A

The Role of Self-Selection in Determining Prenatal Health Care and Infant Health for Asian Women

by

Jianjing Ling

A dissertation submitted to the Graduate Faculty in Economics in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

1998

UMI Number: 9820556

UMI
300 North Zeeb Road
Ann Arbor, MI 48103

This manuscript has been read and accepted for the Graduate Faculty in Economics in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

Jan 20, 1998 Linda N. Edwards

Date Chair of Examining Committee

Jan 20, 1998 Linda N. Edwards

Date Executive Officer

Linda N. Edwards

Michael Grossman

Theodore Joyce

The City University of New York

Abstract

The Role of Self-Selection in Determining Prenatal Health Care

and Infant Health for Asian Women

by

Jianjing Ling

Advisors: Professors Linda N. Edwards and Michael Grossman

This study examines the role of self-selection in determining prenatal health care and the infant health for Asian women in the U.S. The goal is to investigate the effect of using health inputs on the infant's health at birth, and to investigate the differences in birth outcomes and maternal behaviors between this minority group and whites. The dataset consists of vital statistic records in 1991 supplemented with local health area information from the 1990 Census of Population. The Asian sample includes people of the following ethnic backgrounds: Chinese, Japanese, Filipino, Hawaiian, and other Asian or Pacific Islanders.

I estimated infant health (measured by birth weight) production functions controlling for endogeneity and self-selection in the demand for prenatal care and private medical service. Estimates controlling for self-selection in using private medical

service provide an extension of the model. Prenatal care is measured by a modified version of the Kotelchuck index.

Tests for the endogeneity of the prenatal care inputs indicate that, rather than OLS, the appropriate estimation technique is Heckman's two-stage methodology to correct for sample selection bias. I find that the effects of prenatal care on birth weight are elevated as utilization of prenatal care increases except for the level of Adequate or Adequate plus, and the effects of private medical service on birth weight are less significant than that of prenatal care. In addition, I find that the demand for these two health inputs are determined primarily by women's health endowments and their financial status. The three notable differences between Asian and white women are: first, the proportion of receiving intensive levels of prenatal care or using a private physician service is lower for Asian women; second, the effect of prenatal care on birth weight is lower for Asian women; third, the use of substances such as alcohol, tobacco, and illicit drugs is highly associated with the probability of low birth weight for white infants, but not for Asian women. Furthermore, I find strong evidence of adverse selection in the decision to seek an intensive care.

Acknowledgments

I wish to express my gratitude to those who have given me invaluable help with this dissertation. Thanks to Professor Michael Grossman and Professor Linda N. Edwards, for providing valuable directions on theoretical considerations and on empirical implications throughout the past years. I am also very grateful to Dr. Charlotte Muller for her great help and guidance on this work. Thanks to Professor Theodore Joyce for helpful comments. Thanks to Dr. Haruko Noguchi for her help in many ways and for sharing the experiences of graduate student life in New York City.

Special thanks go to Michael and Julia, for all their love and support.

January 22, 1998
Jianjing Ling

Table of Contents

Chapter

List of Tables

I. Introduction

Asian subgroups are among the fastest growing minority groups in the United States[1]. However, there are very limited studies of women's demand behavior for prenatal medical care and the effects on infant health for this group.

Birth weight is a widely accepted indicator of infant health. Since the U.S. experienced higher infant mortality rate than other developed countries, the problem of access to prenatal care have been of central importance for developing public policies to improve the birth weight distribution in the United States.

Statistical data[2] show that the incidence of infant mortality and low birth weight differs across racial groups in the U.S. On average, Asians in the U.S. experienced lower rates of infant mortality than other racial groups. Compared with the infant mortality rate for the 1989-91 birth cohort of non-Hispanic white infants (7.3 deaths per 1,000 live births), mortality was 136 percent higher for non-Hispanic black infants (17.2/1,000), 42 percent higher for Puerto Rican infants (10.4/1,000), and 27-30 percent lower for Japanese (5.3/1,000) and Chinese (5.1/1,000) infants. Moreover, the U.S. experienced higher infant mortality rates than other developed countries. In 1992 the infant mortality rate in the U.S. was 88 percent higher than in Japan and 40 percent higher than in Canada.

---

[1] Many of them are new immigrants. For example, from 1981 to 1990, among all those who migrated to the US, 38% were Asian; this percentage in 1993 was 39.6%.
(Statistical Abstract of the United States 1995, Table 8.)

[2] Source: Health, United States, 1995, U.S. National Center for Health Statistics, Table 20.

Low birth weight (less than 2,500 grams) is associated with elevated risk of death and disability in infants. In 1993 the incidence of low birth weight among live-born infants was 7.2 percent, up from 6.8 percent in 1980. Between 1980 and 1993 the incidence of low birth weight increased among white babies from 5.7 to 6 percent and among black babies from 12.7 to 13.3 percent. However, the incidence of low birth weight decreased among Asian or Pacific Islander babies from 6.7 to 6.5 percent.

The goal of this dissertation is to investigate the relationship between infant health and the use of health inputs of Asian women in the U.S., using 1991 data from the New York City Bureau of Vital Statistics which record all women who gave a birth in that year. The study of demand for health inputs in particular focuses on prenatal care and the type of service used for delivery (private service). My research aims to answer the following questions: How Asian women's birth outcomes differ from other racial women? What is the role of prenatal care in obtaining better birth outcomes? What are the important determinants of Asian women's demand for prenatal health care?

In examing these issues, I pay special attention to two aspects. The first is the issue of self-selection in the demand for health care, and specifically in prenatal care. Women with poor health endowments will seek to offset them by initiating prenatal care earlier or visiting the doctor's office more often. Women's health endowment, which is generally unobserved by the researcher, not only affects the pregnancy and the birth outcome, but also conditions a women's behavior during the pregnancy (Joyce 1994). Ignoring the adverse self-selection of women who seek prenatal care would lead to an underestimate the effect of prenatal care on birth outcomes.

In addition to the previous work of others concerning the effect of self-selection on the use of prenatal care, this study extends the analysis to consider the possibility of a self-selection bias in the choice of private as opposed to public prenatal care and delivery service. It is assumed that the act of selecting between private and public care and delivery service in public hospitals is not exogenous but is also affected by women's unobservable characteristics such as health endowments. Many people believe that private doctors provide better continuity of care during pregnancy and through delivery. Women who anticipate a problematic pregnancy and birth may be more likely to use private physician service. Thus, to circumvent the potential estimation problems resulting from possible correlations between health inputs and the disturbance term in the birth weight production function, both the demand for prenatal care and the demand for private service are estimated jointly with the birth weight production function by using Heckman's two-stage procedure for the sample selection model. The non-random nature of the selection bias will be tested.

The second issue is how best to measure the use of prenatal care. Previous analyses largely used the timing of initiation of prenatal care, or the Kessner Index, to measure the level of prenatal care. The shortcoming of these measurements is that they fail to distinguish between women whose utilization behavior is vastly differ after the care is initiated. In this study, an Adequacy of Prenatal Care Utilization Index is applied to measure the different levels of prenatal care (Kotelchuck 1994). This "Kotelchuck Index" is modified by putting "no care" into a fifth category (G. F. Joyce 1995). Thus, the modified Kotelchuck Index I use distinguishes among five levels of prenatal care:

Adequate plus, Adequate, Intermediate, Inadequate, and No care. Birth outcomes of these women are dramatically different from those in the Kessner's three categories of care. Use of a more refined index of prenatal care allows me to identify women most likely to gain from government health policies.

Previous studies have made certain comparisons among whites, blacks, and Hispanics on maternal behaviors and birth outcomes, but separate analysis of Asian women in the U.S. has been rare. This analysis will perform a comparison of Asian women with non-Hispanic white women.

Section II of this study surveys the literature related to women's demand for health care and infant health production. Section III identifies the household production function that applies to infant health production function, and presents the development of the empirical model and the method of analysis. Section IV introduces the data from New York City birth records, and describes the model estimation technique. Section V discusses the results, and Section VI summarizes main conclusions and indicates some policy implications.

II. Literature Review

This chapter presents findings of a variety of recent studies concerned with the behavior of women with respect to their demand for health care and the effects of health care on infants' birth weight. My reviews focus on the theoretical developments and empirical findings of research on demand and production functions, issues of self-selection, risk factors for low birth weight, other impacts on prenatal care, and racial and ethnic differences in birth characteristics.

2-1. Theoretical studies

The theoretical approach to the demand for health care was built upon the theories of human capital and consumer behavior. In the Grossman's model (1972), health has both consumption and investment components. Health is a consumption good because it directly affects utility, and an investment good since it minimizes lost market time, thereby raising utility by increasing income. Individuals augment their stock of health capital through investments in health.

Health outcomes are determined by technical biological processes: health inputs (i.e., food, medical care) are converted into health outcomes by some production technology. Assuming that utility-maximizing individuals attach positive value to good health outcomes, this yields the principal insight that some goods are not demanded for their direct utility, but rather because they are instrumental in the production of another good (health), which in turn does have direct utility benefits. For example, prenatal care is valued by a pregnant woman for its beneficial effects on the health of her unborn child, which is affects her utility, and on her own health as well.

The health production approach has proved very fruitful in the literature on birth outcomes and infant health. Rosenzweig and Schultz (1983) derive a household production model to interpret the hybrid-type health equations and to assess the effects of health heterogeneity on health behavior and its consequences for estimating the health technology used, using data on the 1967 -69 U.S. National Natality Followback Surveys. The authors estimate an infant health production function using birth weight as an important health indicator, and a set of behavioral variables considered to be the determinants of birth outcomes - prenatal care, working and smoking by the mother during pregnancy, the number of previous births, and the mother's age.

Their results indicate that OLS estimates of the birthweight production function are significantly contaminated by heterogeneity bias. In particular, neglect of heterogeneity appears to lead to a substantial underestimate of the beneficial effects of early prenatal care on the weight of an infant at its birth. There are exogenous variations in health endowment that are known to individuals but not to the researcher (health heterogeneity). These health endowments may affect health outcomes both directly, as they feed into the production technology used, and indirectly, through their effect on the choice of health inputs. The decision to purchase a certain health input may, for example, be triggered by the desire to compensate for an inherent endowment deficiency. Variations in these unobserved health endowments may thus lead to correlations between health input allocations and health outcomes that cannot be used to derive causal conclusions. So, consistent estimates are reported of the effect of endogenous inputs, such as medical care, smoking, and fertility, on birth weight and fetal growth in the presence of health heterogeneity.

Cameron and Trivedi (1988) develop a model of demand for health care under uncertainty to throw light on the issue of health insurance-induced distortions in the demand for health care services. Their theoretical challenge is to derive tractable, closed form and relatively unrestricted demand functions for health insurance and health care for a risk-averse consumer planning under uncertainty. At the econometric level, the critical task is to distinguish the relative importance of the price of services, the so-called moral hazard problem, and self selection in determining the demand for health care.

The authors assume a consumer with a two-period utility function defined by $U[C_0, C_1(s), H(e, s| A, B)]$ where C denotes consumption and H denotes health measured as an income equivalent. U and H are both increasing in their arguments. 0 and 1 refer, respectively, to the current and future periods, s to the uncertain health state. H(.) is regarded as the health production function with input e in state s. Uncertainty arises because at the time the insurance policy is chosen, the health state s is unknown. In brief, the allocation problem is to maximize the expected U function subject to income and budget constraints, in two periods, that must be satisfied for all s. For parametric forms for either the utility function or the demand function, the authors use a tractable direct utility function to derive the demand equations. Application of the dynamic programming method yields the demand equations for C_1, a, e, conditional on insurance policy j and health state s. When micro-level data from the Australian Health Survey were used for estimation, the results indicate that health state appears to be more important in determining health care service use than health insurance choice, while income appears to be more important in determining health insurance choice than in determining health care services use. For a broad range of health services (doctor, hospital, medicines), the authors observe higher use of service on average for those people with insurance policies with more generous coverage. Furthermore, the effect is greater for those services whose net prices vary more with the type of insurance. This health insurance effect is found to be the result of both moral hazard and self-selection.

2-2. Empirical work and findings

There is a tremendous volume of empirical studies. Many of these touch on different points of interest. They are classified into five subjects in Section 2-2-1 to 2-2-5.

The empirical work will be reviewed in the following outlines:

1) How the models are derived?

2) the determinants in the models,

3) estimation methodologies,

4) major findings.

2-2-1. Infant health production

Corman, Joyce, and Grossman (1987) study infant health production functions that simultaneously consider the effects of a variety of inputs on race-specific birth outcomes. The authors took the neonatal mortality rate as the principal birth outcome, with the incidence of low birth weight (2,500 grams or less) as an intermediate outcome. This allows them to examine the extent to which prenatal inputs operate directly on mortality and also to examine the indirect effects on mortality rates through low birth weight.

The authors assume that the parents' utility function depends on their consumption, the number of previous live births, and the survival probability of each birth (which is assumed not vary among births in a given family). Both the number of births and the survival probability are endogenous variables. The survival probability production function depends upon such endogenous inputs as the quantity and quality of medical care, nutrition, and the own time of mother. In addition, the production function is affected by the reproductive efficiency of a mother, including the unobserved biologically endowed probability that her infant will survive the first month of life, and other aspects of her efficiency in household production.

In their structural neonatal mortality production function, the probability that an infant dies within the first month of life at the county level is shown as a vector of prenatal and neonatal care inputs, a vector of prenatal medical inputs, the use of abortion services, the use of contraceptive services, the probability that the infant is born weighing less than 2500 grams, and the infant's biological endowment. The replacement of low birth weight by its structural determinants yields the quasi-structural production function. The model also generates demand functions for birth weight and the five health inputs: prenatal care, neonatal intensive care, teen family planning, abortion, and WIC (the Supplemental Food Program for Women, Infants, and Children). In each of six equations, the dependent variable is related to a vector of price and availability measures, socioeconomic characteristics that reflect command over resources and tastes, the exogenous risk measure, and the biological endowment. Production functions are estimated by two-stage least squares because the inputs are correlated with the disturbance term, which reflects in part the endowment.

The authors find that black neonatal mortality rates are more sensitive to the use of abortion and prenatal care services than are white neonatal mortality rates. The results also indicates the potential importance of neonatal intensive care in the determination of neonatal mortality rates, particularly for blacks. Neonatal intensive care ranks fourth in importance behind prenatal care, abortion, and WIC in explaining declines in both white and black neonatal mortality between 1964 and 1977. These results also suggest an explanation of the slowdown in the downward trend in neonatal mortality in the early 1980s. The abortion rate of white women reached a peak in 1980 and was stable between 1980 and 1981. The abortion rate of black and other nonwhite women peaked in 1977 and declined every year since then with the exception of 1980 (Bureau of the Census 1984). The introduction and diffusion of new techniques in neonatology slowed appreciably in the late 1970s and early 1980s.

Rosenzweig and Wolpin (1991) study inequality at birth --the high degree of population dispersion of an indicator of children's well-being at-birth. The authors utilize information on birth weight and gestational age among siblings and maternal behaviors relevant to birth outcomes to decompose the variable that represents child health at birth into those components associated with variance in endowments, the response of health-relevant behaviors to endowments, the correlation between health endowments and the environmental variables influencing the household choices, and measurement error. The model has been used to study intra-family resource allocation. Each household in a population is assumed to maximize lifetime utility, which depends on the 'final' average health stock of its children and a composite commodity. Households differ in the initial or exogenous healthiness conferred upon children. Children born in different households thus are initially endowed with different levels of healthiness, net of any resources allocated to them. The health stock of each child not only depends on its health endowment but also on the amount of purchased health-related inputs and fertility-related parental behaviors such as the age of the mother, birth order, and birth intervals. Because children are born at different points in time, the prices confronting each household for child-specific resources may differ across children; thus the level of resources allocated to each child and the final health of children within the household may also differ even if they have a common endowment. Moreover, if there are borrowing constraints and if household income varies over time, the optimal level of inputs will differ across children within a household even if input prices remain fixed over time. Thus, utility-maximizing behavior will generally lead to unequal child health outcomes within the household net of any biological birth order effects. And differences in constraints, opportunities, and endowments across households influence the distribution of health across children born to different mothers.

Using this framework, the authors implement a methodology for the decomposition of birth outcome inequality, as measured by the variance in birthweight and gestation, into components associated with two fundamental factors - a mother - specific endowment common to all births to a woman and to the birth outcome measures, and a factor representing optimizing constraints, such as income and prices. The maternal endowment, which is impervious to policy interventions, not only directly contributes to inequality but indirectly affects inequality through its effect on the resources allocated by parents that influence endogenously the birth outcome measures. The estimates based on the 1979 National Longitudinal Survey (NLS) of Youth show that although most of the maternal behaviors presumably subject to policy intervention significantly affect birth outcomes, the variation in the maternal endowment across households contributed almost 90 percent to the (predicted) birthweight variance and 40 to 44 percent to the gestation variance net of measurement error. The results also rejected the hypothesis that birthweight and gestation are measures of a common health factor; each is affected distinctly by parental behaviors. Their findings thus suggest that if all constraint variation were eliminated, i.e., if absolute equality of opportunity were provided for children, in part by equalizing parental incomes, most of the observed inequality at-birth would remain. Moreover, even if compensatory interventions were used, at-birth inequality reductions would be small. In general, targeting policies that would create an inverse correlation between endowments and constraint sets would require knowledge not only of the effects of the constraints on input allocations, but also of the effects of family endowments on family decisions. To obtain such knowledge it is necessary to have measures of all the constraints relevant to allocation decisions that are correlated with the endowment.

Warner (1995) investigates prenatal care demand and the health of newborn infants of black women. The author extended the birthweight production function model by incorporating the number of visits, timing of the initiation of care, and a visits/delay interaction term into prenatal care demand. This interaction term measures the degree of substitution or complementarity between delay and visits, if any exists.

Income and availability measures enter the demand function for prenatal care. The variables used to measure income are the mother's and father's education, the source of financing for the birth, the unemployment rate in the mother's borough of residence in the year of the birth, and the mother's race-specific poverty rate in the health area in the year of the birth. The availability of care is measured by the number of prenatal care clinics and the number of family planning clinics in the mother's health area of residence. Other demand determinants are the mother's age, her marital status, and her place of birth. The birthweight functions are determined by the mother's predicted prenatal-care use, substance use, and her characteristics. The mother's characteristics are her nonmarket productivity measured by her education, marital status and birthplace, miscarriage history, and her lack of knowledge of the father's education level. Year dummy and cohort variables, z, are included in order to capture time effects.

The major finding is the low productivity of prenatal care for black women. In addition, there is a substitutability between delay and visits, ie. those who delay longer can compensate by more frequent visits. The results also indicated that poor health endowments and poor health habits lead to low birth weights.

The impact of early initiation of prenatal care on birthweight outcomes is studied by Frank, Strobino, et al. (1991). They estimated quasi-structural birthweight production functions using data on counties for the years 1975-84. The analysis focuses on the effects of first-trimester initiation of prenatal care, controlling for use of abortion services, smoking, birth order, and income. A fixed-effects model is used to control for unmeasured differences in health endowments of women across counties. The estimation focuses on the single-stage equations because the authors found that first-stage estimates in two-stage least squares models had rather weak explanatory power (R-squared = 0.13 - 0.15) which leads to instability in the coefficient estimates of the production function.

