0.224	-0.322	-0.197
	(0.165)	(0.142)	(0.077)	(0.138)	(0.128)	(0.178)

	DIRECT LOS					
	No Care	**Unknown**	**Inadequate**	**Intermediate**	**Adequate**	**Adequate Plus**
Substances						
Cocaine	0.988[a]	-0.112	-0.238[a]	-0.297[b]	-0.096	-0.269[b]
	(0.042)	(0.059)	(0.052)	(0.081)	(0.079)	(0.081)
Opiates	1.153[a]	-0.096[c]	-0.028	0.005	-0.089	-0.200[b]
	(0.036)	(0.049)	(0.044)	(0.060)	(0.059)	(0.065)
Opiates +Cocaine	1.167[a]	-0.076	-0.026	-0.021	-0.021	-0.217[b]
	(0.039)	(0.057)	(0.050)	(0.086)	(0.087)	(0.090)
Marijuana	0.189	-0.207	-0.81	-0.100	-0.153	-0.085
	(0.123)	(0.129	(0.071)	(0.126)	(0.117)	(0.162)

*Coefficients are from models in which measures of prenatal care are interacted with measures of illicit drug use. The coefficients for No Care reflect the increase in length of stay for infants in the No Care category exposed to illicit drugs relative to infants unexposed in the No Care category. The coefficients for the other prenatal care categories show the differential impact of prenatal care on length of stay for different exposures relative to the impact of No Care on length of stay for that exposure. Thus, the coefficient on length of stay of intermediate care and exposure to cocaine in the top panel, -0.362, indicates that infants exposed to cocaine whose mothers obtained intermediate prenatal care had length of stay 135 percent $[(e^{(1.210-.362)}-1)*100]$ greater than infants unexposed whose mothers had no care. This increase was 30.4 percent less than for infants exposed to cocaine whose mothers had no care $[(e^{(-.362)}-1)*100]$. Standard errors are in parentheses.

[a] p<0.0001, [b] p<0.01, [c] p<0.05

Table 31

Selected Coefficients from Regressions of Exposed Infants; Observations with Positive Revenue N=4631*

	COST (1)	COST (2)	COST (3)	LOS (1)	LOS (2)	LOS (3)
Substances [p]						
Cocaine	0.670[a]	0.648[a]	0.436[a]	0.742[a]	0.607[a]	0.554[a]
	(0.088)	(0.089)	(0.076)	(0.047)	(0.061)	(0.060)
Opiate	1.385[a]	1.376[a]	1.245[a]	1.012[a]	0.898[a]	0.838[a]
	(0.087)	(0.086)	(0.074)	(0.058)	(0.057)	(0.053)
Opiate + Cocaine	1.462[a]	1.455[a]	1.245[a]	1.132[a]	0.984[a]	0.894[a]
	(0.089)	(0.089)	(0.075)	(0.059)	(0.059)	(0.052)
Prenatal Care						
Inadequate		-0.265[a]	-0.022		-0.265[a]	-0.126[a]
		(0.041)	(0.036)		(0.031)	(0.030)
Intermediate		-0.231[b]	0.005		-0.298[a]	-0.160[b]
		(0.066)	(0.057)		(0.050)	(0.047)
Adequate		-0.174[b]	0.059		-0.295[a]	-0.160[b]
		(0.065)	(0.056)		(0.050)	(0.047)
Adequate plus		-0.089	-0.029		-0.219[a]	-0.195[a]
		(0.069)	(0.059)		(0.052)	(0.050)
Care unknown		-0.135[b]	-0.034		-0.124[b]	-0.076
		(0.045	(0.039)		(0.035)	(0.032)

Selected Coefficients from Regressions of the Pooled Sample; Observations with Positive Revenue N=10523*

	COST (1)	COST (2)	COST (3)	LOS (1)	LOS (2)	LOS (3)
Substances [q]						
Cocaine	0.669[a]	0.642[a]	0.378[a]	0.990[a]	0.919[a]	0.757[a]
	(0.037)	(0.038)	(0.033)	(0.028)	(0.028)	(0.026)
Opiate	1.461[a]	1.436[a]	1.254[a]	1.249[a]	1.178[a]	1.058[a]
	(0.028)	(0.029)	(0.025)	(0.020)	(0.021)	(0.019)
Opiate + Cocaine	1.570[a]	1.528[a]	1.263[a]	1.333[a]	1.236[a]	1.068[a]
	(0.035)	(0.036)	(0.031)	(0.026)	(0.026)	(0.024)
Marijuana	0.048	0.038	0.013	0.118[c]	0.103[c]	0.086
	(0.065)	(0.055)	(0.043)	0.050)	(0.050)	(0.048)
Prenatal Care						
Inadequate		-0.169[a]	0.019		-0.225[a]	-0.113[a]
		(0.028)	(0.025)		(0.021)	(0.019)
Intermediate		-0.151[a]	0.043		-0.275[a]	-0.156[a]
		(0.036)	(0.032)		(0.027)	(0.025)
Adequate		-0.141[a]	0.048		-0.270[a]	-0.156[a]
		(0.035)	(0.031)		(0.026)	(0.024)
Adequate plus		0.062	0.082		-0.127[a]	-0.132[a]
		(0.040)	(0.035)		(0.029)	(0.027)
Care unknown		-0.071[c]	0.015		-0.118[a]	-0.071[b]
		(0.032)	(0.028)		(0.024)	(0.022)

[p] Omitted categories are: exposed to marijuana for illicit substances; no care for prenatal care.
[q] Omitted categories are: unexposed for illicit substances; no care for prenatal care.
[a] $p<0.0001$. [b] $p<0.01$. [c] $p<0.05$
* The coefficients are from models that measure the total effect of prenatal care on costs and LOS (see Table 16 or Table 24)

Table 32A

Coefficients on Prenatal Care from Cost and Length of Stay Regressions with Levels of Care by Numbers of Visits, Total Effect. New York Municipal Hospitals 1990-1992*

	Exposed Sample N=5340		Unexposed Sample N=6992		Pooled Sample N=12332	
Levels of care [q]	Cost	LOS	Cost	LOS	Cost	LOS
1-3 visits	-0.148[a]	-0.137[a]	0.075[c]	0.037	-0.086[b]	-0.063[c]
	(0.037)	(0.032)	(0.034)	(0.032)	(0.022)	(0.025)
4 + visits	-0.289[a]	-0.308[a]	-0.085[a]	-0.132[a]	-0.250[a]	-0.192[a]
	(0.028)	(0.024)	(0.021)	(0.020)	(0.016)	(0.017)
Unknown	-0.046	-0.009	0.030	0.006	-0.036	-0.006
	(0.033)	(0.029)	(0.022)	(0.019)	(0.025)	(0.022)

[q] Reference category: no prenatal care
[a] p<0.0001, [b] p<0.01, [c] p<0.05
* The coefficients are from models that measure the total effect of prenatal care on costs and LOS (see Table 16, Table 20, or Table 24)

Table 32B

Coefficients on Prenatal Care from Cost and Length of Stay Regressions with Levels of Care by Trimester of Initiation of Care Holding the Number of Visits Constant, Total Effect. New York Municipal Hospitals 1990-1992*

	Exposed Sample N=4708		Unexposed Sample N=6517		Pooled Sample N=11224	
Trimester of initiation [q]	Cost	LOS	Cost	LOS	Cost	LOS
Trimester 1	-0.064	-0.077	0.077[b]	0.017	0.014	-0.040
	(0.049)	(0.043)	(0.026)	(0.024)	(0.023)	(0.021)
Trimester 2	-0.145[b]	-0.161[b]	0.032	-0.014	-0.048[c]	-0.092[a]
	(0.049)	(0.043)	(0.027)	(0.026)	(0.024)	(0.022)
Trimester 3	-0.216[a]	-0.206[a]	-0.027	-0.047	-0.120[a]	-0.135[a]
	(0.049)	(0.042)	(0.029)	(0.028)	(0.025)	(0.023)
Unknown	-0.086	-0.035	0.030	0.015	-0.066	-0.022
	(0.054)	(0.047)	(0.033)	(0.022)	(0.034)	(0.024)