The results indicate that the expansion of early initiation of prenatal care will make only a small contribution to reducing the risk of low birth weight. Moreover, as a strategy for reducing differences in birthweight outcomes by race, expanding early initiation of prenatal care by blacks would have a minor impact on that differential.

Akin, Guilkey, and Popkin (1991) study the production of infant health in a model which focuses on input demand and health status differences related to the gender of the infant. The authors use a health production function in which gender is viewed as affecting infant health both through its effects on investment in health related inputs and through biological differences in the effects of inputs and in health endowments. The purpose is to test whether there are greater gender-specific investments in various inputs (e.g., feeding patterns and preventive health care) and whether these affect infant morbidity and subsequent infant growth.

The authors' theoretical model closely follows models suggested by Rosenzweig and Schultz (1982, 1983). The child's health at time t is expressed by a set of lagged endogenous variables, a set of exogenous variables that affect child health, and an unobserved variable that captures the initial health endowment of the infant. The model also contains lagged values of child health, indicating that there may be lagged effects of such variables as previous illnesses or health care use. The infant's weight is selected to represent the outcome of the health production process.

The authors used instrumental-variables methods to obtain consistent parameter estimates. The endogenous variables include indicators of ill health, health inputs (such as caloric intake, breast-feeding, and an index of nutrition status), and use of preventive care. In the estimation, gender is entered directly into the equations and interacted with each other variable of the model.

The estimation results show that in a Cebu, Philippines urban sample, there do appear to be some significant gender-related differences in health input demands. Simulations also lead to the prediction of slightly different patterns of health inputs for male and female children. Once male and female weight differences are controlled, growth does not appear to differ significantly for males and females.

2-2-2. Issues of self-selection

In the study of demand for health care and the child health production function, the issue of self-selection has been addressed by many economists. Self-selection creates an estimating problem because the correlation between unobserved variables and endogenous inputs causes estimates of the effects of these inputs to be biased. Selection bias has to be corrected in order to get consistent estimates of parameters.

Women's using of prenatal care, or making an induced abortion is their self-selected choices. Those women are not sampled randomly from the population. The selection bias as a specification error has to be corrected to get unbiased estimates (Heckman, 1979). Heckman's two-stage estimation procedure, which is based on the method of moments and satisfies the criterion of consistency, is one of the methodologies for correction.

Grossman and Joyce (1990) study infant health production functions that simultaneously control for self-selection in the resolution of pregnancies as live births or induced abortions and in the use of prenatal care services. They pointed out that the use of an instrumental-variable approach to correct for self-selection of input use presupposes that this decision is characterized by adverse selection and ignores the problem of self-selection in the resolution of pregnancies. The authors estimate a three-equation model of birth outcomes by Heckman's procedure: the probability of giving birth, given that a woman is pregnant; infant health production function (measured by birth weight); and prenatal care demand function. The determinants of birth probability are the optimal number of children, the spacing of births and family income, mother's education, and marital status. The cost of obtaining the abortion, and the cost of contraception, which is directly related to money price and indirectly related to availability and to contraceptive efficiency or knowledge, are also included in the birth probability function. The determinants of infant birth weight are the sex of the baby, prenatal care, and the mother's previous fetal loss. In the prenatal care demand function, explanatory variables are such correlates of the price of prenatal care defined as the presence of health insurance that finances this service, and the number of prenatal-care providers in the mother's area of residence.

The results suggest that there is strong evidence of selectivity bias in the birth weight production function and the prenatal demand equation among blacks. Such evidence of bias is not apparent among whites. For blacks, the unobserved factors that raise the probability of giving birth are positively correlated with the unobserved factors that decrease delay in the initiation of prenatal care and increase birth weight. These findings are consistent with the interpretation that the mean shadow price of contraception and the variance in this price are greater for blacks than for whites.

In the study of the impact of the wantedness of a pregnancy on the demand for early initiation of prenatal care (Joyce and Grossman 1990), women who give birth are treated as a self-selected sample from the population of pregnant women. The measure of wantedness of the pregnancy is that pregnant women who choose to give birth differ in unobserved ways from similar women who voluntarily terminate their pregnancies.

Equations of prenatal care demand (measured by the months of delay in which prenatal care initiated), and birth probability (1 if give birth, 0 if abort) are estimated simultaneously by maximum likelihood instead of Heckman's procedure.

The authors find evidence of selectivity bias in the prenatal-care demand equations for blacks and Hispanics irrespective of age, but not for whites. The negative correlation between the residuals in the pregnancy resolution equation and the prenatal care demand equation is consistent with the interpretation that women whose pregnancies that are more wanted delay the initiation of prenatal care less.

The demand for prenatal care as the choice in a model of sample selection with endogenous switching is studied by Joyce (1994). The author estimates the effects of prenatal care on birth weight for the total population and for women who were observed to have chosen a particular level of care, and exploits the ordered nature of the prenatal care variable in the correction of sample selection. The level of prenatal care is measured by a modified Kessner index. The selection bias is tested by Heckman's procedure. Gain or loss of birth weight from alternative choices has been compared by conditional mean birth weight of seeking each level of care.

The results suggest that OLS underestimates the true effects of prenatal care. There is adverse selection in the demand for prenatal care. Women who anticipated a problematic pregnancy seek higher levels of care than similar women with more favorable expectations. The effects of prenatal care for women who choose a level of care generally exceed the effects that would be expected for any woman from the total population.

Panis and Lillard (1994, 1995) study the relationship between child mortality and the use of health care in Malaysia. They model child mortality jointly with two decisions related to health care demand: the decision to obtain prenatal care, and the decision to deliver in a clinic or hospital. They suggest two sources of potential selective bias in the estimation of the child production function. The first one stems from self-selection of the amount of input factors that are used. The second one stems from selective fetal survival. So a joint estimation of fetal and postnatal survival is performed in order to distinguish production technologies before and after birth. A significant and positive correlation of both technologies is found.

A hazard model is applied for fetal and postnatal mortality, which include an random heterogeneity term that is correlated with mortality residual terms. The probit binary choice specification is for receiving prenatal care and delivering the baby in a hospital or clinic.

The major findings are that prenatal care and institutional delivery have strong beneficial effects on child survival probabilities, and these effects are substantially underestimated when adverse selection among users of health care is ignored. The risk of infant and child mortality is not independent of fetal survival. Higher infant and child mortality rates among young mothers are partly explained by their lower likelihood of purchasing health care.

The authors also conclude that increased use of prenatal care and institutional delivery contribute to the dramatic decline of infant and child mortality in Malaysia between 1950 and 1988. Increased education by mothers indirectly contributed to the reduction of infant and child mortality by increasing efficient health production technology, such as improving nutrition, stimulating breastfeeding, or encouraging pediatric care. In addition, higher earnings are also associated with lower mortality.

Finally, the mortality rate is higher among Malay children than among their Chinese counterparts. This ethnic difference is explained by higher income levels and more frequent use of medical assistance among the Chinese.

2-2-3. Risk factors for low birth weight

Low birth weight is highly correlated with infant mortality. The U.S. has an infant mortality rate above many of its partners in the OECD (Pample, Pillai, 1986). This has been a continuing source of concern for health policy makers.

Jones (1991) investigates determinants of low birth weight in the United States. In his analysis, the percentage of low birth weight babies is influenced by medical intervention, teenage, unmarried status, the abortion rate, personal income per capita, the percentage of families below the poverty line, the unemployment rate, the percentage of AFDC and SSI recipients, the percentage of educated population. The linear regression is supplemented with non-nested tests (Davidson and MacKinnon's J-test) for comparing models with 'simple' and 'interaction' demographic variables. The results show that significant effects of risk factors on low birth weight vary between white and black samples.

The dynamic relationship between low birth weight and induced abortion has been studied by Joyce and Grossman (1990). The authors believe that if there is a relationship between low birth weight and induced abortion, then one would expect changes in the percentage of pregnancies terminated by induced abortion to precede changes in the rate of low birthweight. A vector autoregression (VAR) including linear trend terms is applied to monthly race-specific data from the New York City on the percentage of low birth weight births, the percentage of births to women who began care in the first trimester and the percentage of pregnancies terminated by induced abortion.

The major findings are that there is a unidirectional relationship between decreases in the percentage of pregnancies terminated by induced abortion and increases in the rate of low birthweight births for black women. Such a relationship is not confirmed by the data for whites. Simulations based on the model reveal that an unanticipated decrease in the percentage of pregnancies that are voluntarily terminated would have a substantial impact on the rate of low birth weight among blacks.

Another study of low birth weight has been done by Joyce, Racine, and Mocan (1992), who examine the excess of low birth weight babies during the 1980s which can be attribute to maternal illicit substance abuse, after controlling for other risk factors. The authors estimate a structural health production function with a pooled time-series cross-section of all NYC singleton live births, aggregated by health district, for the ten year period 1980-1989.

In their structural production function, the risk factors for low birth weight are women with no or unknown prenatal care, out-of-wedlock births, births to women with four or more previous live births, women who smoked during pregnancy, and women who used illicit substances (cocaine, heroin, methadone, and barbiturates) prenatally. The low birth weight function also includes fixed or random effects to adjust for time- and district-specific effects. An instrumental variable, the number of deaths due to drug dependency per 100,000 residents by health district and by year, is used to obtain unbiased estimates of the marginal effect of observed illicit substance use on low birth weight. The cost of low birth weight is limited to initial hospitalization after delivery. The study estimates the average neonatal cost per birth for various birth weight categories including survivors and non-survivors but exclusive of infants born weighing less than 500 grams.

The results show that the independent effect of illicit substance use varied substantially by race with little effect demonstrable among whites, a potentially important but not robust effect discernible among Hispanics, and a statistically significant effect detectable in the black population. Based on the neonatal admission cost estimated, the authors conclude that illicit substance use was a major contributory factor in generating the unprecedented rise in low birth weight among blacks in New York City in the latter part of the 1980s.

Currie and Cole (1993) investigate the relationship between a mother's participation in AFDC during pregnancy and the birth weight of her child by controlling for both observed and unobserved characteristics of the mother. Important unobserved characteristics listed are: the 'wantedness' of the child, perceptions of welfare "stigma," illegal drug use, supportiveness of parents, adequacy of housing, and stress.

The results suggest that mothers on AFDC are more likely to have children at younger ages, to smoke, to drink, and to delay obtaining prenatal care. Also they bear children of lower birth weight than do other mothers. However, the association between participation in AFDC and poor pregnancy outcomes disappears when omitted unobservable variables are controlled for using either instrumental-variables techniques or models with mother fixed effects. The findings indicate that the same mothers who are most likely to participate in AFDC are also most at risk of having low-birth weight babies but this relationship is not causal.

Other factors relating to low birth weight could be maternal employment during pregnancy. and paternal smoking. Peoples-Sheps et al. (1991) and Zhang et al. (1993) have done analysis on these two subjects, respectively.

Logistic regression was used to associate birth of low birth weight or preterm labor with maternal work characteristics. The findings are as follows: those who worked 40 or more hours per week were more likely than women who worked fewer hours to have a low birthweight delivery at more than 37 weeks. No physical or environmental characteristics of work were associated with low birthweight or preterm delivery. Non-black married American women may face a risk of delivering low-birthweight babies at or near term only if they work 40 or more hours each week.

In Zhang's study, infants with environmental tobacco smoking exposure were, on average, 30g lower in birthweight than nonexposed infants, after adjustment for gestational age, parity, maternal age, and occupation. This finding is consistent with other research, suggesting that smoking may have a modestly adverse effect on birthweight.

2-2-4. Other impacts on using prenatal care

Some researches investigate other factors that influence the use of prenatal care, which broaden our understanding of this issue.

York, Williams, and Munro (1993) study factors that influenced women's decisions to obtain prenatal care. The use of prenatal care can be limited by a woman's attitude toward her pregnancy and toward prenatal care, by her cultural beliefs, lifestyle, and other psychological attributes (Poland, 1989). Unlike other studies, which cite financial problems as the major barrier, the authors identify, from the woman's perspective, factors that influence inadequate prenatal care when free care is available and accessible. An interview questionnaire was developed for this study.

Twenty-two personal reasons and structural barriers are identified as factors in receiving inadequate prenatal care. The four most frequently cited reasons were "small children at home", "no medical assistance card", "sadness or ambivalence about the pregnancy", and "just moved to the area". Women also volunteered personal reasons that are not usually discussed in the literature, and these were psychosocial determinants and major barriers to prenatal care. Social reasons, such as a dislike of hospitals, problems at home, and recent change of address, were listed by some women. Other factors, such as unemployment, single parenthood, and interpersonal conflicts with the father or the baby and family, also contributed to women's receiving inadequate prenatal care.

Hansell (1991) examines maternal sociodemographic factors that are related to the adequacy of prenatal health services that U.S. women receive. The adequacy of prenatal care in this study is measured by the quality of health services rather than the timing and quantity of visits. Maternal sociodemographic factors include age, education, marital status, parity, race, and geographic location. Indicator variables for prenatal care quality are the percentage of prenatal visits at which blood pressure and urine were tested, the performance of hemoglobin or hematocrit tests, and the presence or absence of advice regarding salt restriction and diuretics usage during pregnancy. Data from the 1980 National Natality Survey and the 1980 Fetal Mortality Survey were used for the analysis.

The results point out that prenatal care is far from being of even minimally acceptable quality for many women who have made the effort to engage the prenatal care system. Distribution of the tests done to monitor the health of pregnant women varied substantially according to sociodemographic factors, as did the kinds of prenatal advice given. The variability of quality of care according to maternal sociodemographic attributes may be explained in two ways. First, physicians allow their clinical judgment to be significantly affected by the nonmedical characteristics of the woman they are treating. Second, women of different sociodemographic backgrounds are obtaining health services from providers of substantially different quality.

2-2-5. Racial and ethnic differences in birth characteristics

Racial and ethnic differences in birth characteristics or outcomes , especially for minority groups in the USA, have been studied to a very limited extent.

One of the attempts to explain the racial and ethnic differences in birthweight studies the role of income and financial assistance from relatives and public programs

(Cramer 1995). The author constructs a causal model of birthweight containing exogenous social and demographic risk factors and intervening proximate determinants of birthweight. Income, both from earnings and from family and public assistance, is associated with birth weight in the expected direction in all models. Low income accounts for much of the excess incidence of low birth weight among black and other minorities. When annual incomes are unstable, income can also be measured by duration of poverty and number of poverty spells. Birth weight may be affected by the stresses involved in obtaining income and assistance.

Singh and Yu (1994, 1996) investigate birth weight differentials among Asian Americans, and differences in adverse pregnancy outcomes between US and foreign-born women in major US racial and ethnic groups. Chinese, Japanese, and Filipino infants show significantly lower mean birth weight than white infants. The risk of low birth weight was 45% higher for Filipinos, and 49% higher for blacks as compared with whites. After controlling for ethnic differences in sociodemographic risk factors, Filipinos appear to resemble blacks much more closely than they do their Japanese and Chinese counterparts with respect to risk for low birth weight.

The adverse pregnancy outcomes include infant mortality, low birth weight, and preterm birth. The study results show that there are substantial maternal nativity differences in risks of infant mortality and low birth weight. Overall, foreign birth status was associated with 7% and 20% lower risk of low birth weight and infant mortality, respectively. However, the reduced risk of adverse pregnancy outcomes associated with immigrant status tended to be substantially larger for blacks, Cubans, Mexicans, and Chinese than for other ethnic groups.

Helsel et al. (1992) investigate pregnancy and birth weight among Hmong in California. Mean birth weight of Hmong infants was lower than that of non-Hispanic whites. Hmong women were of much higher parity and were more likely to deliver at a young (<18 years) and an old (>40 years) age. However, Hmong women gave birth to very low birthweight babies at essentially the same rates as white women. Their Cesarean section rates were very low (one-half to one-tenth of the rate of whites).

There are two studies on Mexican-Americans' use of prenatal care and its relationship to maternal risk factors and pregnancy outcomes in Arizona (Balcazar et al. 1992, Moore et al. 1994).

Balcazar et al. evaluate the adequacy of prenatal care using a "Gindex" that accounts for the month of initiating care, the number of prenatal visits, and the duration the of pregnancy. The results show that non-Hispanic whites, compared to Mexican-Americans, have a greater risk for low birth weight and preterm delivery in those groups receiving poor prenatal care versus those who received adequate care. Mexican-Americans had a higher overall prevalence of preterm delivery and macrosomia than of low birth weight. Among Mexican-Americans the risk of low birth weight was not the same for each level of prenatal care.

Moore et al. study the case of Mexican-American women who were enrolled in Medicaid. The use of prenatal care is measured by a modified Kessner index. The authors found that Mexican Americans averaged fewer prenatal visits than non-

Hispanic whites, and were less likely to have "Adequate care". For both groups of mothers, percents with Adequate care were well below the national figure of 68%. Controlling for socioeconomic status and cultural characteristics, ethnicity had a strong independent effect on the number of prenatal visits and adequacy of prenatal care.

Health insurance and a regular source of care are insufficient conditions for ensuring adequate use of maternal and child health services by Mexican-American Medicaid enrollees. Factors associated with their less frequent use of these preventive health services include a higher number of children, transportation problems, and less assistance from their support system.

III. Analytical framework

3-1. Theoretical perspective

A number of previous studies by economists have developed comprehensive models of the demand for health inputs, and the health outcome production function. Studies, by Rosenzweig and Schultz (1982, 1988), Corman, Grossman, and Joyce (1987), Grossman and Joyce (1990), and Joyce (1994), reviewed in the previous section are particularly relevant to this paper.

The analysis builds on the notion of household production functions applied to consumer behavior. Assume that a household's utility function, subject to usual properties, is:

$$U = u(H, X, Y). \qquad (3.1\text{-}1)$$

Let the production of child health by the household be defined by

$$H = h(X, Z, \mu), \qquad (3.1\text{-}2)$$

where H is the health of a child. X is a vector of goods that affect utility both directly and through the production of child health, such as exercise, vitamins, alcohol, cigarettes, and illicit drugs. Some of them will have positive effects on infant health and some will have negative effects on infant health. Y represents non-health-related consumer goods, Z stands for health inputs which do not augment utility other than through their effect on H (e.g. health care), and μ represents family-specific endowments (such as genetic traits). These endowments are generally known to the household, but unobserved by the researcher. The budget constraint is:

$$I = pQ', \qquad (3.1\text{-}3)$$

where I is exogenous money income, p is a matrix of exogenous prices with respect to Y, X, and Z; and Q is a matrix of Y, X, and Z. The household model as depicted is characterized by joint production (Pollak and Wachter 1975) in the sense that a subset of goods X both affects child health and contributes to utility directly.

The household's reduced-form demand functions for the goods, including health inputs, derived from maximizing the utility function (3.1-1) subject to production and resource constraints (3.1-2) and (3.1-3), are

$$Q = q\,(p, I, \mu). \qquad (3.1\text{-}4)$$

The reduced-form demand function for the child health outcome may be written analogously:

$$H = g\,(p, I, \mu). \qquad (3.1\text{-}5)$$

The interaction of the reduced-form health-outcome demand function (3.1-5) and health outcome production function (3.1-2) leads to the input demand function for medical care and other health inputs. For example, if we assume Z measures a type of medical care, the input demand function of Z can be represented as

$$Z = z\,(p, I, \mu), \qquad (3.1\text{-}6)$$

where p and I are price and income measures respectively. The optimal levels of X and Y can be derived in the same way.

3-2. Empirical implementation

3-2-1. Model specifications

Since the purpose of this paper is to study infant health, I focus on only that aspect of child health (H, above). The model to follow, therefore, assume that the level of infant health determines the future health of the child. Given this assumption, I replace H in the model above with B, infant health. The infant health production function which presents the relationship between birth outcomes and the health care inputs can be specified as follows:

$$B = b(M, T, G, u), \qquad (3.2\text{-}1)$$

$$\text{where,} \quad M = m(V, u), \qquad (3.2\text{-}2)$$

$$T = t(V, u). \qquad (3.2\text{-}3)$$

Equation (3.2-1) states that infant health production (B) can be expressed as a function of health care inputs use such as prenatal care (M) and private service at delivery (T); and matrix G, which is intended to encompass the medical, socio-economic, and demographic influences on infant health. The disturbance term u measures the mother's reproductive efficiency or health endowment. The mother's health endowment is assumed to be at least partially observable to the mother but not to the researcher. Equations (3.2-2) and (3.2-3) specify that matrix V which corresponds to the P and I in (3.1-6), the determining factors of demand functions and health endowment (u) are expected to affect the demand for prenatal care (M) and demand for private service at delivery (T). The T is measured by the probability that a mother used a private service of delivery. The measurement of infant health and prenatal care will be discussed in the next section.

The literature suggests that mothers with poor health endowments will seek to offset them by demanding more inputs such as prenatal care (or private medical service). Thus, the disturbance term in the production function is correlated with a regressor, i.e. Cov (M,u) or Cov (T,u) is not equal to zero. In this way, unobserved heterogeneity introduces a source of potential bias in the estimation of the infant health production function. Because there is self-selection involved in the amount of health inputs that are used. Self-selection in obtaining prenatal care is well recognized in the literature. Self-selection in using private delivery service is a extension of the model. By applying Heckman's two-stage procedure for a simple selection model, the selection bias can be eliminated by estimating the infant health production function jointly with a behavioral model in which production inputs are themselves choices.

3-2-2. Measurement of prenatal care and infant health

A. Prenatal care index

The assessment of the adequacy of prenatal care utilization is heavily shaped by the way in which utilization is measured. There are two widely used measures of adequacy of prenatal care utilization: the trimester of prenatal care initiation and the Kessner / Institute of Medicine (IOM) Adequacy of Prenatal Care Index (1973). In addition, Kotelchuck (1994) did a critical examination of the Kessner Index, and proposed a new Adequacy of Prenatal Care Utilization Index (the so-called Kotelchuck Index) to overcome the deficiency of the Kessner Index. These three measurements will be evaluated as following.

The trimester of initiation provides no information about prenatal care utilization after initiation. The intensity of care once it has been initiated varies among women. A measure based on trimester of initiation of care is an incomplete way to understand prenatal care utilization.

The Kessner Index was published in 1973 as part of an IOM-supported study of infant mortality in New York City. The Kessner Index combines two numeric measures (the month prenatal care begins and the number of visits, adjusting for length of gestation) and rigidly links them into a easy to understand index with three levels of adequacy (Adequate, Intermediate, and Inadequate). To be rated adequate on the Kessner Index, one must start prenatal care in the first trimester and have nine prenatal care visits for a normal - length pregnancy; to be rated Intermediate, care must begin in the second trimester; and to be rated Inadequate, care must begin in the third trimester or not at all. The number of prenatal visits can only lower the rating category. For example, a woman who initiates care in the first trimester is classified as having received adequate prenatal care, unless she receives fewer than 9 visits for a normal-length pregnancy. In that case, her rating is lowered to intermediate care.

The Kessner Index has been criticized recently (Kotelchuck 1994). The shortcomings of this index have four aspects. First, the Kessner Index is principally a measure of the timing of initiation of prenatal care. The 1980 National Natality Survey data shows that the trimester of care overwhelmingly (for 86.2% of women) predicts the Kessner Index rating. Only 13.8% of all women have their ratings reduced owing to insufficient visits.

Second, the Kessner Index does not distinguish inadequacy of care due to late initiation from inadequacy of care due to insufficient number of visits. Overall, data shows that 24.7% of US women would be classified differently if the two were measured separately.

Third, the Kessner Index is unable to adequately characterize prenatal care utilization for normal-gestation and postmature births. For all normal-length pregnancies (more than 36 weeks gestation), the Kessner Index requires only nine visits for care to be adequate. Yet up to 36 weeks' gestation, the Kessner Index adjusts the required number of visits according to the well-established American College of Obstetricians and Gynecologists (ACOG) recommendations (one visit per month through 28 weeks gestation, one visit every two weeks through 36 weeks' gestation, and one visit per week thereafter). Thus, for a 36 week gestation, the standard would be at least 11 visits. No discussion of the rationale for stopping at nine visits is presented.

Finally, the lack of adequate initial documentation for the Kessner Index has led to nonstandardized definitions and discrepancies in its calculations. In particular, there is insufficient description of how to treat records with missing data on gestational age, visits, initiation date, etc. The result is that each public health entity has had to program the index itself, with resultant inconsistencies. Thus, the Kessner Index ratings may not be comparable across sites.

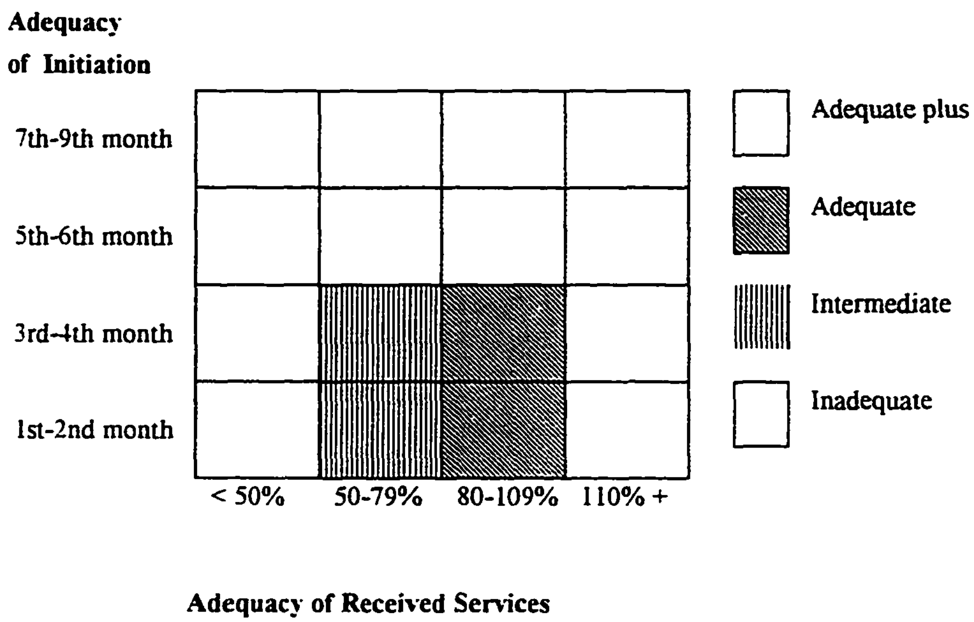
In order to overcome these deficiencies, Kotelchuck proposed the Adequacy of Prenatal Care Utilization Index to characterize prenatal care utilization on two independent and distinctive dimensions: Adequacy of Initiation of Prenatal Care and Adequacy of Received Services once care has begun. However, this two-factor index does not assess the content and therefore the quality of the prenatal care that is delivered, but simply its utilization.

The initial dimension, Adequacy of Initiation of Prenatal Care, characterizes the adequacy of timing of initiation of care. The underlying assumption is that the earlier the initiation, the more adequate the prenatal care. (The month in which care is initiated is grouped into four slightly different adequacy groupings: months 1 and 2, months 3 and 4, months 5 and 6, and months 7 through 9.) No prenatal care is grouped in the late or inadequate care category for this dimension.

The second dimension, Adequacy of Received Services, characterizes the adequacy of the prenatal care visits received from initiation until the delivery. The expected number of visits is based on the ACOG standards for uncomplicated pregnancies, adjusted for the gestational age at initiation of care and at delivery. The measure for Adequacy of Received Services is the ratio of the actual number of visits to the expected number of visits. The expected number of visits for each pregnancy can be calculated by noting the number of ACOG-recommended prenatal care visits for a pregnancy of a given gestation and then adjusting or reducing that number based on the gestational age at initiation of care. The ratio of observed to expected visits is then grouped into four categories: Inadequate (less than 50% of expected visits), Intermediate (50% - 79%), Adequate (80% - 109%), and Adequate plus (≥ 110%). This dimension of Adequacy of Received Services is independent of the previously described dimension of Adequacy of Initiation of Prenatal Care.

Two dimensions can be combined into a single index of four categories: Inadequate, Intermediate, Adequate, and Adequate plus. Inadequate is defined as either later initiation (after the fourth month of pregnancy) or less than 50% of recommended visits. All other categories require initiation of care by the fourth month of pregnancy and then are coded according to the extent of received services. As noted, adequate plus indicates that a woman got additional prenatal care visits beyond the number recommended by the American College of Obstetricians and Gynecologists (ACOG). Figure 1 portrays the construction of the Kotelchuck Index.

Figure 1. The summary: Adequacy of Prenatal Care Utilization Index



Kotelchuck also pointed out the limitations of this new index. First, it does not measure the adequacy of the content of prenatal care, but merely that of the utilization of prenatal care. Second, this index has the opposite bias of the Kessner Index: the longer the pregnancy, the more opportunity to miss visits, and hence the less likelihood of a rating of Adequate or Adequate Plus. Third, the present index does not adjust for the risk conditions of the mother. The index produces a slightly conservative estimate of inadequate prenatal care utilization because it underestimates the true need for prenatal care visits.

When the Kotelchuck Index is applied to my study, it is meaningful to distinguish not having care from having care. Instead of including 'No care' in the Inadequate category, the Kotelchuck Index is modified by adding a fifth category of care for women who had No care (G. F. Joyce 1995). Those women in the 'unknown' group had characteristics similar to those of women who did not seek care. For example, the mean birth weight of Asian baby with 'no care' is 3002.9 grams, and that with 'care unknown' is 3044.4 grams. Comparatively, that mean figure with 'had care' is 3235.8 grams. So the group of 'care unknown' is included in the fifth category of 'No care'.

B. Infant health indicators

Birth weight is the infant health indicator used in infant health production functions in the majority of studies reviewed in the previous chapter. Corman, Joyce, and Grossman (1987) study infant health production functions by taking the neonatal mortality rate as the principal birth outcome, and the incidence of low birth weight (2,500 grams or less) as an intermediate outcome. Some other studies used the regional percentage of low birth weight as an indicator of infant health status. In my study, infant health is measured by birth weight, both because it is widely used by many economists and analysts, and because the data source in my study does not provide much information on infant mortality rate.

3-3. Endogenous and exogenous variables

Table A summarizes the specifications of variables in the production and demand equations. Besides u, all variables other than M or T that enter the production function (B) are in the G matrix (column 1), and all variables that enter the demand functions (M and T) are in the V matrix (column 2 or 3).

Table A Model specifications

Variable	Birthweight production function, B	Prenatal care, M	Private service, T
Endogenous factors			
Prenatal care, M	x		
Private service delivery, T	x		
Potentially endogenous factors			
Maternal age	x	x	x
Smoked, drank, used illicit drugs	x		
Employed during pregnancy	x		
Exogenous factors			
Maternal characteristics:			
Mother is foreign-born	x	x	x
Marital status	x	x	x
Pre-pregnancy weight	x		
Participated in WIC during pregnancy		x	x
Previous fetal mortality	x	x	x
Father's education unknown		x	x
Income measures:			
Mother's education levels	x	x	x
Financial coverage of the birth		x	x
Father's education levels		x	x
Price/availability measures:			
Family planning clinics		x	x
Prenatal care clinics		x	x
Infant characteristics:			
Infant sex	x		
Plurality		x	x
Birth order	x		
Unmeasured reproductive efficiency / health endowments, u	x	x	x

The medical care has a beneficial effect in preventing low birth weight. Mother's observed medical care inputs, which are represented by M and T, are determinants in the birthweight production function B. Other explanatory variables are maternal and infant characteristics such as mother's weight and infant sex. Unobserved behaviors such as mother's exercise, her nutrition, and her effort to relieve stress, etc. are captured within the disturbance term u.

The demand for prenatal care is assumed to be endogenous in the birthweight production function. A woman's health endowment is observed by herself but not by researchers. A expectant mother who has a history of complications during pregnancy is likely to seek early and intensive prenatal care, but at the same time is also likely to have a higher risk of an unsuccessful pregnancy. The utilization of prenatal care is measured by a modified Kotelchuck index.

Another endogenous variable in the birthweight function is the type of medical service at delivery. A explanation is needed for why this is expected to be a endogenous factor. Actually, use of private service at delivery implies that a private doctor will have provided prenatal care in most cases. As noted, prenatal care can be provided either by a private physician service or by a service in a public clinic. The public clinic can be one that is affiliated with the public hospital or with a voluntary hospital. A mother who has prenatal care from a private physician will be more likely to deliver her baby in a private hospital, and the delivery service is performed by her private obstetrician. On the other hand, if a mother's prenatal care is in a public clinic, it is likely to be provided by different doctors or residents. This mother will deliver her baby in a public hospital or a voluntary hospital (Medicaid patients only), and the delivery service is performed by any obstetrician in the hospital. Therefore, there are two sources of care for pregnancy and delivery of mothers: private services, and services in public clinics/hospitals.

Because the charge of a private doctor and hospital is assumed to be higher than that of a public hospital, the choice between these two kinds of medical service is highly dependent on the family's financial situation, specifically on insurance coverage and family income or wealth. For example, statistical data from birth certificates in New York City (1991) used in this study show that the proportion of white mothers using private delivery services is much higher than that of Asian-American mothers, 78% versus 55%. Some economic reasons are behind this. Almost all Asian women (97%) in New York City are not native-born in the US (NYC 1991). Although more and more Asian immigrants are more educated than their ancestors a few decades ago, difficulties in use of the English language and psychological identification with a foreign culture are still two obstacles for many Asian people in America. In addition, NYC 1991 data shows that Asian mothers had less education on average than native white mothers, that is, 12.8 years for Asian women versus 13.4 years for whites. A similar difference exists with regard to father's educational attainment. It is possible that Asian mothers experienced more difficulty in finding jobs with local employers than native or more educated mothers; or they are employed in positions with poorer health insurance benefits or none; or for some cultural reasons, Asian wives may be more oriented to remain at home than white women. These factors could determine the health insurance status, the family income, and hence the choice of private service made by Asian women.

Women's choice of a private-service delivery is also a function of her unmeasured health endowments. Many people believe that private medical service is associated with better-quality care because of the continuity resulting from having the same doctor throughout the pregnancy. Women who experienced a problematic pregnancy before would be more likely to see a private doctor, and get more consistent medical advice. In addition, the selection of a prenatal care provider may influence the content of the mother's prenatal care through a doctor's initiating advice and mothers' requests for and adherence to provider advice on positive pregnancy-related behaviors. These health-promoting behaviors may contribute to reducing the risk of a low birth weight delivery.

Estimation biases will occur when these two health inputs - prenatal care and private delivery service - are treated as exogenous in the birthweight function. Because those women who demand different levels of medical care are self-selected, the sub-samples based on care level are not randomly chosen from the whole sample. This type of bias is a selectivity bias. In order to get unbiased estimates, the demand equations of care and service type have to be jointly modeled with the birth weight function.

Substance use is another observable behavior which is an important risk factor for low weight births. Women who smoked, drank, or used illicit drugs during pregnancy are more likely than abstaining women to experience pregnancy-related problems. These variables are classified as potentially endogenous because I assume that a mother who may have been a user before pregnancy has the ability to modify her behavior regarding substance use if she finds herself pregnant.

The variable indicating whether or not a woman is foreign-born is included in the production and demand functions. This variable will measure the time cost of getting information if a foreign-born women can not speak English well, and may also act as a "technology" factor in the mother's production of child health.

Mother's age is a choice variable that refers to the point in her life cycle at which she is choosing to have a child (Rosenzweig and Schultz, 1983). Thus the age variable is a potentially endogenous variable. Women's age is also a risk factor for pregnancy. Very young or very old pregnant women are more likely to experience difficult pregnancies than women in the more usual age group for maternity (20-35 years old). I measure the mother's age with two dummy variables, indicating if she is less than 19 years old, or older than 35 years old, respectively, these two explanatory variables appear in both the demand and production functions. A teenage girl (less than 19 years old) is more at risk in financial problems, family relationships, and schooling if she happens to be pregnant. The older mothers would have higher risks in their pregnancy and delivery. All those factors could affect women's choice of health inputs and infant health production.

The mother's marital status is included in the production and demand functions to capture the strength of the mother's relationship with the father. It is assumed that the a pregnant women derives benefit from a stable relationship with a man, and that the probability of such relationship is less for a single mother than for a married women.

Due to financial pressures, these single mothers may initiate prenatal care later than married mothers, and the resultant lower level of prenatal care may increase the risk of a low weight birth.

The variable representing whether the father's education is unknown also captures the loss of the benefit a woman may derive from being in a stable relationship with a man even though she may not be married to him. If a woman has forgotten or never know the father's educational attainment, she was not in a very close relationship with him and did not benefit from his potential input into the relationship. There are gradations in the father's investments in his child even among illegitimate children, and that fathers whose education level is known to the mother are less likely to be transient and, consequently, more likely to be involved with the expected child than would fathers whose education level is not known to the mother. Thus, the dummy of father's education unknown is a proxy for that difference in the fathers' involvement.

The variable of mother employed during pregnancy included in the production function as a potential endogenous variable is presumed to measure the mother's stress from working during pregnancy (although work is not always stressful). A woman whose health endowment is low would be more likely to stop working when she is pregnant. In addition, this variable is likely to be correlated with a mother's financial situation. Women who quit a job while pregnant are more likely to have a family which can support her. On the other hand, women with high earnings may continue to work during pregnancy because they want to keep their employment levels and earning benefits. Thus, this variable may be positively or negatively related to B. This variable is omitting from M and T equations because of its potential endogeneity in those functions.

The variable of pre-pregnancy weight captures the mother's genetic and other (such as food habits) characteristics in birth weight production. A large percentage (28 -30%) of the values of pre-pregnancy weight is unknown, and a dichotomous variable was included which equals one if the value was unknown.