[q] Reference category: no prenatal care
[a] p<0.0001, [b] p<0.01, [c] p<0.05
* The coefficients are from models that measure the total effect of prenatal care on costs and LOS (see Table 16, Table 20, or Table 24)

Table 32C

Coefficients on Prenatal Care from Cost and Length of Stay Regressions by Number of Prenatal Care Visits, Total Effect. New York Municipal Hospitals 1990-1992*

Number of visits [q]	Exposed Sample N=5340 Cost	Exposed Sample N=5340 LOS	Unexposed Sample N=6992 Cost	Unexposed Sample N=6992 LOS	Pooled Sample N=12332 Cost	Pooled Sample N=12332 LOS
Visit 1	-0.080	-0.026	0.215[a]	0.164[b]	0.024	0.023
	(0.062)	(0.054)	(0.055)	(0.052)	(0.041)	(0.037)
Visit 2	-0.136[c]	-0.205[a]	-0.021	-0.016	-0.103[b]	-0.161[a]
	(0.057)	(0.049)	(0.051)	(0.048)	(0.038)	(0.034)
Visit 3	-0.215[b]	-0.158[b]	0.058	-0.001	-0.110[b]	-0.112[b]
	(0.057)	(0.050)	(0.048)	(0.046)	(0.037)	(0.034)
Visit 4	-0.092	-0.108[c]	0.079	0.016	-0.025	-0.087[b]
	(0.059)	(0.052)	(0.041)	(0.039)	(0.035)	(0.032)
Visit 5	-0.273[a]	-0.275[a]	0.024	-0.054	-0.138[a]	-0.197[a]
	(0.057)	(0.049)	(0.038)	(0.036)	(0.032)	(0.029)
Visit 6	-0.268[a]	-0.256[a]	0.018	-0.039	-0.136[a]	-0.174[a]
	(0.054)	(0.047)	(0.033)	(0.032)	(0.029)	(0.027)
Visit 7	-0.358[a]	-0.324[a]	-0.077[c]	-0.111[b]	-0.225[a]	-0.253[a]
	(0.068)	(0.059)	(0.034)	(0.032)	(0.032)	(0.029)
Visit 8	-0.222[b]	-0.339[a]	-0.094[b]	-0.156[a]	-0.198[a]	-0.283[a]
	(0.065)	(0.057)	(0.033)	(0.031)	(0.030)	(0.028)
Visit 9 or more	-0.360[a]	-0.388[a]	-0.145[a]	-0.173[a]	-0.271[a]	-0.321[a]
	(0.036)	(0.032)	(0.024)	(0.023)	(0.020)	(0.018)
Unknown	0.053	-0.017	0.001	0.012	-0.053[b]	-0.026
	(0.033)	(0.029)	(0.025)	(0.023)	(0.020)	(0.018)

[q] Reference category: no prenatal care visits
[a] p<0.0001, [b] p<0.01, [c] p<0.05
* The coefficients are from models that measure the total effect of prenatal care on costs and LOS (see Table 16, Table 20, or Table 24)

Table 33

Linear Regressions on Newborn Birth Weight of Infants Who Were Identified As Prenatally Exposed to Illicit Drugs, New York City Municipal Hospital System, 1990-1992 *

	(1)	(2)	(3)	(4)
Substances [q]				
Cocaine	-338.439[a]	-321.843[a]	-259.408[a]	-213.735[a]
	(49.279)	(48.598)	(47.996)	(44.477)
Opiate	-240.944[a]	-253.994[a]	-191.359[a]	-155.213[b]
	(47.996)	(47.446)	(46.834)	(43.414)
Opiate + Cocaine	-363.141[a]	-367.068[a]	-286.457[a]	-233.076[a]
	(49.057)	(48.523)	(48.055)	(44.547)
Alcohol	-132.716[a]	-85.188[b]	-77.149[b]	-82.245[b]
	(26.690)	(25.755)	(25.303)	(23.330)
Tobacco	-52.446[b]	-52.561[b]	-59.185[b]	-53.191[b]
	(19.443)	(18.743)	(18.458)	(17.071)
Prenatal Care				
Inadequate			238.488[a]	159.379[a]
			(22.958)	(22.108)
Intermediate			233.056[a]	145.712[a]
			(36.506)	(34.218)
Adequate			247.298[a]	180.793[a]
			(36.330)	(36.271)
Adequate plus			83.414[c]	180.113[a]
			(38.493)	(36.374)
Care unknown			110.327[a]	127.483[a]
			(25.489)	(23.658)
WIC			70.613[b]	40.510[c]
			(19.298)	(17.881)
Demographic				
Teens		45.557	40.886	44.452
		(45.178)	(44.409)	(41.151)
Older Than 34		-43.553	-46.013[d]	-46.254[d]
		(27.756)	(27.269)	(25.219)
White non-Hispanic		143.503[c]	148.840[b]	103.323[c]
		(58.400)	(57.354)	(53.009)
Puerto Rican		-0.510	-10.816	-33.565
		(47.759)	(46.899)	(43.442)
Dominican		122.653	113.403	103.239
		(76.790)	(75.400)	(69.440)
Black non-Hispanic		-102.627[c]	-98.541[c]	-101.417[c]
		(46.391)	(45.558)	(42.138)
Born in US		17.620	22.943	27.812
		(26.956)	(26.479)	(24.488)

Table 33 con.

	(1)	(2)	(3)	(4)
Socioeconomic				
Unmarried		-15.228 (28.836)	-0.887 (28.370)	15.175 (28.248)
High school		11.226 (19.551)	5.009 (19.202)	8.490 (17.777)
Some college		-3.652 (33.694)	-20.780 (33.112)	-4.980 (30.823)
College +		146.352[d] (85.133)	142.282[d] (83.597	106.147 (76.892)
Education unknown		-69.051[d] (41.911)	-21.784 (41.347)	917.493 (38.247)
Obstetrics				
First birth		-16.812 (26.023)	-35.970 (25.614)	-46.283[c] (23.697)
Fourth + birth		25.213 (21.383)	33.375 (21.011)	41.217[c] (19.457)
Parity unknown		-26.913 (38.855)	-4.444 (38.245)	-4.469 (35.592)
Male infant		112.014[a] (16.918)	108.711[a] (16.638)	109.386[a] (15.393)
Plural birth		-747.155[a] (64.161)	-739.794[a] (63.090)	-698.497[a] (58.552)
Cesarean section		-76.881[b] (23.753)	-100.252[a] (23.430)	-78.375[b] (21.717)
Previous fetal loss		-94.355 (58.306)	-83.567 (57.281)	-71.511 (52.744)
Infant died after delivery		-1415.892[a] (73.561)	-1351.357[a] (72.363)	-1175.947[a] (68.150)
Gestational diabetes			504.707[a] (131.106)	399.249[b] (122.970)
Gestational hypertension			232.200[b] (86.371)	178.090[c] (80.205)
Anemia			-5.397 (51.95)	-7.092 (47.095)
STD			44.818 (41.689)	38.353 (38.182)
Birth outcomes				
Preterm delivery				-502.962[a] (18.671)
Gestation unknown				-247.356[a] (25.143)

Table 33 con.

	(1)	(2)	(3)	(4)
Area Variables				
Female LFPR in census track		0.478	0.409	
		(1.043)	(1.024)	
Percent poor in census track		0.110	0.120	
		(0.658)	(0.642)	
Homicide rate in health area		0.002	0.046	
		(0.346)	(0.340)	
Drug deaths in health area		0.046	0.203	
		(0.565)	(0.555)	
N	5331	5201	5201	5331
Adjusted R-squared	0.0278	0.1348	0.1669	0.2682

* Standard errors are in parentheses. All regressions include controls for hospital of delivery and year of birth.

[q] For all dummy variables yes=1; omitted categories are: marijuana for illicit substances, women 20-34 for mother's age, Hispanics other than Puerto Ricans and Dominicans for race/ethnicity, less than high school for mother's schooling, 1 to 3 previous live births for parity, no care for prenatal care, and deliveries with known gestation after the 37^{th} week for preterm births.