The health endowment consists of two components: measurable and non measurable. A woman becomes aware of her health endowment through her life experience, but the endowment is invisible to the researcher. Any previous experience a women has had with pregnancy may be an observable component of her health endowment. The knowledge women have had from their previous pregnancy and family medical history may have direct effects on the mother's behaviors during pregnancy and hence on the birth outcome. Previous miscarriages, the number of spontaneous termination, serves as a partial proxy for the mother's health endowment in the demand and production functions. Miscarriages are divided into early miscarriages (less than 13 weeks), and late miscarriages (13 weeks or more), since the features of a fetal survival in early pregnancy or in the mid or late term of the pregnancy differ qualitatively. A fetus which survives into the mid or late term of the pregnancy can be assumed to be genetically viable. Thus the late miscarriages (loss of a viable fetus) are assumed to be more representative of the mother's health endowment (G.L. Warner 1994). The unmeasured component of the woman's health endowment is incorporated in the error term.

The price/availability and income measures have no direct effects on birth outcomes, but operate on infant health through their impacts on demand for health inputs (Joyce, 1994). The variable of WIC participation corresponds to the price/availability measure. The WIC program is a federal program that provides nutrition assistance in the form of food, nutrition education and referral to health services for low-income women who are pregnant, breast-feeding and postpartum, and for infants and preschool children who are at nutritional risk. WIC participation is often associated with increased prenatal care because the WIC program tries to link participants with health care. The WIC program encourages the use of health care and local agencies are supposed to make health care available to participants (Rush et al. 1986) or provide them with referrals for health care. Agencies providing prenatal care and WIC may be located at the same site. WIC participation may indirectly impact birth weight production by improving prenatal care, and the variable of WIC participation in the demand functions captures this effect.

In the demand functions the variables for the availability of health services, which are used to control for health area characteristics, are represented by two dichotomous variables, one indicating if there is a family planning clinics in the area in 1990, one indicating if there is a prenatal care clinics in the area in 1990. About 70% of mothers reside in areas with neither of these kinds of health centers. Each of variables equals one if the mother resides in an area where that type of clinic is located.

Explicit information on personal income is not available in our data set. On the other hand, the state-level statistics provide personal income only for the five boroughs in the New York City, and because there is very little variation in this income figure it does not qualify for use as a variable. Instead, I have selected proxy measures which may capture the household income level. These proxies for income are the financial coverage of the birth and mother's or father's educational attainment. Whether the birth is paid by Medicaid or a mother herself also reflects the mother's family income status.

Mother's and father's education levels as the two important income measures enter demand functions as an exogenous variable. Earnings are positively correlated with educational levels. Financial barriers to better prenatal care would be lower if a woman's family income is at a higher earning profile.

As noted, mother's education is also included as a "technology" variable in the production function. It is associated with access to information and the ability to process it, and hence with improvement of knowledge about the effect of behavioral choices on health; it probably also helps people to comply with medical advice (DA Vanzo and Gertler, 1989). Its role is then twofold. First, more educated women may have a better appreciation of the beneficial effects of medical care. Secondly, education makes the production process more efficient. For example, the mother may better understand the instructions and advice that her doctor gives her during a prenatal visit. She will therefore be more able to adapt her behaviors in the right direction and better implement the advice. Also the mother's education level significantly affects non-market production, which includes the production of good nutrition and a stress-free environment. The mother's education has been grouped into three levels in the models:

educational attainment is less than 12 years, 13 - 16 years (college level), and 17 years or more (graduate level). The comparison category is a 12 years of education (high school degree). This classification is expected to show the impacts of the role of mothers' education on their demand behaviors and birth weight production.

Infant characteristics that affect the birth weight production function and the input demand functions are represented by the sex of the infant. Parity (represented by whether it is the first live birth or fourth and higher order of birth), which could indicate the family size to date, enters the birth weight production function only. Omitting this birth order variable from the prenatal care and private service equations is based on an assumption that this variable is potentially endogenous. The plurality of birth affects the demand functions. A woman who is pregnant with twins or triplets may have complications which prompt her to seek prenatal care more often than if the pregnancy is a singleton. Since multiple-birth newborns tend to weigh less , lighter birth weight is not necessarily an adverse outcome for plural births. Thus plurality is not included in the production functions.

IV. Data and Estimation

4-1. The data

The data is from the New York City vital statistics records for the year 1991. This micro-data source presents information on birth weight, timing, and frequency of prenatal care and demographic characteristics of the mother such as nativity, marital status, and age; socio-economic factors such as schooling, income/insurance coverage (categorized by Medicaid, health maintenance organization (HMO), self-pay and other third party); and ongoing exposure to a variety of substances including tobacco, alcohol and illicit drugs. This study uses the entire population of Asian and non-Hispanic white women who gave birth in New York City in 1991. The Asian sample includes women whose origin is Chinese, Japanese, Filipino, Hawaiian, and other Asian or Pacific Islander. There were 9,636 Asian births, and 27,599 non-Hispanic white births. Births with unknown data on birth weight, sex of baby, birth order, payer source and nativity of mother were omitted. The omitted births constituted 5% of the Asian sample, and 7% of the non-Hispanic white sample, respectively.

In addition to variables reported on the birth certificates, some area-specific variables supplement the birth data. New York City is divided into 352 health areas within the five boroughs. Two measures of the availability of health services for these health areas from the 1990 Census data were added to the data set: the number of prenatal care clinics and the number of family planning clinics. The 1990 census data also provided black, white, and Hispanic poverty rates for each health area, but there is no separate rate for Asians. While no data on income or prices is provided, the birth records do provide information on the mother's insurance status and mother's or father's educational attainment. As discussed earlier, these three variables are used as proxies for family income. A complete list of the variables used in this analysis is given in Table 1.

4-2. Estimation layout

The estimations are performed on the Asian and the non-Hispanic white samples separately. In the descriptive statistics, the distributions of two dimensions of the Adequacy of Prenatal Care Utilization Index (Kotelchuck 1994) are presented by race for low weight births and preterm births, respectively, in addition to the total births sample. My aim is to compare how the level of prenatal care is associated with the adverse birth outcomes, and how this relationship differs between Asian and white non-Hispanic women. Descriptive statistics for each variable by entire sample and by levels of prenatal care are presented. They enable us to foresee some interrelationships between a woman's selected level of prenatal care and the determinants of her decision.

The production function of infant health and the demand function for prenatal care and private service are jointly estimated by using the Heckman's two-stage procedure for sample selection model (Heckman 1979).

Equations (3.2-1) to (3.2-3) in the previous section can be expressed as follows:

$$B = \alpha' X + e, \qquad (4.2\text{-}1) \quad \text{birth weight equation}$$

$y^* = \gamma_1'V + \varepsilon_1$ (4.2-2) care equation

$Z^* = \gamma_2'V + \varepsilon_2$ (4.2-3) service equation

where, a) y=0, 1 and z =0,1 for y* and Z* respectively,

or b) y=0, 1, 2, 3, 4 and z=0,1 for y* and Z* respectively.

α and γ_i are parameter vectors. X and V are explanatory variables in the equations for birth weight and use of health care. In order to compare the results of using two alternative measures of prenatal care, I estimate demand for prenatal care in two ways: a) using a binomial probit model in which y is a dichotomous variable for y*, indicating whether the woman had care or not; and b) using a ordered probit model in which y ranks levels of care for y* according to the modified Kotelchuck Index. In the later case, y is a polychotomous indicator that equals 0,1,2,3,4 to indicate whether a women receive No care, Inadequate, Intermediate, Adequate, or Adequate plus care, respectively. An ordered probit model is appropriate because different levels of prenatal care measured by this index are inherently ordered. Z is a binary indicator that equals 1,0 depending on whether a women chooses private service or not. I noted earlier that the residuals e and ε_1, or e and ε_2 are correlated, so OLS estimates will be biased.

Heckman's two-stage procedure is employed here to obtain a consistent estimate. In the first stage, an binary or ordered probit model is estimated for the use of prenatal care (y*), and an binary probit model is estimated for the type of delivery service (Z*). Using the estimated parameters in equation (4.2-2) and (4.2-3) to construct correction factors $\lambda 1_i$ (for care) or $\lambda 2_I$ (for service), the respective inverse Mill's ratios. In the second stage, I estimate equation (4.2-1) separately for each category of care with the corresponding correction factor included as a regressor in each equation. Then I estimate equation (4.2-1) by selecting the observations for each category of care with each type of delivery services, and two corresponding correction factors are included as regressors in each equation. The coefficient of correction factor is the covariance of residuals in the choice-specific equation with the residuals in the probit equation. The null hypothesis of no selection bias (a zero coefficient on the correction factor) can then be tested.

One of the methods to estimate the effects of prenatal care and private service on birth weight production is to apply a 'treatment effects model' in selection specification (Greene 1991). At the second-stage of the sample selection model using the entire sample of observations, the dummy variable for each level of care (taking 'No care' as a reference group) and the dummy variable for private service are included along with all other determinants in the birth weight function. The model specification is as follow:

$B = \alpha' X + \phi' y + \varphi' z + \omega$ (4.2-1*) birth weight equation

$y^* = \gamma_1' V + \varepsilon_1$ (4.2-2) care equation

$Z^* = \gamma_2' V + \varepsilon_2$ (4.2-3) service equation

where, (a) if y=0, 1, there is a single dummy for y in the equation (4.2-1*);

or (b) if y=0, 1, 2, 3, 4, there are four corresponding dummies (y_1, y_2, y_3, y_4) for y: Inadequate, Intermediate, Adequate, and Adequate plus in the equation (4.2-1*), in which y=0 is taken as a reference group.

The second stage estimate of the equation (4.2-1*) by 2SLS, using as the instrumental variable for y and z the predicted probabilities from two probit equations respectively, overcomes the problems of correlation between y and ω, and between z and ω. Therefore, the estimates of α, ϕs, and φ are consistent (Greene 1991). Finally, the Wu-Hausman's exogeneity test is performed to justify that OLS is not the consistent estimate for the equation (4.2-1*).

In addition, it is also necessary to test if the disturbance term ε_1 in the care equation is correlated with the disturbance term ε_2 in the service equation. A bivariate probit model applies if they are correlated. Because of computational difficulties associated with multinomial probit, the test is limited to dichotomous variables (Greene 1991).

The resulting empirical model can be expressed as follows:

$B = \alpha'X + e,$	(4.2-1)	birth weight equation
$Z_1^* = \gamma_1'V + \varepsilon_1$	(4.2-2˜)	care equation
$Z_2^* = \gamma_2'V + \varepsilon_2$	(4.2-3˜)	service equation

where, $Z_j = 1$ if $Z_j^* > 0$ and 0 otherwise for j=1,2, if Z_1 takes a dichotomous format.

The definitions of other parameters are the same as above. Let Z_1 be a binary choice variable (1,0), used care or not; let Z_2 be a binary indicator that equals 1,0 depending on a woman choosing private service or not. Then test if ε_1 and ε_2 are correlated. If the null hypothesis that $\rho = \text{Cov}[\varepsilon_1, \varepsilon_2] = 0$ cannot be rejected, then the model is one of two independent selection criteria.

For estimation of the care equation (4.2-2(b)), the ordered probit model is built around a latent regression.

$$y^* = \beta' x + \varepsilon.$$

y^* is unobserved for prenatal care. What we do observe is

$y=0$ = no care	if $y^* \leq 0$,
$y=1$ = inadequate care	if $0 \leq y^* < \mu_1$
$y=2$ = intermediate care	if $\mu_1 \leq y^* < \mu_2$
$y=3$ = adequate care	if $\mu_2 \leq y^* < \mu_3$
$y=4$ = adequate plus care	if $\mu_3 \leq y^*$.

The μ's are unknown threshold parameters to be estimated with β. A limitation of the ordered probit is the inability to identify changes in probabilities from the sign of the coefficients, so that the coefficients in the model must be interpreted with care (Greene 1991).

In the general case, related to the signs of the coefficients, only the signs of the changes in the tail probabilities are unambiguous. But what happen to the middle cells is ambiguous. In other words, the response of probabilities other than the tails to marginal changes in the regressors cannot be signed from the coefficients.

It is important to notice that in an ordered probit model the marginal effects of the regressors on the probabilities are not equal to the coefficients. Given the probability for obtaining each level of prenatal care, rated from 0 to 4, the impact of a change in a categorical variable on the likelihood of five levels of care is measured by comparing the probabilities for various categories, holding the other characteristics constant. Note that the marginal effects sum to zero; this follows from the requirement that the probabilities add to one. If there is a dummy variable, we can analyze this kind of variable by comparing the probabilities of that result when the variable takes its two different values with those that occur with the other variables held at their sample means (Greene 1991).

The service equation (4.2-3) is estimated by a binomial probit model because the dependent variable is dichotomous (private or general).

V. Results

Tables 1 to 7B present definitions of variables and general descriptions of statistics. Table 8 to 16 contain parameter estimates for the various models outlined previously: the binary probit model for prenatal care and private service; the ordered probit model for prenatal care; and the birth weight production functions associated with the care and service equations. The following discussions also highlight the difference in results between Asian and non-Hispanic white women.

5-1. Descriptive statistics

Means and percentages of variables are shown in Table 2 by ethnicity, and most of the variables are used in my model analysis.

From the descriptive statistics, we can observe some obvious differences between Asians and non-Hispanic whites with respect to maternal behaviors and birth characteristics.

The average weight of Asian babies is 3218 grams, which is lighter than that of white babies (3371 g). The percent of adverse birth outcomes (LBW or preterm) is slightly higher for Asians than that of whites. With regard to the use of prenatal care, the percentage of Asian women who obtain Inadequate care is higher than that of white, 32.6% versus 17.7%, and Asian women are less likely to get Intermediate or Adequate care (15% or 29%) than their white counterparts (19% or 35%). The percentage of white women who used private service for delivery is about one third more in percentage points than that of Asian women (55% Asians, 78% whites); as discussed, this may be largely a result of the mother's financial status.

Other variables are demographic. Fewer of the Asian mothers or fathers (36%) had education above a high school degree (12 years) compared to white mothers or fathers (46%). Fewer teenage (1.2%) or single mothers (13%) are among Asians. Only 25% of white mothers were not native born, while almost all of the Asian mothers (97%) were born outside the US. 12 percent of Asian mothers were participants in the WIC during pregnancy, and 8 percent of whites. The proportion of Asian mothers covered by Medicaid is almost double of that for white mothers (31% Asians, 18% whites). This discrepancy in source of payment may reflect the lower income level of Asian families compared to white families. 18.6% of white mothers were covered by Medicaid, and 22% of white mothers used public delivery services. This indicates that almost all white mothers who used public delivery services might be Medicaid recipients. However, in the Asian sample, 31% of mothers were paid by Medicaid, whereas 45% of mothers used public delivery services. This may suggest that many poorer Asian women went to public hospital for delivery without Medicaid coverage. One of the reasons may be that some of Asian women who delivered in the public hospital are illegal residents, and they can not be covered by Medicaid. Another difference is that Asians were less often exposed to tobacco and alcohol than whites. A possible explanation for this difference is the traditional Asian conservatism regarding women's smoking or drinking behavior.

Tables 3A and 3B show the percentage distributions of birth rated on the two dimensions of the Adequacy of Prenatal Care Utilization Index by birth outcomes and by race. Table 4A and 4B present the distributions of the prenatal care index among adverse birth outcomes and among total births in New York City for the year 1991. There appears to be a U-shaped association between care used and birth outcomes. Asian women had higher rates of low birth weight and preterm births among those with Inadequate care (27%), and among those with Adequate plus care (23-34%). The situation for white women is similar. The higher rates for low birthweight or preterm births appear for those with no care (25%) and those with adequate plus care (32-43%). This U-shaped association of low birthweight and prenatal care utilization indicated by the Kotelchuck index is clinically plausible and has been noted previously (Kotelchuck 1994). Extensive prenatal care visits have been linked to high-risk pregnancies. But because the predominant Kessner Index has no classification for intensive prenatal care services, the association between low birth weight and prenatal care has been predominantly described in a more linear fashion, misrepresenting this U-shaped relation and emphasizing that poor birth outcomes are directly related to poor prenatal care. Women who received extra prenatal care visits are clearly a very high-risk group, but they are already known to health care providers. The efficacy of prenatal care interventions, rather than access, may be the important issue for these women. Their high proportion of low weight births should make us somewhat sanguine about proposals to improve US infant mortality rates that simply recommend more prenatal care visits generally or for high-risk women only (M. Kotelchuck 1994).

If we take a look at the Asian birth outcomes by national origins (Tables 5 and 6), 63 percent of Japanese had Adequate or Adequate plus care; this is the highest rate among Asian women. The rate of Intermediate care for the Japanese is 8%, which is the lowest one compared with other Asian groups (13 - 18%). It seems that Japanese women take more initiative and are more persistent in obtaining prenatal care than others, a difference which could reflect their economic advantages.

Table 7A summarizes the means and percents for all variables by five prenatal care levels (a modified Kotelchuck Index) for Asians, and Table 7B does the same for whites. The U-shaped pattern appears in infant birth weight. No care or adequacy plus care associate with lighter babies. The latter is the evidence of adverse selection: women with less favorable potential birth outcomes obtain the most care. Fewer Asian women with graduate education had Adequate plus care (7.6%) than those women had No care (9.8%). That is to say higher educated Asian women are less likely to seek intensive care. This situation is not true for white women. Asian teenage women are more likely to have Intermediate care (1.8%). White single women are more likely to obtain Inadequate care (15%). Women who had a previous history of miscarriage would demand more care. So the percents of those women who had Adequate plus care are highest among other care categories. The proportion of Asian women exposed to substances is less in every level of care. Smoking or drinking during pregnancy are even less likely than taking illicit drugs. Among Asian women who had Inadequate care, half were Medicaid recipients. The other four care categories had much lower percents of women with Medicaid. Large number of uninsured women had No care (20.3% Asians, 21.2% whites). Table 7A also shows the differential selection within the Asian group: a higher percentage of Chinese women obtained Intermediate care, whereas a higher percentage of both Japanese and Filipino women had adequate plus care.

The descriptive statistics by prenatal care index shows us a detailed picture of the discrepancy in birth characteristics between different levels of care. Further investigation on demand and production is provided by the two-stage model estimations and tests of selectivity bias for choice behaviors.

5-2. Results and discussion

Table 8 to 16 contain results with parameter estimates of all equations: the demand for prenatal care in binary choice and in multiple choice settings, the demand for private delivery service, and the birth weight production associated with those different choices in health care utilization.

The determinants of mothers' demand for health care, and the impacts on mothers' demand behavior and on infant health production are discussed. The discussion focuses first on Asians, and secondly, on comparing differences between Asians and non-Hispanic whites.

5-2-1. Estimates of prenatal care and private medical service

The basic two-stage model for self-selection treats prenatal care and type of delivery service as endogenous. To facilitate comparisons with two-stage procedure, I estimate the care equation with dichotomous measures first, then with polynomial measures. By following Heckman's procedure, the first-stage estimate is used to calculate the appropriate correction factors, λs, which are inserted as separate regressors in the second-stage birth weight equation. In theory, the correction factor captures the role of unobservable influences that direct women to different levels of care, or different types of delivery service.