[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p<0.05$, [d] $p<0.10$

Table 34

Linear Regressions on Newborn Birth Weight of a Random Sample of Unexposed Infants, New York City Municipal Hospital System, 1990-1992 *

	(1)	(2)	(3)
Substances [q]			
Alcohol	57.517	51.574	81.593
	(107.778)	(106.834)	(99.062)
Tobacco	-144.725[a]	-142.756[a]	-145.832[a]
	(30.272)	(30.040)	(27.914)
Prenatal Care			
Inadequate		89.263[b]	43.388[d]
		(26.743)	(25.405)
Intermediate		142.069[a]	71.802[b]
		(29.772)	(28.268)
Adequate		136.045[a]	83.481[b]
		(29.201)	(27.724)
Adequate plus		-81.045[b]	22.659
		(32.855)	(31.152)
Care unknown		59.279[c]	61.671[c]
		(30.965)	(29.848)
WIC		51.285[b]	40.180[b]
		(15.581)	(14.552)
Demographic			
Teens	-54.700[b]	-49.294[b]	-41.228[c]
	(20.408)	(20.269)	(18.935)
Older Than 34	-13.812	-7.173	-6.237
	(25.114)	(25.031)	(23.388)
White non-Hispanic	113.459[b]	117.169[a]	111.857[a]
	(30.339)	(30.083)	(27.815)
Puerto Rican	-1.011	-2.147	5.600
	(24.369)	(24.178)	(22.469)
Dominican	68.029[b]	67.249[b]	62.170[b]
	(23.583)	(23.385)	(21.743)
Black non-Hispanic	-77.627[b]	-68.656[b]	-59.502[b]
	(21.738)	(21.586)	(20.006)
Born in US	-52.033[b]	-45.499[b]	-49.130[b]
	(18.014)	(17.896)	(16.477)

Table 34 con.

	(1)	(2)	(3)
Socioeconomic			
Unmarried	-47.370[b]	-45.232[b]	-23.451[d]
	(15.255)	(15.140)	(14.111)
High school	15.133	13.367	6.300
	(16.094)	(15.982)	(14.922)
Some college	-13.792	-13.895	-11.728
	(24.909)	(24.722)	(23.070)
College +	105.510[b]	102.794[b]	89.081[c]
	(43.835)	(43.482)	(40.232)
Education unknown	-107.571[b]	-90.069[c]	-88.537[c]
	(42.686)	(42.466)	(39.545)
Obstetrics			
First birth	-95.065[a]	-94.066[a]	-94.887[a]
	(15.561)	(15.462)	(14.399)
Fourth + birth	25.487	24.756	43.071[d]
	(28.065)	(27.853)	(25.066)
Parity unknown	-55.399[d]	-43.530	-46.168
	(32.956)	(32.751)	(30.619)
Male infant	111.082[a]	112.335[a]	113.011[a]
	(13.495)	(13.375)	(12.476)
Plural birth	-774.261[a]	-735.412[a]	-623.218[a]
	(59.220)	(58.836)	(55.047)
Cesarean section	-6.031	1.022	9.376
	(18.227)	(18.130)	(16.936)
Previous fetal loss	10.891	16.456	28.769
	(56.490)	(56.025)	(52.032)
Infant died after delivery	-2055.880[a]	-1994.599[a]	-1690.673[a]
	(97.663)	(97.025)	(92.133)
Gestational diabetes		182.693[a]	139.989[b]
		(40.180)	(37.361)
Gestational hypertension		-146.629[b]	-116.532[b]
		(49.622)	(46.612)
Anemia		-49.220	-14.027
		(52.848)	(48.974)
STD		9.236	24.968
		(56.381)	(52.415)
Birth outcomes			
Preterm delivery			-615.829[a]
			(21.088)
Gestation unknown			-98.182[b]
			(30.980)

Table 34 con.

	(1)	(2)	(3)
Area Variables			
Female LFPR in census track	0.651	0.596	
	(0.871)	(0.864)	
Percent poor in census track	0.401	0.528	
	(0.572)	(0.568)	
Homicide rate in health area	-0.972	-0.459	
	(0.325)	(0.322)	
Drug deaths in health area	0.032	0.153	
	(0.564)	(0.560)	
N	6835	6835	6982
Adjusted R-squared	0.1242	0.1402	0.2337

* Standard errors are in parentheses. All regressions include controls for hospital of delivery and year of birth.

[q] For all dummy variables yes=1; omitted categories are: women 20-34 for mother's age, Hispanics other than Puerto Ricans and Dominicans for race/ethnicity, less than high school for mother's schooling, 1 to 3 previous live births for parity, no care for prenatal care, and deliveries with known gestation after the 37th week for preterm births.

[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p < 0.05$, [d] $p < 0.10$

Table 35

Linear Regressions on Newborn Birth Weight of a Pooled Sample of Exposed and Unexposed Infants, New York City Municipal Hospital System, 1990-1992 *

	(1)	(2)	(3)	(4)
Substances [q]				
Cocaine	-529.902[a]	-460.743[a]	-407.443[a]	-345.682[a]
	(20.412)	(20.612)	(21.056)	(19.634)
Opiate	-450.544[a]	-409.318[a]	-360.416[a]	-300.099[a]
	(15.953)	(16.913)	(17.130)	(16.042)
Opiate + Cocaine	-569.921[a]	-514.171[a]	-449.139[a]	-375.045[a]
	(20.632)	(20.769)	(21.435)	(20.012)
Marijuana	-191.043[a]	-98.343[c]	-95.497[c]	-90.722[c]
	(44.814)	(42.589)	(42.118)	(39.679)
Alcohol	-116.064[a]	-89.660[a]	-82.007[b]	-67.369[b]
	(24.740)	(23.789)	(23.512)	(21.776)
Tobacco	80.658[a]	-77.603[a]	-77.676[a]	69.731[a]
	(15.885)	(15.337)	(14.970)	(14.107)
Prenatal Care				
Inadequate			179.054[a]	115.383[a]
			(16.591)	(15.974)
Intermediate			209.917[a]	128.795[a]
			(21.097)	(20.097)
Adequate			210.759[a]	146.996[a]
			(20.573)	(19.628)
Adequate plus			11.517	98.195[a]
			(23.417)	(22.248)
Care unknown			103.254[a]	122.484[a]
			(18.978)	(17.852)
WIC			64.695[a]	44.011[a]
			(12.068)	(11.244)
Demographic				
Teens		-44.209[c]	-40.607[c]	-32.057[d]
		(18.710)	(18.519)	(17.263)
Older Than 34		-25.590	-23.827	-25.294
		(18.538)	(18.519)	(17.103)
White non-Hispanic		115.357[a]	124.742[a]	103.272[a]
		(26.268)	(25.964)	(24.027)
Puerto Rican		-14.546	-15.277	-20.972
		(20.148)	(19.917)	(18.515)
Dominican		73.784[b]	71.071[b]	63.665[b]
		(22.980)	(22.713)	(21.105)
Black non-Hispanic		-97.508[a]	-88.187[a]	-83.128[a]
		(19.199)	(18.995)	(17.593)
Born in US		-34.167[c]	-27.224[d]	-25.060[d]
		(14.702)	(14.545)	(12.588)

Table 35 con.

	(1)	(2)	(3)	(4)
Socioeconomic				
Unmarried		-45.521[b]	-40.349[b]	-22.098[d]
		(13.688)	(13.524)	(12.588)
High school		13.855	9.773	9.956
		(12.423)	(12.284)	(11.438)
Some college		-11.529	-19.720	-9.767
		(20.093)	(19.869)	(18.546)
College +		123.183[b]	114.882[b]	99.875[b]
		(39.584)	(39.129)	(36.154)
Education unknown		-89.975[b]	-55.882[c]	-55.105[c]
		(28.957)	(28.738)	(26.723)
Obstetrics				
First birth		-72.223[a]	-75.470[a]	-80.639[a]
		(13.475)	(13.344)	(12.410)
Fourth + birth		17.746	24.029	37.204[c]
		(16.593)	(16.412)	(15.296)
Parity unknown		-43.404[d]	-26.250	-26.340
		(25165)	(24.925)	(23.287)
Male infant		112.418[a]	112.649[a]	113.357[a]
		(10.590)	(10.470)	(9.747)
Plural birth		-765.175[a]	-737.420[a]	-663.929[a]
		(43.373)	(42.937)	(40.075)
Cesarean section		-35.584[b]	-38.756[b]	-24.849[d]
		(14.539)	(14.416)	(13.440)
Previous fetal loss		-49.577	-43.861	-29.032
		(40.357)	(39.888)	(36.961)
Infant died after delivery		-1627.158[a]	-1570.952[a]	1354.427[a]
		(57.693)	(57.117)	(54.092)
Gestational diabetes			220.905[a]	174.026[a]
			(39.460)	(36.691)
Gestational hypertension			-38.772	-36.907
			(43.704)	(40.928)
Anemia			-22.940	-12.533
			(36.816)	(34.096)
STD			35.505	35.324
			(32.939)	(30.391)
Birth outcomes				
Preterm delivery				-545.058[a]
				(13.823)
Gestation unknown				-202.454[a]
				(19.157)

Table 35 con.

Area Variables				
Female LFPR in census track		0.579 (0.669)	0.510 (0.661)	
Percent poor in census track		0.257 (0.430)	0.338 (0.425)	
Homicide rate in health area		-0.198 (0.235)	-0.219 (0.232)	
Drug deaths in health area		-0.006 (0.393)	0.169 (0.389)	
N	12314	12036	12036	12314
Adjusted R-squared	0.1757	0.2683	0.2859	0.3663

* Standard errors are in parentheses. All regressions include controls for hospital of delivery and year of birth.

[q] For all dummy variables yes=1; omitted categories are: unexposed for illicit substances, women 20-34 for mother's age, Hispanics other than Puerto Ricans and Dominicans for race/ethnicity, less than high school for mother's schooling, 1 to 3 previous live births for parity, no care for prenatal care, and deliveries with known gestation after the 37th week for preterm births.

[a] $p \leq 0.0001$, [b] $p \leq 0.01$, [c] $p < 0.05$, [d] $p < 0.10$

Table 36

Selected Coefficients From a Loglinear Birth Weight Regression of a Pooled Sample of Exposed and Unexposed Infants, New York City Municipal Hospital System, 1990-1992

	(1)	(2)
Substances [q]		
Cocaine	-0.148[a]	-0.114[a]
	(0.008)	(0.008)
Opiate	-0.121[a]	-0.090[a]
	(0.006)	(0.006)
Opiate + Cocaine	-0.159[a]	-0.116[a]
	(0.008)	(0.008)
Marijuana	-0.029	-0.019
	(0.017)	(0.015)
Alcohol	-0.036[a]	-0.026[b]
	(0.009)	(0.009)
Tobacco	-0.038[a]	-0.028[a]
	(0.006)	(0.005)
Prenatal Care		
Inadequate	0.082[a]	0.048[a]
	(0.006)	(0.006)
Intermediate	0.089[a]	0.049[a]
	(0.008)	(0.008)
Adequate	0.089[a]	0.056[a]
	(0.008)	(0.007)
Adequate plus	0.008	0.040[a]
	(0.009)	(0.008)
Care unknown	0.048[a]	0.031[b]
	(0.007)	(0.008)

[q] Omitted categories are: unexposed for illicit substances, no care for prenatal care.
[a] $p < 0.0001$, [b] $p < 0.01$

Table 37A

Adjusted Odds Ratio by Prenatal Care Utilization Index Among Women Who Were Identified as Exposed to Illicit Drugs Delivering in New York City Municipal Hospitals 1990-1992 * N = 5409

	Low Birth Weight < 2500 g		Very Low Birth Weight < 1500 g		Preterm < 37 weeks	
	OR	95% CI	OR	95% CI	OR	95% CI
No care	1.00	...	1.00	...	1.00	...
Inadequate care	0.53	0.45-0.62	0.26	0.17-0.39	0.52	0.44-0.63
Intermediate care	0.54	0.41-0.70	0.31	0.13-0.63	0.49	0.36-0.65
Adequate care	0.54	0.41-0.70	0.53	0.28-0.95	0.60	0.45-0.79
Adequate plus care	0.85	0.65-1.11	0.96	0.57-1.58	2.69	2.05-3.54
Care unknown	0.75	0.63-0.90	0.58	0.40-0.85	1.14	0.92-1.41

* OR indicates odds ratio; and CI, confidence interval; No prenatal care is the reference category

Table 37B

Adjusted Odds Ratio by Prenatal Care Visits Among Women Who Were Identified as Exposed to Illicit Drugs Delivering in New York City Municipal Hospitals 1990-1992 * N = 5409

	Low Birth Weight < 2500 g		Very Low Birth Weight < 1500 g		Preterm < 37 weeks	
	OR	95% CI	OR	95% CI	OR	95% CI
No visits	1.00	...	1.00	...	1.00	...
1 – 3 visits	0.81	0.67-0.96	0.55	0.37-0.81	1.02	0.84-1.23
4 + visits	0.52	0.46-0.60	0.34	0.24-0.48	0.53	0.45-0.61
Unknown visits	0.74	0.63-0.91	0.59	0.41-0.86	1.13	0.91-1.40

* OR indicates odds ratio; and CI, confidence interval; No visits is the reference category

Table 37C

Adjusted Odds Ratio by Trimester of Initiation of Prenatal Care[a] Among Women Who Were Identified as Exposed to Illicit Drugs Delivering in New York City Municipal Hospitals 1990-1992 * N = 5409

	Low Birth Weight < 2500 g		Very Low Birth Weight < 1500 g		Preterm < 37 weeks	
	OR	95% CI	OR	95% CI	OR	95% CI
No prenatal care	1.00	...	1.00	...	1.00	...
Trimester 1	1.21	0.97-1.51	1.92	1.50-2.47	1.68	1.01-2.78
Trimester 2	0.97	0.77-1.12	1.44	1.12-1.84	0.77	0.43-1.36
Trimester 3	0.68	0.54-0.86	0.50	0.38-0.66	0.25	0.10-0.53
Unknown care	1.01	0.89-1.35	1.04	0.81-1.43	1.15	0.83-1.95

[a] Number of visits is held constant

* OR indicates odds ratio; and CI, confidence interval; No care is the reference category

Table 38A

Adjusted Odds Ratio by Prenatal Care Utilization Index For a Pooled Sample of Exposed and Unexposed Women Delivering in New York City Municipal Hospitals 1990-1992 *
N =12323

	Low Birth Weight <2500 g		Very Low Birth Weight <1500 g		Preterm <37 weeks	
	OR	95% CI	OR	95% CI	OR	95% CI
No care	1.00	...	1.00	...	1.00	...
Inadequate care	0.51	0.44-0.58	0.25	0.17-0.36	0.52	0.45-0.61
Intermediate care	0.47	0.38-0.58	0.25	0.13-0.44	0.37	0.29-0.46
Adequate care	0.43	0.35-0.53	0.40	0.24-0.64	0.50	0.41-0.62
Adequate plus care	0.96	0.78-1.17	1.30	0.88-1.89	2.80	2.31-3.39
Care unknown	0.73	0.62-0.85	0.65	0.46-0.90	1.14	0.95-1.37

* OR indicates odds ratio; and CI, confidence interval; No prenatal care is the reference category

Table 38B

Adjusted Odds Ratio by Prenatal Care Visits For a Pooled Sample of Exposed and Unexposed Women Delivering in New York City Municipal Hospitals 1990-1992 *
N = 12323

	Low Birth Weight <2500 g		Very Low Birth Weight <1500 g		Preterm <37 weeks	
	OR	95% CI	OR	95% CI	OR	95% CI
No visits	1.00	...	1.00	...	1.00	...
1 – 3 visits	0.86	0.73-1.01	0.65	0.46-0.91	1.15	0.97-1.35
4 + visits	0.48	0.42-0.54	0.29	0.22-0.32	0.54	0.47-0.62
Unknown visits	0.90	0.78-1.04	0.82	0.60-1.12	1.19	1.01-1.40

* OR indicates odds ratio; and CI, confidence interval; No visits is the reference category