A. Binary probit models

Tables 8 presents the results for the first-stage estimation of binary choice for prenatal care, (1 if a woman had care, or 0 if no care). Table 9 shows the estimated choice for private delivery service (1 if a women used private delivery service, or 0 otherwise). The bivariate probit model estimated for Table 9 is to test the independence between choice of care and choice of service. Its estimates result for prenatal care is almost identical to the result in Table 8.

A full set of control variables for the foregoing demand models contains maternal characteristics, insurance status, and father's educational attainment. Maternal education did not significantly affect the initiation of prenatal care for either Asian or white mothers. However, it did affect the use of private service. A higher educated mother was more likely to choose a private obstetrician, compared with the omitted category. This phenomenon probably reflects the correlation between mothers' educational attainments and their income status, which affects their choice of service type.

The demographic variable of teenage mother or out-of-wedlock birth is not a significant determinant of having prenatal care. However, those two groups of women were less likely to have a private service. I believe that income effects probably dominated those women's decisions on private service.

The variables of foreign born, participated in WIC, and previous miscarriage have the expected signs. Non-native-born women were less likely to obtain care, or to use private service. The variable of WIC participants is positive and significant in the care equation, and is not significant in the service equation. Enrollment in WIC could help those mothers to obtain care but would not assist them significantly to use private physician service. Previous miscarriage did affect women's choice of having care significantly, but this partial proxy for endowment did not significantly affect the mother's choice of private service.

The factors of health service availability do not have much effect on the demand for health care. Only for the white sample in the service equation, the coefficient of prenatal care clinics is positively significant, and the coefficient of family planning clinics is negatively significant.

Income measured by insurance status is significant, as expected, in the care equations. Medicaid recipients or uninsured women were more likely to abstain from prenatal care. However, insurance status did not affect women's demand for private services significantly.

Another income measure, father's schooling, had the expected sign in the most equations for the white sample. White mothers were less likely to have care if fathers were less educated (no high school degree). One of the reasons might be the shortage in their family financial resources. Similarly, choosing private services by mothers is significantly affected by fathers' education level. The more education fathers had, the more likely it was that their wives would use private services. In addition, if a white father's education was unknown, implying that the relationship between the mother and her partner is relatively weak, then white women would be less likely to have private services. These results are not found in our Asian sample.

To test whether demand for prenatal care and demand for private service are independent decision choices or not, I estimate the bivariate probit model for prenatal care and private service jointly. By definition, if the estimate of the correlation coefficient $\rho(1,2)$[1] is not significantly different from zero, indicating that the residuals of the care equation and the service equation are not correlated, the model is one of two independent selection criteria (Greene 1991). The data from the Asian sample shows that the ρ is not significant at 95 percent of the t-statistic but significant at 90 percent, whereas the ρ is not significant at all for the white sample. This discrepancy between Asians and whites is interesting. One interpretation can be that Asian women's choosing of private medical service is more likely interrelated with their seeking of prenatal care. Meanwhile, the estimated result of parameters for prenatal care equation is almost identical to the result in Table 8.

B. Ordered probit model

The results of the ordered probit model estimation based on five prenatal care

[1] 1 is the decision on whether to have prenatal care or not , 2 is the decision on whether to have private delivery service or not.

levels in a modified Kotelchuck index are presented in the Table 10. The dependent variable is coded 4 if a woman received Adequate plus care, 3 if a woman had Adequate care, 2 if a woman had Intermediate care, 1 if a woman had Inadequate care, and 0 if a woman had No care. Most results of coefficients are similar to the previous binary probit model of prenatal care. In addition, the variable of late miscarriages for both the Asian and white samples becomes positive and significant. This variable is a partial proxy to measure observed health endowments. It significantly determines the level of prenatal care obtained. The variable of plural birth also becomes positive and significant here. A woman would expect some complications during her pregnancy if she would have plural birth, thus she would demand more prenatal care.

5-2-2. Estimates of the birth weight production

A. With binomial measures in prenatal care

Tables 11A and 11B present the second-stage results by race, in which the birth weight is the dependent variable and the effect of correcting for self-selection in a binary choice of care is measured. Tables 12A and 12B explore the joint effect of the type of delivery service and receipt of prenatal care on birth weight production. Table 13 shows the impacts of prenatal care and private service on birth weight outcomes.

Selection bias is tested by the coefficient on the correction factor λ. The coefficient on the correction factor is the covariance between the residuals in either the care or the service selection equation and the residuals in the relating birth weight equation.

The estimation results generally conform to the literature. For mothers who received care: lower education, unmarried, previous late miscarriages, and first live birth have negative impacts on birth weight production; foreign born, pre-pregnant weight, and male baby have positive impacts on birth weight production in the Asian sample. Chinese women have heavier babies than the reference group (other Asian women). Most of those significant socio-demographic factors in the Asians birth weight equation are shown similarly in the white sample except that the latter has negative impacts from substance use.

The various types of substance use are not significant factors in Asian baby's birth weight production. The possible reason is that the proportion of those Asian female substance users is very small. However, for the white sample, smoking and using illicit drugs reduce a white infant's birth weight significantly (about 100 grams). This is consistent with other research findings that substance use is a major preventable risk factor for low weight birth.

The test confirms the existence of selection bias. The coefficients of the correction factor for Asians and whites are significant and negative, which suggests that women who have a greater than expected probability of receiving care have infants with less than the expected birth weight. The magnitude of the selection factor is smaller for Asian women than for white women.

When use of private service is included jointly with prenatal care in the birth weight functions (Tables 12A and 12B), the significant variables are similar compare with care choice alone. But the magnitude of some significant variables becomes bigger: previous late miscarriage (from -137 g to -206 g for Asians, from -61g to -83g for whites), Chinese infants (from +39 g to +51 g) in the Asian sample, and illicit drug use (from -125g to -135g) in the white sample. The test on coefficients of the correction factors shows that the null hypothesis of no selection bias in receiving care can be rejected among white women choosing private service but cannot be rejected among Asian women making a similar choice.

For those women <u>who had no care</u>: variables of out-of-wedlock and previous miscarriage negatively affect an Asian infant's birth weight, and pre-pregnant weight is positively significant. Variables for substance use by white women have larger negative impacts on birth weight than those who had care (from -100g to -300g). So substances use plus no care led to even worse birth outcomes.

Within the sub-sample of using private delivery service under no care, most variables are not significant in the production functions except late miscarriage (-) and pre pregnant weight (+) for Asian women, and substance use (-) for white women. So far in the most production functions, the age variable has no effect on birth weight, however the variable of white teenage motherhood is negative and significant in the birth weight production here.

The test shows that the hypothesis of no selection bias of choosing not having care can be rejected for both Asian and white women who use private service.

Table 13 illustrates the estimated coefficients on prenatal care and private service in the birth weight equation (4.2-1*(a)) by 2SLS and OLS. The model was estimated on all specified variables with entire observations, but the results of variables other than prenatal care and private service are not shown in this table. The Wu-Hausman test rejects the exogeneity of above two health inputs in the birth weight function, so the OLS estimate is not consistent.

Obtaining prenatal care positively contributed to birth weight for both Asian and white women compared with not having care. The magnitude of the effects is smaller for Asian (+ 113 g) than for whites (+145 g). However, having private care and delivery service is not significant to birth weight changes.

B. With polynomial measures in prenatal care

The second-stage results for birth weight productions with which prenatal care is estimated by an ordered probit model on the Kotelchuck index are shown in Tables 14A and 14B. The estimation results of production functions including selection of private service are presented in Tables 15A and 15B. Table 16 presents the effects of different levels of care and private service on birth weight production.

In the Asian sample, the impacts of independent variables on birth weight production vary among different levels of care. Only mother's pre-pregnant weight, and sex of baby are positively significant across levels of care. Schooling is significant only for women who had Adequate or Inadequate care: the less educated mothers had lighter babies (-60 g) than mothers who completed high school. Unmarried status (-155 g) and previous late miscarriage (-280 g) decrease birth weight for women who had intensive care or no care. Single women who did not have care because of financial shortage or who chose extensive care because of a high-risk pregnancy get worse birth outcomes than married women. The variables for substance use have no impact on birth weight, as before. There are some differences based on mother's country of origin. Chinese mothers had heavier babies across all levels of care except No care. The value of the coefficients decreases as the utilization of care diminishes. Japanese origin is positively significant in birth weight production while the mother had Adequate plus care.

The testing results show that the null hypothesis of no selection bias can be rejected among Asian women who received Adequate plus or Inadequate care. As mentioned above, the negatively significant coefficient of correction factor indicates the adverse selection among high risk women. On the other hand, the positive coefficient of correction factor at Inadequate care indicates that unobservable factors leading women to seek this level of care increase expected birth weight.

There are several differences between the white and the Asian samples. First is the higher education and teenage variables. The higher level of education positively impacts birth weight production for white women who had Adequate plus or Intermediate care. White teenage motherhood negatively impacts birth weight production with intermediate care. Those factors are not significant for the Asian sample. Secondly, white women's substance use variables negatively influence birth weight production in almost every level of care. This contrary impact from smoking or drug use on production worsens as the level of care declines, and the worst case is for those women who had No care. Thirdly, in the white sample, the no selection bias of choosing different levels of care can be rejected except for No care. In the Asian sample, it can only be rejected in the levels of Adequate plus and Inadequate. The negative coefficients of the correction factors suggest that the effects of favorable health endowments outweigh the impact of bad behaviors. The magnitude of the selection effect in the white sample is largest in the Intermediate care group, and smallest in the Inadequate care group.

It is worthwhile to examine whether jointly estimating the selection on private service would have further impacts on birth weight production (Tables 15A and 15B).

In the Asian sample, the statistical significance of each variable in the production functions follows a similar pattern to that discussed above. The notable change appears at the sub-sample of Intermediate care. In this sub-group, the variables of education, age, marital status, foreign born, and employed during pregnancy become significant compared with the case when use of private service is not included in the production functions. The coefficient of the correction factor for choosing private service is negatively significant in this choice specific birth weight functions. Thus the evidence of self-selection in private service is confirmed at this particular level of care.

The white sub-sample shows a notable change in the Inadequate care level. Out of wedlock decreased infant's birth weight. The correction factor of selecting non-private service is positively significant. Self-selection of choosing non-private service is confirmed at the Inadequate care level. This is different from the evidence in the Asian sample.

Table 16 presents the estimated coefficients on different levels of prenatal care and private service in the birth weight equation (4.2-1*(b)) by both 2SLS and OLS. In this estimation, there are four dummies for prenatal care (y_1, y_2, y_3, y_4 for Inadequate, Intermediate, Adequate, and Adequate plus, respectively), while taking No care (y=0) as a reference group. In this way we can compare how much birth weight production is affected by receiving a particular level of care versus without having care.

The Wu-Hausman test rejects the exogeneity of prenatal care and private medical service in the birth weight function. So the OLS is not justified to estimate the effects of these two health inputs on birth weight function.

In the Asian sample, the positive effects of prenatal care on birth weight production are elevated except 'Adequate' and 'Adequate plus'. The magnitude of the impact for Asians is less than that for whites (from 94 to 120 g for Asians, from 115 g to 180 g for whites).

Private service is beneficial to birth weight production (+ 202g) for Asians, but not for whites.

VI. Summary and Conclusion

In this dissertation I analyze infant health production functions for Asian women by using vital statistics for 1991 for New York City, controlling for endogeneity and self-selection of two important inputs: prenatal care and private medical service. In estimation, demand equations of these two health inputs are jointly estimated with birth weight functions. Estimates controlling for self-selection in using private medical service is a extension of the model. Tests for the endogeneity of the prenatal care inputs indicate that, rather than OLS, the appropriate estimation technique is Heckman's two-stage procedure to correct for sample selection bias.

The results can be used to answer the three questions addressed at the beginning of this thesis. First, what is the role of prenatal care and private medical service in getting better birth outcomes? The results show that, the prenatal care is beneficial to birth weight production. Its effect is elevated as utilization of prenatal care increases except for the level of Adequate or Adequate plus. The negative and significant coefficient of correction factor in the choice-specific (Adequate plus) birth weight equation and the U-shaped curve of birth weight related to levels of care indicates the existence of adverse selection in seeking prenatal care: i.e. high-risk women are more likely to seek intensive prenatal care than healthy women.

The positive impacts of private medical service on birth weight production is less than that of prenatal care. Other variables, such as pre-pregnant weight and male baby, have positive effects on birth weight; where less education, unmarried, and previous miscarriage have negative influences.

Second, what are the important determinants of Asian women's demand for these two health inputs? The results indicate that the significant determinants of demand for prenatal care for a Asian woman are her birth place, participated in WIC, her previous miscarriage history, insurance status, and plural birth. Foreign born Asians or those who got Medicaid or those who were uninsured are less likely to seek care or higher level of care. It may be that the likelihood of receiving Medicaid is negatively correlated with prenatal care demand. WIC enrollees, or women with a history of miscarriages, or having plural baby are more likely to seek care. On the other hand, the demand for private service is affected by mother's or father's educational level, teenage motherhood, unmarried status, and mother's birth place. As mother's or father's educational attainment increases, the probability of using private doctors changes from negative to positive and then increases. Teenage, single, and foreign-born women are less likely to choose private service.

Third, how Asian women's birth outcomes and maternal characteristics differ from other racial women. In this paper, the white sample is used as comparison. On average, Asian women do not have far better birth outcomes than white women. The sample data shows that Asian babies have lighter mean birth weight than that of white babies. Asians' adverse birth outcomes in terms of percentage of low weight births or preterm births are slightly higher than those of whites. Higher percentage of Asian women participated WIC and have Medicaid. The percentage of lower education (less than 12 years of schooling) is higher for Asian women. Evidently, we see that the percentage of Asian women seeking higher level of prenatal care or private medical service is lower than white women. However, nationally, the infant mortality rate of Asian is less than white.

Additionally, two notable differences are: the impacts of receiving prenatal care on birth weight production are smaller for Asians than for whites. Secondly, behavior of substance use, such as alcohol, tobacco, and illicit drugs, during pregnancy does not show any significant impact on Asians' birth weight production, but this behavior is highly associated with probability of low birth weight for white infants. Asian females are more conservative to substance use, particularly when they are pregnant. So the proportion of Asian substance users is very low compared with whites. Thus the variables of substance use could not become reliable determinants in Asian birth weight production.

This study didn't have exact data information on income and price, and the substitute variables used as proxies for them may not completely capture the income and price effects in demand models. On the other hand, if quality of care can be scientifically measured and combined with utilization of care, the investigation of demand for prenatal care would be more objective. Better measures of these variables would greatly enhance the estimates for the model.

The findings of this study imply that improving infant health outcomes by decreasing the number of low weight birth can be done in several ways: if women have poor health and less likely to seek prenatal care, then a health education program is needed to help and encourage those minority women to use prenatal care, and to give their language assistance if they have communication difficulties with medical providers; if women use substances during pregnancy, then it is important to help those women to change their bad behaviors. The intervention can be effective before pregnancy as well, for example, organizing a prevention from substance abuse program for fertile-age females and their partners can help those abused women and their family members. Overall, improving family financial status is important in improving utilization of health inputs and better birth outcomes for Asian women.

Table I Definition of variables

Variables	Definition
Birth Outcomes	
Birth weight	Infant weight at birth in grams.
Level of Prenatal Care	
No care	Prenatal care was none or unknown.
Inadequate	Prenatal care begun after the 4th month or less than 50% of recommended visits received.
Intermediate	Prenatal care begun by the 4th month and 50-79% of recommended visits received.
Adequate	Prenatal care begun by the 4th month and 80-109% of recommended visits received.
Adequate plus	Prenatal care begun by the 4th month and 110% of recommended visits received.
Type of Delivery Service	
Private service delivery	Delivery of infant was performed by private physicians (including prenatal care).
Mother's Education	
Mother's edu. < 12 years schooling	1 if mother's completed schooling was less than 12 years; 0 otherwise.
Mother's edu. is 13 to 16 years of schooling	1 if mother's completed schooling was between 13 to 16 years; 0 otherwise.
Mother's edu. > 16 years schooling	1 if mother's schooling was higher 16 years; 0 otherwise.
Father's Education	
Father's edu. < 12 years schooling	1 if father's completed schooling was less than 12 years; 0 otherwise.
Father's edu. is 13 to 16 years of schooling	1 if father's completed schooling was between 13 to 16 years; 0 otherwise.
Father's edu. > 16 years schooling	1 if father's schooling was higher 16 years; 0 otherwise.
Father's edu. was unknown	1 if father's schooling year was unknown; 0 otherwise.
Maternal Measures	
Age <= 18 years old (teenage)	1 if mother was younger than 19 years old at the birth; 0 otherwise.
Age >= 35 years old	1 if mother was older than 35 years old at the birth; 0 otherwise.
Out-of-wedlock	1 if mother was unmarried; 0 otherwise.
Works during pregnancy	1 if mother was employed during pregnancy; 0 otherwise.
Foreign-born	1 if mother was born out of the U.S.; 0 otherwise.
Previous early miscarriage	1 if mother had previous miscarriages during the first 13 weeks of pregnancy; 0 otherwis
Previous late miscarriage	1 if mother had previous miscarriages after the first 13 weeks of pregnancy; 0 otherwise.
Pre-pregnancy weight (log)	Natural log of the pre-pregnancy weight of mother measured in pounds.
Pre-pregnancy weight unknown	1 if the pre-pregnancy weight of mother was unknown; 0 otherwise.
This is first live birth	1 if it was the mother's first live birth; 0 otherwise.
This is fourth or higher order birth	1 if it was the mother's fourth or higher order birth; 0 otherwise.
Sex of baby is male	1 if the sex of the infant was male; 0 female.
Plural birth	1 if it was a plural birth; 0 otherwise.
Participated in WIC during pregnancy	1 if mother enrolled in WIC during this pregnancy; 0 otherwise.
Exposures	
Tobacco	1 if more than 1/2 pack per day of tobacco was consumed during pregnancy; 0 otherwise.
Alcohol	1 if more than 2 drinks per week of alcohol was consumed during the pregnancy; 0 other
Illicit drugs	1 if heroin, cocaine, methadone, and other illicit drugs used during the pregnancy; 0 othe
Source of Payment	
Medicaid	1 if the primary financial coverage of the birth was Medicaid; 0 otherwise.
Self pay	1 if the primary financial coverage of the birth was mothers themselves; 0 otherwise.
Health Area Characteristics	
Family planning clinics	1 if woman resided in a health area where contains one or more family planning clinics in 1990; 0 if no clinic.
Prenatal care clinics	1 if woman resided in a health area where contains one or more prenatal care clinics in 1990; 0 if no clinic.