Table 38C

Adjusted Odds Ratio by Trimester of Initiation of Prenatal Care[a] For a Pooled Sample of Exposed and Unexposed Women Delivering in New York City Municipal Hospitals 1990-1992 * N = 12323

	Low Birth Weight <2500 g		Very Low Birth Weight <1500 g		Preterm <37 weeks	
	OR	95% CI	OR	95% CI	OR	95% CI
No prenatal care	1.00	...	1.00	...	1.00	...
Trimester 1	1.51	1.23-1.86	2.61	1.67-4.07	2.80	2.27-3.45
Trimester 2	1.16	0.95-1.42	1.05	0.63-1.70	1.82	1.48-2.23
Trimester 3	0.72	0.58-0.89	0.27	0.12-0.53	0.64	0.51-0.80
Unknown care	1.29	1.02-1.62	1.33	0.77-2.19	2.85	2.15-3.78

[a] Number of visits is held constant
* OR indicates odds ratio; and CI, confidence interval; No care is the reference category

Table 39

Means and Frequencies of Selected Characteristics of Mother/Infant pairs Based on Urine Prevalence Study and matched birth certificates and Discharge Abstracts Kings County Hospital, November, 1991 – April 1992, New York (Percentages unless otherwise stated) N=1669

Urine Prevalence Study [q]				
	Cocaine + other drugs	Cocaine	Other drugs	Unexposed
Characteristics				
Cost per discharge ($)	13203	5829	3286	3771
Geometric mean cost ($)	6963	2481	2034	1665
Acute care LOS (days)	15.10	7.80	6.60	5.20
Geometric LOS (days)	9.90	4.80	4.90	3.40
Birth weight (grams)	2718	2895	3182	3241
Low birth weight (LBW)	39	18	14	9
Very Low Birth weight	8	3	2	2
African American	80	65	47	26
Mother's age	29	28	28	26
First birth	25	21	22	27
Smoked during pregnancy	86	56	40	11
Cesarean delivery	24	18	38	16
4 + prenatal visits	27	53	67	81
N	51	34	58	1136

Matched Birth Certificates and Discharge Abstracts				
	Cocaine + other drugs	Cocaine	Other drugs	Unexposed
Characteristics				
Cost per discharge ($)	13730	19143	7738	3972
Geometric mean cost ($)	9045	7044	5395	1939
Acute care LOS (days)	17.97	21.27	12.15	5.50
Geometric LOS (days)	13.06	16.12	9.04	5.26
Birth weight (grams)	2747	2286	2844	3221
Low birth weight (LBW)	36.36	53.85	25.64	9.87
Very Low Birth weight	6.06	23.08	0.00	2.10
African American	87.88	88.46	84.62	80.33
Mother's age	29	28	29	26
First birth	0.00	11.54	10.25	34.95
Smoked during pregnancy	75.76	57.69	64.10	6.81
Cesarean delivery	24.24	11.54	15.38	17.25
4 + prenatal visits	51.52	57.69	61.54	85.55
N	33	26	39	1571

[q] Figures in the top panel are from Table 1 in Joyce et al. (1995).

Table 40

Coefficients on Illicit Drug Use from Loglinear Regressions of Newborn Costs and Acute Care length of Stay from Urine Prevalence Study and Matched birth Certificates and Discharge Abstracts from Kings County Hospital. November 1991-April 1992

	Urine Prevalence Study [q]		Matched Birth Certificates and Discharge Abstracts	
Newborn Costs				
	Total effect	Direct effect	Total effect	Direct effect
Substances				
Cocaine	0.37[c]	0.06	1.09[a]	0.62[a]
	(0.18)	(0.13)	(0.166)	(0.13)
Other drugs	0.14	0.11	0.93[a]	0.79[a]
	(0.14)	(0.12)	(0.14)	(0.11)
Cocaine + other drugs	1.34[b]	0.95[b]	1.34[a]	1.17[a]
	(0.18)	(0.12)	(0.15)	(0.12)
Prenatal care				
4 + visits	-0.09	0.19[b]	-0.30[a]	0.0002
	(0.09	(0.06)	(0.05)	(0.04)
Adjusted R squared	0.10	0.47	0.18	0.51
N	1279	1279	1669	1669
Length of Stay				
	Urine Prevalence Study [q]		Matched Birth Certificates and Discharge Abstracts	
	Total effect	Direct effect	Total effect	Direct effect
Substances				
Cocaine	0.24	-0.002	1.37[a]	0.91[a]
	(0.14)	(0.10	(0.14)	(0.12)
Other drugs	0.15	0.06	0.97[a]	0.75[a]
	(0.09)	(0.07)	(0.11)	(0.11)
Cocaine + other drugs	0.84[b]	0.47[b]	1.11[a]	1.01[a]
	(0.13)	(0.08)	(0.13)	(0.12)
Prenatal care				
4 + visits	-0.28[b]	-0.05	-0.23[a]	-0.023
	(0.06)	(0.03)	(0.04)	(0.042)
Adjusted R squared	0.22	0.64	0.26	0.46
N	1279	1279	1669	1669

[q] Coefficients for newborn costs and length of stay from urine prevalence study are from Table 2 in Joyce et al. (1995).
[a] $p<0.0001$. [b] $p<0.01$. [c] $p<0.05$

Appendix Tables

Table A-1

Total Number and Proportion of Matched and Unmatched Mother/Infant Pairs from all deliveries in New York City Municipal Hospital System by Year, 1990-1992

Year	Matched Mother/Infants	Unmatched Mother/Infants	Total Infants	Percent Matched
1990	23122	12960	36082	62.8%
1991	24690	8614	33233	74.1%
1992	30860	606	31466	98.7%
Totals	78601	22180	100781	78.0%

Table A-2

Matched Mother/Infant Pairs by Year and by Facility as Obtained from Discharge Abstracts, New York City Municipal Hospitals, 1990-1992

Hospital	Year			Total
	1990	1991	1992	
Bellevue	1556	1850	1948	5364
Bronx Municipal	2325	2193	2026	6544
Coney Island	0	1070	2886	3956
Elmhurst	2637	2426	3398	8462
Harlem	1598	2038	2460	6098
Kings County	4312	3826	4080	12218
Lincoln	1762	1547	2087	5375
Metropolitan	3530	3740	3910	11210
North Central Bronx	2030	1995	2575	6600
Queens	3262	3043	3426	9731
Woodhull	131	890	2034	3055
Total	23122	24619	30860	78601

Table A-3

Proportion of Mother/Infant Pairs to all Birth in the Municipal Hospital System as Recorded by Birth Certificates by Year and Facility, New York City 1990-1992

Hospital	Year			Total
	1990	1991	1992	
Bellevue	0.81	0.93	0.96	0.90
Bronx Municipal	0.84	0.88	0.93	0.88
Coney Island	0.00	0.35	0.96	0.42
Elmhurst	0.57	0.64	0.98	0.71
Harlem	0.64	0.85	1.05	0.84
Kings County	0.89	0.85	0.99	0.90
Lincoln	0.57	0.66	0.97	0.71
Metropolitan	0.86	0.91	0.97	0.91
North Central Bronx	0.67	0.74	0.97	0.78
Queens	0.96	0.89	0.99	0.94
Woodhull	0.06	0.44	0.97	0.50
Total	0.65	0.75	0.98	0.78

Table A-4

Comparison of Study and Non-Study Infants Based on Infant's Length of Stay and Birth Weight from Discharge Abstracts, New York City Municipal Hospitals, 1990-1992

Characteristic	Year	Study Mean	Non-Study Mean	T-statistics
Infant LOS	1990-92	6.01	6.80	9.64
	1990	6.23	6.73	4025
	1991	6.20	6.89	5.01
	1992	5.70	7.06	3.03
Birth weight (grams)	1990-92	3203	3174	0.96
	1990	3248	3221	0.49
	1991	3168	3114	6.29
	1992	3198	3044	5.23

Table A-5a

Distribution of Drug Exposures in the Final Data Set Based on the HHC Designation, 1990-1992

Exposure	Number	Percent
Cocaine Only	595	0.8
Opiate Only	3,319	4.6
Cocaine and Opiates	40	0.1
Other Drug	8	0.0
Unspecified Drug	113	0.2

Table A-5b

Distribution of Drug Exposures in the Final Data Set Based on the Birth Certificate Designation. 1990-1992

Exposure	Number	Percent
Cocaine Only	1,905	2.6
Opiates Only	534	0.7
Cocaine and Opiates	77	0.1
Marijuana	290	0.4

Table A-5c

Distribution of Drug Exposures in the Final Data Set Based on Composite Designation, 1990-1992

Exposure	Number	Percent
Cocaine Only	1,112	1.5
Opiate Only	2,260	3.1
Cocaine and Opiates	1,291	1.8
Marijuana	189	0.3
Other Drug	5	0.0
Unspecified Drug	59	0.1

Table A-5d

Concordance Between HHC Designation and Birth Certificate Designation in the Final Data Set, 1990-1992

	Unexposed	Cocaine Only	Opiates Only	Cocaine and Opiates	Marijuana	Total HHC
Unexposed	67,983	554	89	12	184	68,824
Cocaine Only	370	197	12	2	14	595
Opiates Only	1,661	1,102	411	58	87	3,319
Cocaine and Opiates	15	13	10	2	0	40
Other Drug	5	2	0	0	1	8
Unspecified	59	37	12	1	4	113
Total Birth Certificate	70,093	1,905	534	77	290	72,899

References

Abma JC, Mott FL. Substance Use and Prenatal Care During Pregnancy Among Young Women. Family Planning Perspectives 1991;23:117-122.

Alexander GR, Cornely DA. Racial Disparities in Pregnancy Outcomes: The Role of Prenatal Care Utilization and Maternal Risk Status. American Journal of Preventive Medicine 1987;3:254-261.

American College of Obstetricians and Gynecologists (ACOG). Substance Abuse in Pregnancy. Technical Bulletin Number 195. July 1994.

Adirim T, Gupta N. A National Survey of State Maternal and Newborn Drug Testing and Reporting Policies. Public Health Reports 1991;106:292-296.

Bandstra ES and Burkett G. Maternal-Fetal and Neonatal Effects of In Utero Cocaine Exposure. Seminars in Perinatology 1991;15:288-301.

Bateman DA, Ng SK, Hansen CA, Heagarty MC. The Effects of Intrauterine Cocaine Exposure In Newborns. American Journal of Public Health 1993;83:190-193.

Behnke M, Eyler FD, Conlon M, et al. How Fetal Cocaine Exposure Increases Neonatal Hospital Costs. Pediatrics 1997;99:204-208.

Behnke M, Eyler FD. The Consequences of Prenatal Substance Use for the Developing Fetus, Newborn, and Young Child. The International Journal of the Addictions 1993;28:1341-1391.

Berenson AB, Wilkinson GS, Lopez AL. Effects of Prenatal Care on Neonates Born to Drug-Using Women. Substance Use and Misuse 1996;31:1063-1076.

Birchfield M, Scully J, Handler A. Perinatal Screening for Illicit Drugs: Policies in Hospitals in a Large Metropolitan Area. Journal of Perinatlology 1995;15:208-214.

Brantley M, Rochat R, Floyd V, Norris D et al. Population-Based Prevalence of Perinatal Exposure to Cocaine - Georgia, 1994. MMWR 1990;45:887-891.

Breitbart V, Chavkin W, Wise H, The Accessibility of Drug Treatment for Pregnant Women: A Survey of Programs in Five Cities. American Journal of Public Health 1994;84:1658-1661.

Broekhuizen FF, Utrie J, Van Mullem C. Drug Use or Inadequate Prenatal Care? Adverse Pregnancy Outcome in an Urban Setting. American Journal of Obstetrics and Gynecology 1992;166:1747-1754.

Buchi KF, Varner MW, Chase RA. The Prevalence of Substance Abuse Among pregnant Women in Utah. Obstetrics and Gynecology 1993;81:239-242.

Calhoun BC, Watson PT. The Cost of Maternal Cocaine Abuse: I. Perinatal Cost. Obstetrics and Gynecology 1991;78:731-734.

Chasnoff IF. Drug Use and Women: Establishing a Standard of Care. Annals of NY Academy of Science 1989;562:208-210.

Chasnoff IF, Griffith DR. Cocaine: Clinical Studies of Pregnancy and the Newborn. Annals of NY Academy of Science 1989;562:260-266.

Chasnoff IF, Burns KA, Burns WJ, Scholl SH. Prenatal Drug Exposure; Effects on Neonatal and Infant Growth and Development. Neurobehavioral Toxicology and Teratology 1986;8:357-362.

Chasnoff IJ, Griffith DR, MacGregor SM et al. Temporal Patterns of Cocaine Use in Pregnancy. Journal of the American Medical Association 1989;261:1741-1744.

Chassnof IF, Landress H, Barrett M. The Prevalence of Illicit-Drug or Alcohol Use During Pregnancy and Discrepancies in Mandatory reporting in Pinellas County, Florida. New England Journal of Medicine 1990;332:1202-1206.

Chavkin W, Allen MH, Oberman M. Drug Abuse and Pregnancy: Some Questions on Public Policy, Clinical Management, and Maternal and Fetal Rights. Birth 1991;18:107-112.

Chavkin W. Drug Addiction and Pregnancy: Policy Crossroads. American Journal of Public Health 1990;80:483-487.

Chazotte C, Youchah J, Freda C. Cocaine use During Pregnancy and low Birth Weight: The Impact of Prenatal Care and Drug Treatment. Seminars in Perinatology 1995;19:293-300.

Cherukuri R, Minkoff H. Feldman J, Parekh A, Glass L. A Cohort Study of Alkaloidal Cocaine ("crack") in Pregnancy. Obstetrics and Gynecology 1988;72:147-151.

Chow GC. Tests of Equality Between Sets of Coefficients in Two Linear Regressions. Econometrica 1960;28:591-605.

Corman H, Joyce T, Grossman M. Birth Outcome Production Function in the United States. The Journal of Human Resources 1987;22:339-360.

Davis M. NMIHS fact sheet. Hayattsville, MD.: National Center for Health Statistics, date not reported.

Day NL, Richardson GA. Prenatal Marijuana Use: Epidemiology, Methodologic Issues, and Infant Outcome. Clinics in Perinatology 1991;18:77-91.

Day NL, Cottreau CM, Richardson GA. The Epidemiology of Alcohol, Marijuana, and Cocaine Use Among Women of Childbearing Age and Pregnant Women. Clinical Obstetrics and Gynecology 1993;36:232-245.

Doberczak TM, Thornton JC, Bernsten J Kandall SR. Impact of Maternal Drug Dependency on Birth Weight and Head Circumference of Offspring. American Journal of Diseases of Children 1987;141:1163-1167.

Evans AT, Gillogley K. Drug Use in Pregnancy; Obstetric Perspective. Clinics in Perinatology 1991;18:23-32.

Feldman JG, Minskoff HL, McCalla S, Salwen M. A Cohort Study of the Impact of Pernatal Drug Use on Prenaturity in an Inner-City Population. American Journal of Public Health 1992;82:726-728.

Fiscella K. Does Prenatal Care Improve Birth Outcomes? A Critical Review. Obstetrics and Gynecology 1995;85:468-479.

Finnegan LP. Outcome of Children Born to Women Dependent Upon Narcotics. In Stimmel B. (Ed.) The Effects of Maternal Alcohol and Drug Abuse on the Newborn. 1982; 55-101. New York, NY: The Haworth Press.

Finnegan LP, Connaughton JF, Emich JP, Wieland WF. Comprehensive Care of the Pregnant Addict and its Effect on Maternal and Infant Outcome. Contemporary Drug Problems. 1972; 1:795-809.

Finnegan LP, Kandall SR. Maternal and Neonatal Effects of Alcohol and Drugs. In JH Lowinson, P Ruinz, RB Millman Eds. Substance Abuse: A Comprehensive Textbook Baltimore, MD: Williams and Wilkins. pp. 628-656.

Fitzsimmons J, Tunis S, Webster D, Izes J, et al. A Pregnancy in a Drug-Abusing Population. American Journal of Drug and Alcohol Abuse 1986;12:247-255.