Table 2 Descriptive Statistics (means and percents)
– Entire sample

Variables	Asian	White (non-Hispanic)
Observations	9,636	27,599
Birth Outcomes		
Mean of birth weight (g)	3,217.66	3,371.04
Low birth weight (< 2500g)	0.068	0.059
Preterm labor (< 37 gestational weeks)	0.065	0.061
Prenatal Care Index		
(a modified Kotelchuck Index)		
No care	0.116	0.144
Inadequate	0.326	0.177
Intermediate	0.147	0.189
Adequate	0.293	0.350
Adequate Plus	0.117	0.140
Type of Delivery Service		
Private service	0.553	0.778
Mother's Education a/		
Mean of mother's education (years)	12.826	13.434
Mother's edu., less than 12th grade	0.159	0.101
Mother's edu. was 13-16 years	0.267	0.321
Mother's edu. was 17 years or higher	0.089	0.137
Mother's edu., completed 12 years	0.413	0.405
Mother's edu. unknown	0.071	0.036
Father's Education a/		
Mean of father's education (years)	13.277	13.740
father's edu., less than 12th grade	0.115	0.070
father's edu., was 13-16 years	0.257	0.284
Father's edu. was 17 years or higher	0.131	0.176
father's edu., completed 12 years	0.366	0.366
father's edu. unknown	0.130	0.103
Maternal Measures		
Mean of age (years)	29.258	29.273
Age < =18 years	0.012	0.021
Age >= 35 years	0.144	0.185
Out-of-wedlock	0.130	0.142
Works during pregnancy (1=yes)	0.315	0.334
Foreign born (1=yes)	0.974	0.250

a/ Observations of 'no education' in mothers and fathers are too few to list in the table.

Table 2 Descriptive Statistics (means and percents) -- Entire sample

(continued)

Variables		Asian	White (non-Hispanic)
Previous early miscarriage		0.127	0.149
Previous late miscarriage		0.017	0.021
Pre-pregnancy weight (log) (g)		4.799	4.935
Pre-pregnancy weight unknown		0.282	0.327
This is first live birth (1=yes)		0.416	0.368
Parity is fourth or higher (1=yes)		0.124	0.196
Sex of baby is male (1=yes)		0.506	0.514
Plural birth (1=yes)		0.016	0.029
Participate in WIC		0.116	0.084
Exposures			
Tobacco		0.006	0.081
Alcohol		0.001	0.008
Illicit drugs		0.018	0.021
Source of Payment			
Medicaid		0.309	0.186
Self- pay		0.112	0.097
Health Area Characteristics			
Family planning clinics:	1	0.176	0.155
	2	0.042	0.032
	3	0.031	0.009
	yes	0.249	0.196
	none	0.751	0.803
Prenatal care clinics:	1	0.152	0.130
	2	0.094	0.054
	3	0.017	0.026
	yes	0.263	0.210
	none	0.737	0.790
National groups			
Chinese		0.370	-
Japanese		0.023	-
Filipino		0.093	-
Other Asian and Pacific Islanders		0.514	-

Source: Birth data of New York City in 1991.

Table 3 A Percentage distribution of births rated on the two dimensions of the Adequacy of Prenatal Care Utilization Index, by birth outcomes -- Asian sample

I. Total sample

	% of Recommended Visits Received				
Month of initiation of care	< 50	50-79	80-109	110+	% of all Births
7-9	1.2	3.0	3.9	5.7	13.9
5-6	1.0	5.4	6.7	7.4	20.5
3-4	1.5	9.7	23.1	9.9	44.2
1-2	0.9	6.9	10.1	3.3	21.2
% of all births	4.7	25.1	43.8	26.4	100

II. Sample of low-birth weight births

	% of Recommended Visits Received				
Month of initiation of care	< 50	50-79	80-109	110+	% of all Births
7-9	1.2	2.1	1.7	5.8	10.8
5-6	0.2	3.5	6.2	12.9	22.8
3-4	1.2	6.8	16.0	20.5	44.4
1-2	0.2	3.5	9.3	9.1	22.0
% of all births	2.7	15.8	33.2	48.3	100.0

III. Sample of preterm births

	% of Recommended Visits Received				
Month of initiation of care	< 50	50-79	80-109	110+	% of all Births
7-9	0.4	1.9	1.9	6.9	11.0
5-6	0.0	1.0	5.0	18.7	24.7
3-4	0.6	3.7	8.5	29.9	42.8
1-2	0.2	1.3	5.2	14.8	21.4
% of all births	1.3	7.9	20.6	70.3	100.0

Source: Birth data of New York City in 1991.

Table 3 B Percentage distribution of births rated on the two dimensions of the Adequacy of Prenatal Care Utilization Index, by birth outcomes -- white sample

I. Total sample

Month of initiation of care	% of Recommended Visits Received <50	50-79	80-109	110+	% of all births
7-9	1.0	1.6	1.7	2.6	6.9
5-6	1.1	2.8	3.6	3.3	10.8
3-4	1.8	10.6	21.4	9.3	43.1
1-2	1.2	11.4	19.5	7.1	39.2
% of all births	5.0	26.4	46.2	22.4	100.0

II. Sample of low-birth weight births

Month of initiation of care	% of Recommended Visits Received <50	50-79	80-109	110+	% of all births
7-9	0.7	1.3	1.8	2.8	6.6
5-6	0.5	2.1	2.8	5.8	11.2
3-4	1.5	6.7	12.8	23.1	44.2
1-2	0.7	5.6	12.1	19.7	38.0
% of all births	3.4	15.7	29.5	51.4	100.0

III. Sample of preterm births

Month of initiation of care	% of Recommended Visits Received <50	50-79	80-109	110+	% of all births
7-9	0.2	1.1	0.6	3.6	5.5
5-6	0.9	0.9	2.8	8.1	12.7
3-4	0.5	4.7	8.4	29.7	43.4
1-2	0.5	1.8	7.3	28.9	38.5
% of all births	2.2	8.4	19.2	70.2	100.0

Source: Birth data of New York City in 1991.

Table 4 A Distributions of total, low birth weight, and preterm births, by level of prenatal care (a modified Kotelchuck Index) -- Asian sample

Prenatal Care Index	Total births. % (1)	All low birth weight births, % (2)	All preterm births, % (3)	Ratio I (2)/(1)	Ratio II (3)/(1)
No care	11.6	22.0	23.8	1.9	2.1
Inadequate	32.6	27.3	27.9	0.8	0.9
Intermediate	14.7	8.0	3.8	0.5	0.3
Adequate	29.4	19.7	10.5	0.7	0.4
Adequate plus	11.7	23.0	34.0	2.0	2.9

Table 4 B Distributions of total. low birth weight. and preterm births. by level of prenatal care (a modified Kotelchuck Index) -- white sample

Prenatal Care Index	Total births. % (1)	All low birth weight births. % (2)	All preterm births. % (3)	Ratio I (2)/(1)	Ratio II (3)/(1)
No care	14.4	25.4	26.3	1.8	1.8
Inadequate	17.7	14.9	14.1	0.8	0.8
Intermediate	18.9	9.2	4.8	0.5	0.3
Adequate	35.0	18.6	11.6	0.5	0.3
Adequate plus	14.0	31.9	43.2	2.3	3.1

Source: Birth data of New York City in 1991.

Table 5 Percentage distribution of Asian births rated on the two dimensions of the Adequacy of Prenatal Care Utilization Index, by some national origins

1. Chinese

	% of Recommended Visits Received				
Month of initiation of care	< 50	50-79	80-109	110+	% of all births
7-9	1.2	2.8	2.8	3.2	10.0
5-6	1.1	7.1	6.1	5.5	19.8
3-4	1.9	11.8	24.1	9.9	47.7
1-2	0.5	6.8	11.7	3.4	22.4
% of all births	4.7	28.6	44.6	22.2	100.0

2. Japanese

Month of initiation of care					
7-9	1.0	2.5	1.0	5.0	9.5
5-6	0.5	2.5	3.0	5.9	11.9
3-4	0.0	6.0	24.3	24.9	55.2
1-2	0.5	3.0	15.9	4.0	23.4
% of all births	2.0	13.9	44.3	39.8	100.0

3. Filipino

Month of initiation of care					
7-9	0.3	2.3	1.7	2.8	7.1
5-6	0.9	3.3	4.2	4.0	12.4
3-4	1.7	12.4	28.1	10.1	52.3
1-2	1.6	7.4	12.8	6.5	28.2
% of all births	4.4	25.4	46.7	23.4	100.0

4. Other Asian

Month of initiation of care					
7-9	1.5	3.3	5.4	8.2	18.4
5-6	1.0	4.7	7.8	9.6	23.1
3-4	1.3	7.8	21.3	9.1	39.6
1-2	1.1	7.2	8.0	2.6	18.9
% of all births	4.9	22.9	42.6	29.5	100.0

Source: Birth data of New York City in 1991.

Table 6 Ratings assigned to Asian births according to the Adequacy of Prenatal Care Utilization Index, by some national origins

	Chinese, %	Japanese, %	Filipino, %	Other Asian, %
Month of initiation of care				
7-9	10.2	9.5	7.3	18.8
5-6	19.9	11.9	12.4	23.0
3-4	47.6	55.2	52.1	39.3
1-2	22.4	23.4	28.2	18.8
% of recommended visits received				
< 50	4.7	2.0	4.4	4.9
50-79	28.6	13.9	25.4	22.9
80-109	44.6	44.3	46.7	42.6
110+	22.2	39.8	23.4	29.5
Prenatal care index				
No care	8.6	9.0	9.0	14.4
Inadequate	29.4	19.9	20.8	37.6
Intermediate	17.0	8.1	18.0	12.8
Adequate	32.7	36.7	37.2	25.1
Adequate plus	12.2	26.2	15.0	10.1

Source: Birth data of New York City in 1991.

Table 7 A — Means and percents of variables, by levels of prenatal care -- Asian sample

Variables	Adequate plus	Adequate	Intermediate	Inadequate	No care
Observations (N=9636)	1,127	2,825	1,421	3,143	1,120
Birth Outcomes					
Mean of birth weight (g)	3,084.34	3,256.93	3,303.30	3,230.26	3,117.25
Low birth weight (< 2500g)	0.136	0.046	0.037	0.058	0.121
Preterm labor (< 37 gestational weeks)	0.191	0.023	0.017	0.056	0.114
Type of delivery service					
Private service	0.535	0.553	0.559	0.565	0.527
Mother's Education a/					
Mean of mother's education (years)	12.787	12.841	12.824	12.792	12.869
Mother's edu., less than 12th grade	0.166	0.153	0.151	0.167	0.155
Mother's edu. was 13-16 years	0.278	0.264	0.265	0.265	0.263
Mother's edu. was 17 years or higher	0.076	0.088	0.084	0.091	0.098
Mother's edu., completed 12 years	0.402	0.426	0.435	0.399	0.424
Mother's edu. unknown	0.078	0.069	0.065	0.078	0.060
Father's Education a/					
Mean of father's education (years)	13.232	13.313	13.297	13.250	13.228
Father's edu., less than 12th grade	0.119	0.106	0.116	0.121	0.118
Father's edu., was 13-16 years	0.263	0.256	0.265	0.252	0.259
Father's edu. was 17 years or higher	0.126	0.132	0.122	0.134	0.128
Father's edu., completed 12 years	0.353	0.380	0.367	0.358	0.376
Father's edu. unknown	0.139	0.126	0.130	0.135	0.119
Maternal Measures					
Mean of age (years)	28.932	29.183	29.317	29.366	29.305
Age < =18 years	0.014	0.009	0.018	0.014	0.008
Age >= 35 years	0.128	0.139	0.144	0.154	0.148
Out-of-wedlock	0.140	0.133	0.127	0.122	0.132

a/ Observations of 'no education' in mothers' and fathers' are too few to list in the table.

Table 7 A Means and percents of variables, by levels of prenatal care -- Asian sample

(continued)

Variables	Adequate plus	Adequate	Intermediate	Inadequate	No care
Works during pregnancy (1=yes)	0.287	0.317	0.318	0.327	0.303
Foreign born (1=yes)	0.967	0.972	0.979	0.972	0.987
Previous early miscarriage	0.154	0.114	0.110	0.146	0.105
Previous late miscarriage	0.024	0.015	0.023	0.013	0.013
Pre-pregnancy weight (log) (g)	4.800	4.788	4.796	4.810	4.814
Pre-pregnancy weight unknown	0.184	0.160	0.180	0.349	0.621
This is first live birth (1=yes)	0.436	0.430	0.386	0.406	0.428
Parity is fourth or higher (1=yes)	0.112	0.107	0.105	0.143	0.145
Sex of baby is male (1=yes)	0.515	0.513	0.517	0.488	0.520
Plural birth (1=yes)	0.043	0.012	0.006	0.010	0.022
Participate in WIC	0.116	0.090	0.050	0.175	0.097
Exposures					
Tobacco	0.005	0.007	0.004	0.007	0.005
Alcohol	0.001	0.001	0.000	0.002	0.001
Illicit drugs	0.019	0.009	0.007	0.030	0.016
Source of Payment					
Medicaid	0.214	0.159	0.148	0.538	0.334
Self pay	0.091	0.090	0.096	0.111	0.203
Health Area Characteristics					
Family planning clinics yes	0.211	0.253	0.257	0.254	0.252
Prenatal care clinics: yes	0.230	0.270	0.265	0.268	0.263
National groups					
Chinese	0.388	0.414	0.428	0.335	0.273
Japanese	0.051	0.029	0.013	0.014	0.018
Filipino	0.119	0.118	0.113	0.059	0.072
Other Asian and Pacific Islanders	0.442	0.440	0.446	0.591	0.637

Source: Birth data of New York City in 1991.

Table 7 B   Means and percents of variables, by levels of prenatal care -- white sample

Variables	Adequate plus	Adequate	Intermediate	Inadequate	No care
Observations (N=27599)	3,858	9,670	5,206	4,889	3,976
Birth Outcomes					
Mean of birth weight (g)	3,194.69	3,437.72	3,464.02	3,375.87	3,257.78
Low birth weight (< 2500g)	0.134	0.031	0.029	0.050	0.101
Preterm labor (< 37 gestational weeks)	0.187	0.020	0.015	0.048	0.104
Type of Delivery Service					
Private service	0.775	0.779	0.782	0.772	0.774
Mother's Education a/					
Mean of mother's education (years)	13.418	13.381	13.436	13.474	13.427
Mother's edu., less than 12th grade	0.103	0.101	0.100	0.099	0.102
Mother's edu. was 13-16 years	0.327	0.313	0.328	0.326	0.314
Mother's edu. was 17 years or higher	0.136	0.134	0.133	0.136	0.137
Mother's edu., completed 12 years	0.401	0.416	0.405	0.401	0.405
Mother's edu. unknown	0.033	0.036	0.034	0.038	0.042
Father's Education a/					
Mean of father's education (years)	13.759	13.701	13.758	13.714	13.728
Father's edu., less than 12th grade	0.068	0.069	0.069	0.069	0.075
Father's edu., was 13-16 years	0.298	0.278	0.284	0.285	0.280
Father's edu. was 17 years or higher	0.177	0.174	0.176	0.173	0.173
Father's edu., completed 12 years	0.360	0.372	0.371	0.370	0.363
Father's edu. unknown	0.097	0.107	0.100	0.103	0.109
Maternal Measures					
Mean of age (years)	28.947	29.378	29.232	29.341	29.320
Age <=18 years	0.019	0.023	0.019	0.022	0.240
Age >= 35 years	0.186	0.177	0.189	0.184	0.191
Out-of-wedlock	0.144	0.142	0.134	0.151	0.143

a/ Observations of 'no education' in mothers' and fathers' are too few to list in the table.

Table 7 B   Means and percents of variables, by levels of prenatal care -- white sample

(continued)

Variables	Adequate plus	Adequate	Intermediate	Inadequate	No care
Works during pregnancy (1=yes)	0.352	0.337	0.335	0.323	0.318
Foreign-born (1=yes)	0.254	0.252	0.252	0.246	0.242
Previous early miscarriage	0.182	0.137	0.154	0.153	0.135
Previous late miscarriage	0.029	0.018	0.019	0.021	0.019
Pre-pregnancy weight (log) (g)	4.892	4.888	4.900	4.914	4.902
Pre-pregnancy weight unknown	0.207	0.243	0.299	0.323	0.698
This is first live birth (1=yes)	0.372	0.390	0.338	0.316	0.415
Parity is fourth or higher (1=yes)	0.183	0.156	0.180	0.285	0.218
Sex of baby is male (1=yes)	0.509	0.509	0.516	0.512	0.515
Plural birth (1=yes)	0.081	0.018	0.015	0.019	0.036
Participate in WIC	0.073	0.047	0.046	0.205	0.084
Exposures					
Tobacco	0.065	0.080	0.085	0.096	0.076
Alcohol	0.005	0.011	0.005	0.007	0.009
Illicit drugs	0.027	0.014	0.012	0.025	0.037
Source of Payment					
Medicaid	0.124	0.093	0.115	0.445	0.243
Self pay	0.075	0.071	0.070	0.101	0.212
Health Area Characteristics					
Family planning clinics: yes	0.204	0.194	0.196	0.204	0.190
Prenatal care clinics: yes	0.213	0.205	0.213	0.218	0.205

Source: Birth data of New York City in 1991

Table 8 Binomial probit estimates of prenatal care 1/
The sample of women who gave birth in 1991, New York City

Variable	Asian b		Asian |t|	Whites b		Whites |t|
Constant	1.53	**	11.05	1.23	**	59.62
Mother's edu. < 12 yrs	0.01		0.18	0.03		0.72
Mother's edu., 13-16 yrs	-0.00		0.02	0.01		0.37
Mother's edu.>= 17 yrs	-0.13		1.59	-0.01		0.26
Mother's age < = 18 yrs old	0.23		1.30	-0.08		1.24
Mother's age > 35 yrs old	0.00		0.05	-0.03		1.32
Out-of-wedlock	-0.05		0.93	0.03		0.88
Plural birth	-0.26	**	2.07	-0.19	**	3.54
Foreign born	-0.39	**	2.95	0.03		1.33
Participated WIC	0.24	**	3.99	0.20	**	5.31
Early Miscarriages	0.14	**	2.59	0.06	**	2.38
Late Miscarriages	0.09		0.61	0.04		0.60
Prenatal Care Clinics	0.06		1.07	-0.01		0.14
Family Planning Clinics	-0.05		1.02	0.02		0.45
Medicaid	-0.19	**	4.31	-0.44	**	16.22
Self-pay	-0.49	**	9.63	-0.75	**	26.62
Father's edu. < 12 yrs	-0.01		0.18	-0.08	*	1.79
Father's edu., 13-16 yrs	0.83		0.15	-0.04		0.14
Father's edu.>= 17 yrs	0.96		1.30	0.00		0.07
Father's edu. unknown	0.10		1.60	-0.06		1.49
Chinese	0.28	**	7.27	-		
Japanese	0.22	*	1.78	-		
Filipino	0.21	**	3.20	-		
Log likelihood	-3319.93			-10953.07		
Chi-squared	212.21			850.41		

1/ The dependent variable is coded 1 if a woman received care, and 0 if a woman did not have care. The omitted categories for education and national origin are high school degree (12 years) and other Asian women, respectively.

* 5% < P < 10%
** P < 5%

Table 9 Estimates of private delivery service by bivariate probit model with prenatal care 1/
The sample of women who gave birth in 1991, New York City

Variable	Asian			Whites		
	b		t	b		t
Constant	0.66	**	5.63	1.07	**	52.62
Mother's edu. < 12 yrs	-0.55	**	11.10	-0.61	**	19.32
Mother's edu., 13-16 yrs	0.23	**	5.70	0.30	**	11.08
Mother's edu.>= 17 yrs	0.43	**	6.50	0.47	**	10.47
Mother's age < = 18 yrs old	-0.69	**	4.70	-0.41	**	7.29
Mother's age > 35 yrs old	0.29	**	7.38	0.27	**	9.99
Out-of-wedlock	-0.91	**	19.88	-1.20	**	41.96
Plural birth	-0.18		1.57	0.00		0.10
Foreign-born	-0.63	**	5.61	-0.65	**	31.83
Participated WIC	-0.01		0.28	-0.03		0.81
Early Miscarriages	0.01		0.30	-0.02		0.08
Late Miscarriages	0.11		1.04	-0.19		0.28
Prenatal Care Clinics	0.05		1.26	1.84	**	3.31
Family Planning Clinics	0.00		0.07	-0.20	**	3.62
Medicaid	0.00		0.04	-0.01		0.50
Self-pay	0.01		0.24	0.00		0.10
Father's edu. < 12 yrs	-0.21	**	3.79	-0.30	**	8.53
Father's edu., 13-16 yrs	0.23	**	5.62	0.25	**	8.62
Father's edu. >= 17 yrs	0.45	**	7.76	0.45	**	10.59
Father's edu. unknown	0.34	**	6.69	-0.30	**	8.95
Chinese	0.04		1.26			
Japanese	-0.16	*	1.71			
Filipino	-0.01		0.19			
Rho (1,2) 2/	0.04	*	1.80	0.01		0.53
Log likelihood	-9055.15			-21496.75		

1/ The bivariate probit model is estimated for prenatal care and private service together. Prenatal care and private service are dichotomous variables. Its estimate result for prenatal care is almost identical to the result in the Table 8.

2/ 1= decision of whether to have prenatal care; 2= decision of whether to have private delivery service.

* 5% < P < 10%
** P < 5%

Table 10 Ordered probit estimates of prenatal care 1/
The sample of women who gave birth in 1991, New York City

Variable	Asian			White		
	b		|t|	b		|t|
Constant	1.51	**	19.79	1.27	**	83.14
Mother's edu. < 12 yrs	0.01		0.25	0.03		1.20
Mother's edu., 13-16 yrs	0.00		0.06	-0.01		0.52
Mother's edu.>= 17 yrs	-0.09	*	1.83	-0.01		0.53
Mother's age < = 18 yrs old	-0.02		0.20	-0.05		1.05
Mother's age > 35 yrs old	-0.07	**	2.06	-0.02		1.16
Out-of-wedlock	0.02		0.48	0.01		0.52
Plural birth	0.28	**	4.12	0.41	**	13.59
Foreign born	-0.17	**	2.29	0.02		1.39
Participated WIC	0.29	**	7.47	0.10	**	3.72
Early Miscarriages	0.09	**	2.77	0.06	**	3.45
Late Miscarriages	0.19	**	2.24	0.15	**	3.20
Prenatal Care Clinics	-0.01		0.23	-0.05		1.56
Family Planning Clinics	-0.02		0.66	-0.06		1.62
Medicaid	-0.66	**	22.01	-0.67	**	33.74
Self-pay	-0.48	**	14.71	-0.59	**	30.34
Father's edu. < 12 yrs	-0.02		0.52	-0.03		1.15
Father's edu., 13-16 yrs	0.07		0.22	0.02		1.33
Father's edu.>= 17 yrs	0.05		1.10	0.02		0.65
Father's edu. unknown	0.04		0.94	-0.03		1.15
Chinese	0.16	**	6.50	-		-
Japanese	0.43	**	6.58	-		-
Filipino	0.21	**	5.36	-		-
Threshold parameter mu (1)	1.11	**	64.87	0.64	**	77.36
Threshold parameter mu (2)	1.51	**	82.89	1.16	**	120.23
Threshold parameter mu (3)	2.52	**	112.93	2.25	**	183.50
Log likelihood	-13910.48			-41444.79		
Chi-squared	888.02			2,008.59		

1/ The dependent variable is coded 4 if a woman received adequate plus care, 3 if a woman had adequate care, 2 if a woman had intermediate care, 1 if a woman had inadequate care, and 0 if a woman had no care. The omitted categories for education and national origin are high school degree (12 years) and other Asian women, respectively.

* 5% < P < 10%
** P < 5%

Table 11 A Estimates of birth weight equations corrected and uncorrected for self selection for women who received or did not receive prenatal care 1/ -- Asian sample

Variable	Had prenatal care: Corrected b	|t|	Had prenatal care: Uncorrected b	|t|	No prenatal care: Corrected b	|t|	No prenatal care: Uncorrected b	|t|
Constant	2,043.50 **	14.67	1,995.80 **	14.46	1,211.20 *	1.79	1,527.80 **	2.42
Mother's edu. < 12 yrs	-48.85 **	2.79	-49.28 **	2.96	85.34	1.45	87.32	1.48
Mother's edu., 13-16 yrs	-20.86	1.43	-20.14	1.45	-61.91	1.26	-63.58	1.28
Mother's edu.>= 17 yrs	12.46	0.55	5.85	0.27	57.01	0.77	40.81	0.56
Mother's age < = 18 yrs old	-1.38	0.03	19.08	0.37	260.57	1.14	284.74	1.25
Mother's age > 35 yrs old	0.60	0.04	0.54	0.03	45.64	0.79	45.79	0.79
Out-of-wedlock	-45.65 **	2.49	-46.74 **	2.69	-156.86 **	2.59	-163.89 **	2.71
Foreign born	111.22 **	2.86	76.14 **	2.16	38.01	0.21	0.64	0.00
Employed during pregnancy	17.14	1.36	16.98	1.35	-14.12	0.31	-11.88	0.27
Early Miscarriages	-25.19	1.28	-12.53	0.68	-15.93	0.22	5.35	0.08
Late Miscarriages	-137.56 **	2.89	-129.12 **	2.86	-369.78 **	2.08	-345.96 *	1.95
Log (pre-pregnant weight)	237.48 **	8.46	235.51 **	8.39	348.40 **	2.74	344.31 **	2.71
Pre-pregnant weight unknown	-34.89 **	2.50	-38.31 **	2.75	-118.61 **	2.66	-126.38 **	2.86
Tobacco	15.66	0.22	19.03	0.27	-222.02	0.80	-208.56	0.80
Alcohol	-		-		-		-	
Illicit drugs	106.52 **	2.48	100.10 **	2.32	-133.70	0.83	-131.62	0.82
Baby is male	72.46 **	6.35	71.95 **	6.29	16.97	0.42	15.98	0.39
First live birth	-77.49 **	6.10	-78.12 **	6.13	-70.91	1.57	-71.70	1.59
Parity is four or more	22.33	1.18	23.16	1.22	19.41	0.31	18.66	0.30
Chinese	39.48 **	2.43	70.22 **	5.58	-4.92	0.09	37.69	0.81
Japanese	-52.05	1.26	-23.42	0.61	116.26	0.73	163.81	1.05
Filipino	-28.98	1.26	-1.15	0.06	125.84	1.49	164.63 **	2.08
Lambda (correction factor)	-352.77 **	3.29	-	-	-165.79	1.29	-	-
Adj. R-squared	0.03		0.02		0.02		0.02	

1/ Birth weight is measured in grams.
The omitted categories are: high school degree (12 years), 1-3 previous live births in parity, and other Asian women in national origin.

* 5% < P < 10%
** P < 5%

Table 11.B Estimates of birthweight equations corrected and uncorrected for self selection for women who received or did not receive prenatal care 1/ -- White sample

Variable	Had prenatal care				No prenatal care			
	Corrected		Uncorrected		Corrected		Uncorrected	
	b	|t|	b	|t|	b	|t|	b	|t|
Constant	1,393.90 **	14.72	1,284.20 **	13.62	1,198.70 **	2.91	1,497.50 **	3.71
Mother's edu. < 12 yrs	13.95	1.00	15.55	1.20	46.85	1.25	45.62	1.22
Mother's edu., 13-16 yrs	-1.46	0.16	0.84	0.10	-13.91	0.55	-10.85	0.43
Mother's edu.>= 17 yrs	10.10	0.81	10.99	0.94	8.98	0.27	8.25	0.24
Mother's age < = 18 yrs old	-13.87	0.50	-28.25	1.09	-16.57	0.23	-22.13	0.32
Mother's age > 35 yrs old	-0.97	0.10	-5.22	0.55	5.57	0.21	0.38	0.01
Out-of-wedlock	-4.32	0.37	-4.14	0.39	-43.41	1.40	-39.33	1.27
Foreign born	-0.59	0.07	3.30	0.40	-18.10	0.74	-14.30	0.58
Employed during pregnancy	4.46	0.60	4.15	0.52	-37.79	1.59	-38.35	1.61
Early Miscarriages	-19.53 *	1.68	-5.41	0.50	-6.32	0.19	6.84	0.21
Late Miscarriages	-61.74 **	2.27	-55.60 **	2.20	-99.58	1.32	-92.59	1.23
Log (pre-pregnant weight)	423.38 **	22.12	422.55 **	22.03	371.61 **	4.53	363.76 **	4.43
Pre-pregnant weight unknown	-9.37	1.16	-20.26 **	2.50	-28.60	1.24	-41.82 *	1.83
Tobacco	-95.54 **	7.21	-98.73 **	7.40	-269.23 **	6.61	-279.53 **	6.86
Alcohol	270.88 **	6.59	272.38 **	6.61	-94.80	0.82	-93.10	0.81
Illicit drugs	-125.95 **	4.70	-127.87 **	4.75	-341.57 **	6.09	-345.37 **	6.15
Baby is male	116.03 **	15.83	116.15 **	15.88	85.61 **	4.04	86.94 **	4.10
First live birth	-37.75 **	4.62	-37.48 **	4.58	-6.79	0.28	-9.46	0.39
Parity is four or more	12.36	1.23	2.24	0.22	38.84	1.34	30.68	1.06
Lambda (correction factor)	-453.42 **	11.04	-	-	-165.37 **	3.78	-	-
Adj. R-squared	0.04		0.04		0.04		0.03	

1/ Birthweight is measured in grams.
The omitted categories are: high school degree (12 years), 1-3 previous live births in parity.

* 5% < P < 10%
** P < 5%

Table 12A Estimates of birth weight equations corrected for self selection for women who received or did not receive prenatal care; and who used private delivery service 1/ — Asian sample

Variable	Had prenatal care Used private delivery service b		t	No prenatal care Used private delivery service b		t
Constant	2,100.60	**	11.35	393.18		0.43
Mother's edu. < 12 yrs	12.14		0.22	101.82		0.55
Mother's edu., 13-16 yrs	-46.74	*	1.86	29.94		0.32
Mother's edu. >= 17 yrs	-41.76		1.04	103.28		0.70
Mother's age <= 18 yrs old	-171.61		1.06	-		-
Mother's age > 35 yrs old	-31.14		1.26	128.87		1.38
Out-of-wedlock	7.30		0.13	-237.09		1.17
Foreign born	101.39	**	2.06	-31.38		0.15
Employed during pregnancy	8.64		0.56	-15.89		0.28
Early Miscarriages	-4.33		0.17	-25.69		0.27
Late Miscarriages	-206.43	**	3.43	-512.93	**	2.34
Log (pre-pregnant weight)	235.20	**	6.32	438.13	**	2.77
Pre-pregnant weight unknown	-32.34	*	1.72	-78.16		1.28
Tobacco	-31.10		0.33	-582.33		1.47
Alcohol	-524.88	*	1.72	-		-
Illicit drugs	109.87	*	1.78	-388.25		1.24
Baby is male	76.96	**	5.02	81.21		1.46
First live birth	-65.14	**	3.81	-53.84		0.86
Parity is four or more	40.16		1.59	-22.13		0.26
Chinese	51.45	**	2.45	-64.90		0.77
Japanese	-52.53		0.99	130.06		0.58
Filipino	-12.74		0.41	61.11		0.52
Lambda-1 (correction factor) 2/	-142.60		0.99	-339.66	*	1.68
Lambda-2 (correction factor)	-136.71		1.56	123.00		0.41
Adj. R-squared	0.02			0.02		

1/ Birth weight is measured in grams.
The omitted categories are: high school degree (12 years), 1-3 previous live births in parity, and other Asian women in national origins.

2/ Lambda-1 = correction factor for prenatal care; lambda-2 = correction factor for private service.

* 5% < P < 10%
** P < 5%

Table 12B Estimates of birth weight equations corrected for self selection for women who received or did not receive prenatal care: and who used private delivery service 1/
-- White sample

Variable	Had prenatal care Used private delivery service b		t	No prenatal care Used private delivery service b		t
Constant	1,419.40	**	12.93	1,317.50	**	2.75
Mother's edu. < 12 yrs	-36.28		1.25	79.70		1.01
Mother's edu., 13-16 yrs	6.48		0.52	-4.61		0.13
Mother's edu. >= 17 yrs	22.27		1.29	24.79		0.51
Mother's age < = 18 yrs old	11.55		0.20	-270.52	*	1.88
Mother's age > 35 yrs old	6.54		0.56	20.17		0.62
Out-of-wedlock	-37.20		1.09	-84.75		0.88
Foreign born	-16.10		1.01	-64.41		1.44
Employed during pregnancy	9.85		1.14	-39.53		1.54
Early Miscarriages	-13.25		1.02	-28.82		0.74
Late Miscarriages	-82.93	**	2.69	-119.86		1.37
Log (pre-pregnant weight)	415.26	**	18.84	341.74	**	3.59
Pre-pregnant weight unknown	-9.44		1.02	-38.59		1.45
Tobacco	-91.62	**	6.01	-270.01	**	5.75
Alcohol	244.81	**	5.34	-117.89		0.89
Illicit drugs	-134.54	**	4.34	-293.19	**	4.38
Baby is male	118.15	**	14.01	90.22	**	3.68
First live birth	-43.83	**	4.68	-14.87		0.53
Parity is four or more	7.92		0.69	47.48		1.42
Lambda-1 (correction factor) 2/	-468.35	**	9.44	-174.98	**	3.35
Lambda-2 (correction factor)	58.13		1.20	94.38		0.70
Adj. R-squared	0.04			0.03		

1/ Birth weight is measured in grams.
The omitted categories are: high school degree (12 years), 1-3 previous live births in parity.

2/ Lambda-1 = correction factor for prenatal care; lambda-2 = correction factor for private service.

* 5% < P < 10%
** P < 5%

Table 13 Coefficients on prenatal care and private delivery in infant birth weight specifications 1/ controlling for self-selection into having care, and private delivery

Variable	Asian						White					
	2SLS			OLS			2SLS			OLS		
	b		|t|	b		|t|	b		|t|	b		|t|
Had care	112.97	**	6.2	106.59	**	5.9	144.67	**	13.8	123.65	**	12.1
Private delivery	1.63		0.1	-7.04		0.6	-15.14		1.4	-11.9		1.3
Adj. R-squared	0.03			0.03			0.04			0.04		
Wu-Hausman exogeneity test	F = 9.42						F = 16.03					

1/ Estimates were done on all variables of birth weight equations with entire observation, but those results of variables other than prenatal care and private delivery are not shown here.

Critical F-statistic: 5%: 3.00, 1%: 4.61.

** P < 5%

Table 14 A Estimates of birth weight equations corrected for self selection for women, by level of prenatal care (a modified Kotelchuck Index) 1/
-- Asian sample

	4 Adequate plus		3 Adequate		2 Intermediate		1 Inadequate		0 No Care	
Variable	b	|t|	b	|t|	b	|t|	b	|t|	b	|t|
Constant	3,552.30 **	6.03	2,065.70 **	6.56	2,607.70 **	3.97	1,916.90 **	8.08	1,761.10 **	2.72
Mother's edu. < 12 yrs	-18.83	0.34	-51.67 *	1.89	-39.28	0.94	-62.67 **	2.43	88.29	1.50
Mother's edu., 13-16 yrs	-29.58	0.64	-26.52	1.17	11.15	0.33	-19.86	0.91	-65.83	1.32
Mother's edu.>= 17 yrs	62.19	0.82	-40.22	1.16	57.22	1.08	-18.57	0.56	27.56	0.38
Mother's age < = 18 yrs old	-25.82	0.16	27.69	0.28	-25.68	0.23	1.29	0.02	287.72	1.27
Mother's age > 35 yrs old	-123.09 **	2.15	38.30	1.39	11.28	0.28	-5.03	0.20	40.72	0.71
Out-of-wedlock	-150.30 **	2.73	-46.22	1.64	37.72	0.86	-23.50	0.84	-164.14 **	2.71
Foreign born	99.38	0.91	19.71	0.34	-28.18	0.29	64.18	1.17	-3.05	0.02
Employed during pregnancy	-1.12	0.03	-10.74	0.53	46.70	1.50	18.49	0.95	-10.02	0.22
Early miscarriages	-21.78	0.37	14.39	0.45	-10.72	0.22	20.90	0.75	16.35	0.23
Late miscarriages	-263.36 **	2.03	-166.15 **	2.17	24.84	0.26	4.54	0.06	-310.27 *	1.74
Log (pre-pregnant weight)	265.40 **	2.89	282.25 **	6.43	197.71 **	3.15	243.55 **	5.05	345.19 **	2.71
Pre-pregnant weight unknown	-118.41 **	2.34	-44.98 *	1.74	-39.01	1.05	-39.06 *	1.94	-142.36 **	3.15
Tobacco	-168.74	0.66	105.55	0.96	200.63	0.86	-58.87	0.56	-197.04	0.71
Alcohol	-		-		-		-		-	
Illicit drugs	163.48	1.16	61.90	0.62	-268.78	1.61	134.45 **	2.54	-152.69	0.95
Baby is male	77.45 **	2.04	57.08 **	3.06	64.28 **	2.30	93.17 **	5.19	17.02	0.43
First live birth	-99.45 **	2.33	-44.23 **	2.16	-44.88	1.45	-104.63 **	5.16	-71.66	1.59
Parity is four or more	-99.86	1.54	61.49 *	1.90	32.95	0.67	15.12	0.54	12.39	0.20
Chinese	189.41 **	3.97	75.57 **	3.21	87.06 **	2.60	65.33 **	3.05	67.96	1.35
Japanese	453.70 **	4.38	-30.94	0.47	-52.74	0.37	-42.36	0.53	240.57	1.47
Filipino	104.94	1.52	5.98	0.17	3.06	0.06	66.09	1.62	209.26 **	2.50
Lambda (correction factor)	-299.73 **	4.94	-50.78	0.91	-147.54	0.56	187.07 *	1.86	141.42	1.58
Adj. R-squared	0.05		0.03		0.01		0.03		0.02	

1/ Birth weight is measured in grams.
The omitted categories are: high school degree (12 years), 1-3 previous live births in parity, and other Asian women in national origin

* 5% < P < 10%
** P < 5%

Table 14 B Estimates of birth weight equations corrected for self selection for women, by level of prenatal care (a modified Kotelchuck Index) 1/ -- White sample