Forrest JD, Singh S. Timing of Prenatal Care in the United States: How Accurate Are Our Measurements? Health Services Research 1987;22:235-253.

Frank DA, Bauchner H, Parker S, et al. Neonatal Body Proportionality and Body Compositions after in Utero Exposure to Cocaine and Marijuana. Journal of Pediatrics 1990;117:622-626.

Frank DA, Zuckerman BS, Amaro H, et al. Cocaine Use During Pregnancy: Prevalence and Correlates. Pediatrics 1988;82:888-895.

Fried PA. Marijuana Use During Pregnancy: Consequences for the Offspring. Seminars in Perinatology 1991;15:280-287.

Fried PA. Buckingham M, Von Kulmiz P. Marijuana Use During Pregnancy and Perinatal Risk Factors. American Journal of Obstetrics and Gynecology 1983;146:992-994.

Fried PA, Watkinson B, Grant A, Knights RM. Changing Patterns of Soft Drug Use Prior to and During Pregnancy: A Prospective Study. Drug and Alcohol Dependence 1980;6:323-343.

General Accounting Office (GAO). Drug-Exposed Infants A Generation at Risk. US General Accounting Office. 1991; Publication GAO/HRD-90-138.

Gillogley, KM, Evans AT, Hansen RL, Samuels SJ, Batra KK. The Perinatal Impact of Cocaine, Amphetamine, and Opiate Use Detected by Universal Intrapartum Screening. American Journal of Obstetrics and Gynecology 1990;163:1535-1542.

Gomby DS and Shiono PH. Estimates of the Number of Substance-Exposed Infants. The Future of Children 1991;1:17-25.

Gotmaker S. The Effects of Prenatal Care Upon the Health of the Newborn. American Journal of Public Health 1979;69:653-660.

Greenberg RS. The Impact of Prenatal Care on Different Social Groups. American Journal of Obstetrics and Gynecology 1983;145:797-801.

Grossman M. The Demand for Health: A Theoretical and Empirical Investigation. New York: National Bureau of Economic Research. 1972.

Grossman M, Joyce T. Unobservables, Pregnancy Resolutions, and Birthweight Production Function in New York City. Journal of Political Economy. 1990;98:983-1007.

Hollinshead WH, Griffin JF, Scott HD, et al. Statewide Prevalence of Illicit Drug use by Pregnant Women-Rhode Island. MMWR 1990;39:225-227.

Holzman C, Paneth N. Maternal Cocaine Use During Pregnancy and Perinatal Outcomes. Epidemiologic Reviews 1994;16:315-334.

Hurt H, Porat R, Gedon DE, et al. Nursery length of stay (LOS) is Increased in Infants of Cocaine-Abusing Mothers. Pediatric Research 1989; 254A.

Institute of Medicine. Infant Death: An Analysis by Maternal Risk and Health Care. In: Kessner DM, ed. Contrasts in Health Status. Vol. 1. Washington, DC: National Academy of Science, 1973.

Institute of Medicine. 1985. Preventing Low Birth Weight. Washington, DC. National Academy Press.

Jacobson JL, Jacobson SW, Sokol FJ, et al. Effects of Alcohol Use, Smoking, and Illicit Drug Use on Fetal Growth in Black Infants. Journal of Pediatrics 1994;124:757-764.

Johnson SF. McCarter RJ, Ferench C. Changes in Alcohol, Cigarette, and Recreational Drug Use During Pregnancy: Implications for Intervention. American Journal of Epidemiology 1987;126:695-702.

Joyce T. Self-Selection, Prenatal Care and Birthweight Among Blacks, Whites, and Hispanics in New York City. Journal of Human Resources. 1994;29:762-794.

Joyce T, Racine A, Grossman M. Neonatal Costs of Maternal Substance Abuse. Final Report for The National Institute on Drug Abuse. 1996.

Joyce T, Racine AD, McCalla S, Wehbeh H. The Impact of Prenatal Exposure to Cocaine on Newborn Costs and Length of Stay. Health Services Research 1995;30:341-358.

Kaestner R, Joyce T, Wehbeh H. The Effect of Maternal Drug Use on Birth Weight: Measurement Error in Binary Variables. Economic Inquiry 1996;34:617-629.

Kandall SR, Gartner LM. Late Presentation of Drug Withdrawal Symptoms in Newborns. American Journal of Diseases of Children 1974;127:58-61.

Kaye D, Elkind L, Goldberg D, Tytun A. Birth Outcomes for Infants of Drug Abusing Mothers. New York State Journal of Medicine 1989;89:256-262.

Keith LG, MacGregor S, Friedell S, Rosner M, et al. Substance Abuse in Pregnant Women: Recent Experience at the Perinatal Center for Chemical Dependence of Northwestern Memorial Hospital. Obstetrics and Gynecology 1989;73:715-720.

Korenbrot CC, Simpson L, Phibbs CS. Prenatal Care Needs Assessment Comparing Service Use and Outcomes in Fresno, CA. Public Health Reports 1994;109:68-76.

Kotelchuck M. An Evaluation of the Kessner Adequacy of Prenatal Care Index and a Proposed Adequacy of Prenatal Care Utilization Index. American Journal of Public Health 1994a;84:1414-1420.

Kotelchuck M. The Adequacy of Prenatal Care Utilization Index: Its US Distribution and Association with Low Birthweight. American Journal of Public Health 1994b; 84:1486-1489.

Krieger JW, Connell FA, LoGerfo JP. Medicaid Prenatal Care: A Comparison of Use and Outcomes in Fee-for-Service and Managed Care. American Journal of Public Health 1992;82:185-190.

Kumpfer KL. Treatment Programs for Drug-Abusing Women. The Future of Children 1991;1:50-60.

Little B, Snell LN, Klein VM, Gilstrap LC. Cocaine Abuse During Pregnancy: Maternal and Fetal Implications. Obstetrics and Gynecology 1989;73:157-160.

MacGregor SN, Keith LG, Bachicha A, Chasnoff IJ. Cocaine Abuse During Pregnancy: Correlation Between Prenatal Care and Perinatal Outcome. Obstetrics and Gynecology 1989;74:882-885.

MacGregor SN, Keith LG, Chasnoff IF, et al. Cocaine Use During Pregnancy: Adverse Perinatal Outcome. American Journal of Obstetrics and Gynecology 1987;157:686-690.

Matera C, Warren WB, Moomjy M, Fink DJ, Fox HE. Prevalence of Use of Cocaine and Other Substances in an Obstetric Population. American Journal of Obstetrics and Gynecology 1990;163:797-801.

McCalla S, Minkoff HL, Feldman J, Delke I, et al. The Biologic and Social Consequences of Perinatal Cocaine Use in an Inner-City Population: Results of an Anonymous Cross-Sectional Study. American Journal of Obstetrics and Gynecology 1991;164:625-630.

McCalla S, Minkoff HL, Feldman J. et al. Predictors of Cocaine Use in Pregnancy. Obstetrics and Gynecology 1992;79:641-644.

Melnilow J, Alemagno S. Adequacy of Prenatal Care Among Inner-City Women. The Journal of Family Practice 1993;37:575-582.

Meyer MB, Jonas BS, Tonascia JA. Perinatal Events Associated With Maternal Smoking During Pregnancy. American Journal of Epidemiology 1976;103:464-476.

Miller G. Addicted Infants and Their Mothers. Zero to Three 1989;8:20-23.

Miller JM, Bourdreaux MC, Regan FA. A Case-Control Study of Cocaine Use in Pregnancy. American Journal of Obstetrics and Gynecology 1995;172:180-185.

Murray JL, Bernfield M. The Differential Effect of Prenatal Care On the Incidence of Low Birth Weight Among Blacks and Whites in a Prepaid Health Care Plan. New England Journal of Medicine 1988;319:1385-1391.

National Institute on Drug Abuse. National Pregnancy and Health Survey Rockville, MD.: United States Department of Health and Human Services, National Institute on Drug Abuse, NIH Publication No. 96-3819; 1996.

Neerhof MG, MacGregor SN, Retzky SS, Sullivan TP. Cocaine Abuse During Pregnancy: Peripartum Prevalence and Perinatal Outcome. American Journal of Obstetrics and Gynecology 1989;161:633-638.

Noble LM, Kim M, Checola RT, et al. Cost of Maternal Drug Use on Neonatal Care in the South Bronx. Pediatric Research 1989; 225A.

Norton EC, Zarkin GA, Calingaert B, Bradley CJ. The Effect of Maternal Substance Abuse on the Cost of Neonatal Care. Inquiry 1996; 3:247-256.

Ostrea EM, Brady M, Gause S, Raymundo L, Stevens M. Drug Screening of newborns by Meconium Analysis: A Large-Scale, Prospective, Epidemiologic Study. Pediatrics 1992;89:107-113.

Pegues DA, Engelgau MM, Woernle CH. Prevalence of Illicit Drugs Detected in the Urine of Women of Childbearing Age in Alabama Public Health Clinics. Public Health Reports 1994;109:530-538.

Pettiti, DB, Coleman C. Cocaine and the Risk of Low Birth Weight. American Journal of Public Health 1990;80:25-28.

Phibs CS, Bateman DA, Schwartz RM. The Neonatal Costs of Maternal Cocaine Use. Journal of the American Medical Association 1991;266:1521-1526.

Poland ML, Dombrowski MP, Ager JW, Sokol RJ. Punishing Pregnant Drug Users: Enhancing the Flight From Care. Drug and Alcohol Dependence 1993;31:199-203.

Racine A, Joyce T, Anderson R. The Association Between Prenatal Care and Birth Weight Among Women Exposed to Cocaine in New York City. Journal of the American Medical Association 1993;270:1581-1586.

Rosenzweig MR, Schultz TP. The Behavior of Mothers as Inputs to Child Health: The Determinants of Birth Weight, Gestation, and Rate of Fetal Growth. In Economic Aspects of Health, ed. Victor R Fuchs. Chicago: University of Chicago Press for the National Bureau of Economic Research. 1982.

Rosenzweig MR, Schultz TP. Estimating a Houselold Production Function: Heterogeneity, the Demand for Health Inputs, and Their Effects on Birth Weight. Journal of Political Economy 1983;91:723-746.

Rosner MA, Keith L, Chasnoff I. The Northwestern University Drug Dependence Program: The Impact of Intensive Prenatal Care on Labor and Delivery Outcomes. American Journal of Obstetrics and Gynecology 1982;144:23-27.

Schulman M, Morel M, Karmen A, Chazotte C. Perinatal Screening for Drugs of Abuse: Reassessment of Current Practice in a High-Risk Area. American Journal of Perinatology 1993;10:374-377.

Schwartz RM. What Price Prematurity? Family Planning Perspectives 1989;21:170-174.

Showstack JA, Bundetti PP, Minkler D. Factors Associated With Birthweight: An Exploration of the Roles of Prenatal Care and Length of Gestation. American Journal of Public Health 1984;74:1003-1008.

Underwood P, Hester LL, Luffite T, Greg KV. The relationship of Smoking to the Outcome of Pregnancy. American Journal of Obstetrics and Gynecology 1965;91:270-276.

Vaughn AJ, Carzoli RP, Sanchez-Ramos L, Murphy S, Khan N, Chiu T. Community-Wide Estimation of Illicit Drug Use in Delivering Women: Prevalence, Demographics, and Associated Risk Factors. Obstetrics and Gynecology 1993;81:92-96.

Vega WA, Kolody B, Hwang J, Noble A. Prevalence and Magnitude of Perinatal Substance Exposures in California. New England Journal of Medicine 1993;329:850-854.

Volp KG. Cash subsidies to Medically Indigent Women: Incentives for Use of Prenatal Care. Public Health Reports 1994;109:175-176.

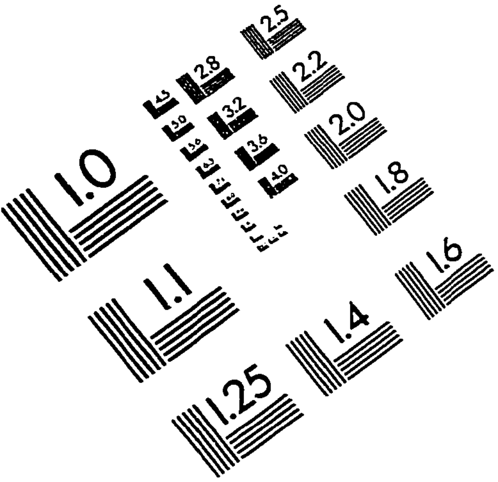
Yawn BP, Thompson LR, Lupo BR, Googins BK, Yawn RA. Prenatal Drug Use in Minneapolis-St. Paul, Minn. Archive of Family Medicine 1994;3:520-527.

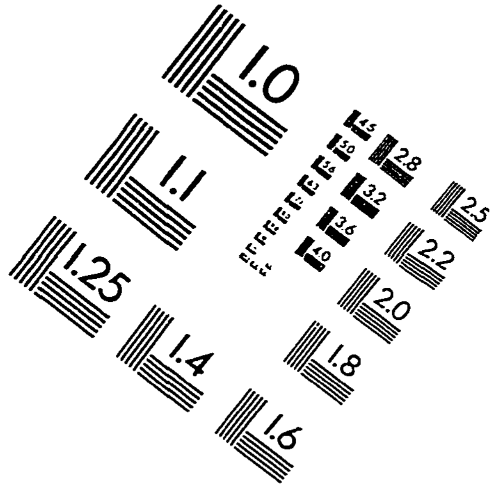
Zuckerman B. Drug-Exposed Infants: Understanding the Medical Risk. The Future of Children 1991;1:26-35.

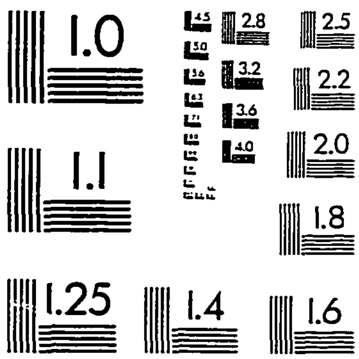
Zuckerman B, Bresnahan K. Developmental and Behavioral Consequences of Prenatal Drug and Alcohol Exposure. Pediatric Clinics of North America 1991;38:1387-1407.

Zuckerman B, Frank DA, Hingson R, et al. Effects of Maternal Marijuana and Cocaine Use on Fetal Growth. New England Journal of Medicine 1989;320:762-768.

IMAGE EVALUATION TEST TARGET (QA-3)







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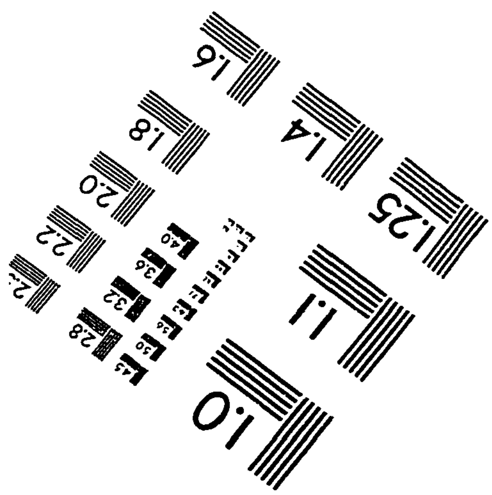

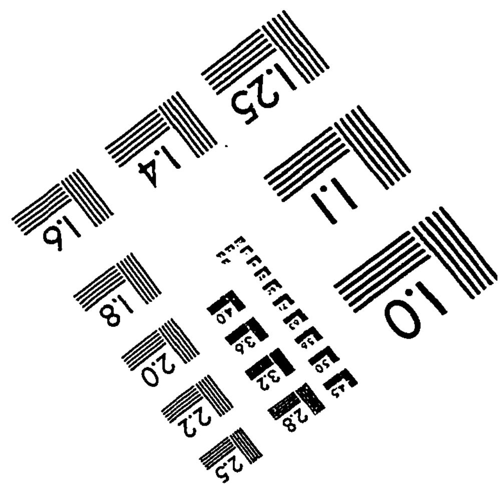

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