Variable	4 Adequate plus b		|t|	3 Adequate b		|t|	2 Intermediate b		|t|	1 Inadequate b		|t|	0 No Care b		|t|
Constant	4,182.70	**	11.51	2,444.20	**	11.18	5,611.30	**	7.86	1,361.60	**	6.81	1,577.00	**	3.83
Mother's edu. < 12 yrs	17.70		0.45	19.60		1.06	18.55		0.76	36.27		1.32	46.95		1.26
Mother's edu., 13-16 yrs	7.67		0.29	-1.94		0.16	35.67	**	2.22	-27.95		1.55	-7.43		0.30
Mother's edu.>= 17 yrs	61.68	*	1.73	-5.78		0.35	47.49	**	2.15	-18.87		0.77	19.53		0.58
Mother's age < = 18 yrs old	-61.25		0.73	-19.24		0.54	-103.71	**	2.00	-25.23		0.47	-27.25		0.39
Mother's age > 35 yrs old	-38.04		1.33	-11.71		0.86	-6.76		0.38	19.17		0.96	-3.21		0.12
Out-of-wedlock	39.61		1.21	-19.57		1.27	-1.04		0.05	4.03		0.18	-43.41		1.40
Foreign-born	0.06		0.00	6.59		0.55	11.77		0.75	9.03		0.51	-16.80		0.68
Employed during pregnancy	-18.29		0.75	1.02		0.09	18.02		1.18	21.40		1.25	-43.52	*	1.83
Early miscarriages	59.76	*	1.87	2.08		0.13	57.67	**	2.79	-21.67		0.96	0.10		0.00
Late miscarriages	91.87		1.39	-49.10		1.25	49.03		0.98	-88.77	*	1.68	-86.14		1.13
Log (pre-pregnant weight)	423.21	**	7.62	367.50	**	13.31	469.84	**	12.47	415.25	**	10.27	370.28	**	4.49
Pre-pregnant weight unknown	-78.54	**	2.90	-11.45		0.96	-29.07	**	1.96	-41.51	**	2.57	-52.57	**	2.28
Tobacco	-188.79	**	4.18	-34.40	*	1.78	-117.85	**	4.79	-187.31	**	7.08	-281.73	**	6.83
Alcohol	140.90		0.94	545.75	**	10.74	-276.32	**	2.84	-74.66		0.81	-123.65		1.06
Illicit drugs	-69.88		1.04	-7.12	**	0.16	-17.33		0.28	-198.29	**	4.03	-365.12	**	6.42
Baby is male	78.95	**	3.54	107.61	**	10.28	137.96	**	9.96	137.95	**	8.97	81.24	**	3.83
First live birth	-3.77		0.15	-38.64	**	3.37	-38.29	**	2.47	-58.86	**	3.24	-12.96		0.53
Parity is four or more	-60.85	*	1.90	16.93		1.09	-25.83		1.34	33.58	*	1.76	32.31		1.11
Lambda (correction factor)	-512.85	**	13.45	-208.37	**	4.91	-2109.60	**	6.66	-165.26	**	2.58	58.40		1.44
Adj. R-squared	0.06			0.04			0.07			0.06			0.04		

1/ Birth weight is measured in grams.
The omitted categories are: high school degree (12 years), 1-3 previous live births in parity.

* 5% < P < 10%
** P < 5%

Table 15 A Estimates of birth weight equations corrected for self selection for women level of prenatal care (a modified Kotelchuck Index), and for women who used or did not use private delivery service 1/ -- Asian sample

Variable	Adequate plus: Total 2/ b	Adequate plus: Total 2/ |t|	Adequate plus: Private delivery service used 3/ Yes b	Adequate plus: Private delivery service used 3/ No b	Adequate: Total 2/ b	Adequate: Total 2/ |t|	Adequate: Private delivery service used 3/ Yes b	Adequate: Private delivery service used 3/ No b
Constant	3,552.30 **	6.03	4,173.70 **	2,502.60 **	2,065.70 **	6.56	1,796.30 **	2,534.90 **
Mother's edu. < 12 yrs	-18.83	0.34			-51.67 *	1.89		
Mother's edu., 13-16 yrs	-29.58	0.64			-26.52	1.17		
Mother's edu.>= 17 yrs	62.19	0.82			-40.22	1.16		
Mother's age < = 18 yrs old	-25.82	0.16			27.69	0.28		
Mother's age > 35 yrs old	-123.09 **	2.15	-178.91 **		38.30	1.39		
Out-of-wedlock	-150.30 **	2.73			-46.22	1.64		
Foreign born	99.38	0.91		498.36 *	19.71	0.34		
Employed during pregnancy	-1.12	0.03			-10.74	0.53		
Early miscarriages	-21.78	0.37			14.39	0.45		
Late miscarriages	-263.36 **	2.03	-453.44 **		-166.15 **	2.17	-234.85 **	
Log (pre-pregnant weight)	265.40 **	2.89	222.31 *	330.94 **	282.25 **	6.43	322.62 **	211.71 **
Pre-pregnant weight unknown	-118.41 **	2.34		-140.18 *	-44.98 *	1.74		
Tobacco	-168.74	0.66	482.82 **		105.55	0.96		
Alcohol	-				-			
Illicit drugs	163.48	1.16			61.90	0.62		
Baby is male	77.45 **	2.04		142.10 **	57.08 **	3.06	48.69 *	63.25 **
First live birth	-99.45 **	2.33		-168.35	-44.23 **	2.16	-54.17 *	
Parity is four or more	-99.86	1.54		-174.86	61.49 *	1.90	79.05 *	
Chinese	189.41 **	3.97	197.27 **	180.77 **	75.57 **	3.21	87.75 **	60.77 *
Japanese	453.70 **	4.38	408.00 **	552.42 **	-30.94	0.47		
Filipino	104.94	1.52			5.98	0.17		
Lambda 1 (for prenatal care)	-299.73 **	4.94	-342.81 **	-274.38 **	-50.78	0.91		
Lambda 2 (for delivery service)	-	-			-	-		
Adj. R-squared	0.05		0.06	0.06	0.03		0.03	0.02

Table 15 A Estimates of birth weight equations corrected for self selection for women by level of prenatal care (a modified Kotelchuck Index), and for women who used or did not use private delivery service 1/
-- Asian sample

(continued)

	Intermediate				Inadequate				No care			
	Total 2/		Private delivery service used 3/		Total 2/		Private delivery service used 3/		Total 2/		Private delivery service used 3/	
			Yes	No			Yes	No			Yes	No
	b	|t|	b	b	b	|t|	b	b	b	|t|	b	b
Constant	2,607.70 **	3.97	4,375.00 **		1,916.90 **	8.08	2,049.30 **	1,404.00 **	1,761.10 **	2.72		2,026.20 *
Mother's edu. < 12 yrs	-39.28	0.94	322.30 **		-62.67 **	2.43	-153.62 **		88.29	1.50		
Mother's edu., 13-16 yrs	11.15	0.33	-182.6 **		-19.86	0.91			-65.83	1.32		-260.17 **
Mother's edu.>= 17 yrs	57.22	1.08	-282.65 **		-18.57	0.56			27.56	0.38		
Mother's age < = 18 yrs old	-25.68	0.23			1.29	0.02			287.72	1.27		
Mother's age > 35 yrs old	11.28	0.28	-107.61 *		-5.03	0.20			40.72	0.71		
Out-of-wedlock	37.72	0.86	414.61 **		-23.50	0.84			-164.14 **	2.71		
Foreign-born	-28.18	0.29		497.83 **	64.18	1.17		262.02 **	-3.05	0.02		
Employed during pregnancy	46.70	1.50		101.82 *	18.49	0.95			-10.02	0.22		
Early miscarriages	-10.72	0.22			20.90	0.75			16.35	0.23		
Late miscarriages	24.84	0.26			4.54	0.06			-310.27 *	1.74	-428.18 *	
Log (pre-pregnant weight)	197.71 **	3.15	181.74 **	202.18 **	243.55 **	5.05	211.35 **	286.11 **	345.19 **	2.71	424.54 **	
Pre-pregnant weight unknown	-39.01	1.05			-39.06 *	1.94		-54.36 *	-142.36 **	3.15	-107.27 *	-176.98 **
Tobacco	200.63	0.86			-58.87	0.56			-197.04	0.71		
Alcohol	-				-				-			
Illicit drugs	-268.78	1.61			134.45 **	2.54		205.09 **	-152.69	0.95		
Baby is male	64.28 **	2.30	85.52 **		93.17 **	5.19	107.03 **	73.98 **	17.02	0.43		
First live birth	-44.88	1.45			-104.63 **	5.16	-87.13 **	-132.26 **	-71.66	1.59		
Parity is four or more	32.95	0.67			15.12	0.54			12.39	0.20		
Chinese	87.06 **	2.60		106.17 **	65.33 *	3.05	74.03 **		67.96	1.35		
Japanese	-52.74	0.37			-42.36	0.53			240.57	1.47		
Filipino	3.06	0.06			66.09	1.62			209.26 **	2.50		241.36 **
Lambda 1 (for prenatal care)	-147.54	0.56	-644.35 *		187.07 *	1.86			141.42	1.58		
Lambda 2 (for delivery service)	-	-	-723.66 **		-	-			-	-		
Adj. R-squared	0.01		0.02	0.03	0.03		0.02	0.03	0.02		0.01	0.02

1/ Birth weight is measured in gra The omitted categories are: high school degree (12 years), 1-3 previous live births in parity, and other Asian women in national origin.
2/ Results are from Table 14A.
3/ Estimates was done on all variables, but results of t-ratio and non statistically significant variables are not shown here.

* 5% < P < 10%
** P < 5%

Table 15 B Estimates of birth weight equations corrected for self selection for women level of prenatal care (a modified Kotelchuck Index), and for women who used or did not use private delivery service 1/ -- White sample

	Adequate plus				Adequate			
	Total 2/		Private delivery service used 3/		Total 2/		Private delivery service used 3/	
			Yes	No			Yes	No
	b	|t|	b	b	b	|t|	b	b
Constant	4,182.70 **	11.51	4,577.80 **	2,700.30 **	2,444.20 **	11.18	2,289.10 **	2,854.70 **
Mother's edu. < 12 yrs	17.70	0.45			19.60	1.06		78.36 **
Mother's edu., 13-16 yrs	7.67	0.29			-1.94	0.16		
Mother's edu.>= 17 yrs	61.68 *	1.73			-5.78	0.35		-131.93 *
Mother's age < = 18 yrs old	-61.25	0.73			-19.24	0.54		
Mother's age > 35 yrs old	-38.04	1.33			-11.71	0.86		
Out-of-wedlock	39.61	1.21			-19.57	1.27		
Foreign born	0.06	0.00			6.59	0.55		
Employed during pregnancy	-18.29	0.75			1.02	0.09		-65.36 *
Early miscarriages	59.76 *	1.87	66.33 *		2.08	0.13		
Late miscarriages	91.87	1.39			-49.10	1.25		
Log (pre-pregnant weight)	423.21 **	7.62	358.11 **	646.18 **	367.50 **	13.31	371.07 **	360.51 **
Pre-pregnant weight unknown	-78.54 **	2.90	-73.26 **	-104.00 *	-11.45	0.96		
Tobacco	-188.79 **	4.18	-188.38 **	-218.68 **	-34.40 *	1.78		
Alcohol	140.90	0.94			545.75 **	10.74	483.12 **	847.41 **
Illicit drugs	-69.88	1.04			-7.12 **	0.16		
Baby is male	78.95 **	3.54	90.21 **		107.61 **	10.28	111.93 **	95.91 **
First live birth	-3.77	0.15			-38.64 **	3.37	-38.15 **	-44.83 *
Parity is four or more	-60.85 *	1.90	-68.14 *		16.93	1.09		
Lambda 1 (for prenatal care)	-512.85 **	13.45	-525.87 **	-472.14 **	-208.37 **	4.91	-178.65 **	-331.92 **
Lambda 2 (for delivery service)	-	-			-	-		
Adj. R-squared	0.06		0.06	0.08	0.04		0.04	0.06

Table 15 B Estimates of birth weight equations corrected for self selection for women by level of prenatal care (a modified Kotelchuck Index), and for women who used or did not use private delivery service 1/
-- White sample

(continued)

	Intermediate				Inadequate				No care			
	Total 2/		Private delivery service used 3/		Total 2/		Private delivery service used 3/		Total 2/		Private delivery service used 3/	
			Yes	No			Yes	No			Yes	No
	b	|t|	b	b	b	|t|	b	b	b	|t|	b	b
Constant	5,611 30 **	7 86	6,137 80 **	3,196 00 **	1,361 60 **	6 81	1,445 20 **	1,531 40 **	1,577 00 **	3 83	1,730 20 **	
Mother's edu < 12 yrs	18 55	0 76			36 27	1 32			46 95	1 26		
Mother's edu , 13-16 yrs	35 67 **	2 22	51 58 **		-27 95	1 55	-57 63 **		-7 43	0 30		
Mother's edu >= 17 yrs	47 49 **	2 15	61 50 **		-18 87	0 77	-64 44 *	281 65 **	19 53	0 58		
Mother's age < = 18 yrs old	-103 71 **	2 00			-25 23	0 47			-27 25	0 39	-302 58 **	
Mother's age > 35 yrs old	-6 76	0 38			19 17	0 96			-3 21	0 12		
Out-of-wedlock	-1 04	0 05			4 03	0 18		-229 80 **	-43 41	1 40		
Foreign born	11 77	0 75			9 03	0 51			-16 80	0 68		
Employed during pregnancy	18 02	1 18			21 40	1 25			-43 52 *	1 83	-46 92 *	
Early miscarriages	57 67 **	2 79	61 41 **		-21 67	0 96			0 10	0 00		
Late miscarriages	49 03	0 98			-88 77 *	1 68	-138 62 **		-86 14	1 13		
Log (pre-pregnant weight)	469 84 **	12 47	487 88 **	424 55 **	415 25 **	10 27	407 25 **	450 95 **	370 28 **	4 49	334 43 **	476 21 **
Pre-pregnant weight unknown	-29 07 **	1 96			-41 51 **	2 57	-58 05 **		-52 57 **	2 28	-61 51 **	
Tobacco	-117 85 **	4 79	-111 48 **	-141 15 **	-187 31 **	7 08	-198 10 **	-171 34 **	-281 73 **	6 83	-281 29 **	-275 98 **
Alcohol	-276 32 **	2 84	-239 57 **	-390 58 *	-74 66	0 81			-123 65	1 06		
Illicit drugs	-17 33	0 28			-198 29 **	4 03	-214 11 **		-365 12 **	6 42	-301 85 **	-523 44 **
Baby is male	137 96 **	9 96	136 62 **	142 84 **	137 95 **	8 97	139 66 **	129 06 **	81 24 **	3 83	86 32 **	
First live birth	-38 29 **	2 47		-77 23 **	-58 86 **	3 24	-77 92 **		-12 96	0 53		
Parity is four or more	-25 83	1 34			33 58 *	1 76		83 91 **	32 31	1 11		
Lambda 1 (for prenatal care)	-2109 60 **	6 66	-2409 30 **		-165 26 **	2 58	-132 46 *	-256 30 *	58 40	1 44		
Lambda 2 (for delivery service)								245 36 **				
Adj. R-squared	0 07		0 07	0 06	0 06		0 06	0 06	0 04		0 03	0 05

1/ Birth weight is measured in grams The omitted categories are high school degree (12 years), 1-3 previous live births in parity
2/ Results are from Table 14 B
3/ Estimates were done on all variables, but results of t-raito and non statistically significant variables are not shown here

* 5% < P < 10%
** P < 5%

Table 16 Coefficients on prenatal care and private delivery in infant birthweight specifications controlling for self-selection into level of care, and private delivery

Variable	Asian						White					
	2SLS			OLS			2SLS			OLS		
	b		|t|	b		|t|	b		|t|	b		|t|
No care	--			--			--			--		
Inadequate	93.84	**	4.7	107.77	**	5.6	115.47	**	9.3	112.78	**	9.2
Intermediate	157.47	**	6.8	167.82	**	7.5	204.29	**	16.6	201.88	**	16.7
Adequate	120.08	**	5.8	130.09	**	6.5	180.58	**	16.1	179.60	**	16.2
Adequate plus	-48.96	**	2.0	-34.88		1.5	-68.90	**	5.2	-64.63	**	4.9
Private delivery	202.76	**	2.4	-7.02		0.6	-36.20		0.6	-13.25		1.4
Adj. R-squared	0.01			0.04			0.06			0.06		
Wu-Hausman exogeneity test:			F = 4.82						F = 15.90			

** $P < 0.05$
Critical F-statistic: 5%: 2.21, 1%: 3.02.

VIII. Bibliography

Akin, J. S., et al. 1991. The production of infant health: Input demand and the health status differences related to gender of the infant, Research in Population Economics 7, 267-289.

Alexander, G. R., et al. 1991. Source of bias in prenatal care utilization indices: implications for evaluating the Medicaid expansion, American Journal of Public Health 81, no. 8, 1013 -1028.

Alexander, G. R., et al. 1995. The role of prenatal care in preventing low birth weight, The Future of Children - Low Birth Weight, Vol. 5, no. 1, 103-120.

Balcazer, H., Cole, G., et al. 1992. Mexican-Americans' use of prenatal care and its relationship to maternal risk factors and pregnancy outcome, American Journal of Preventive Medicine 8(1): 1-7.

Cameron, A. C., et al. 1988. A microeconometric model of the demand for health care and health insurance in Australia, Review of Economic Studies LV, 85 - 106.

Corman, H., T. J. Joyce, M. Grossman 1986. Birth outcome production function in the United States, Journal of Human Resources XXII, no. 3, 339 - 360

Cramer, J.C. 1995. Racial and ethnic differences in birthweight: The role of income and financial assistance, Demography 32 (2), 231-247.

Currie, J., N. Cole 1993. Welfare and child health: the link between AFDC participation and birth weight, American Economic Review 83, no. 4, 971 - 985.

Davidson, R. and J. G. Mackinnon 1981. Several tests for model specification in the presence alternative hypothesis, Econometrica 49, no. 3, 781 - 793.

Even, W. E. 1987. Testing exogeneity in a probit model, Economics Letters 26, 125-128.

Frank, R. G. et al. 1991. Updated estimates of the impact of prenatal care on birthweight outcomes by race, Journal of Human Resources XXVII, no. 4, 629 - 642.

Greene, W. H. 1990. Econometric analysis, Macmillan Publishing Co. and Collier Macmillan Publishers.

Grossman, M. 1972. The Demand for Health: A theoretical and empirical investigation. New York, National Bureau of Economic Research.

Grossman, M., T. J. Joyce 1990. Unobservable, pregnancy resolutions, and birth weight production functions in New York city, Journal of political economy 98, no. 5, 983 - 1007.

Hansell, M. J. 1991. Sociodemographic factors and the quality of prenatal care, American Journal of Public Health 81, No. 8. 1023-1028.

Hausman, J. A. 1978. Specification tests in econometrics, Econometrica 46, no.6, 1251-1271.

Hausman, J. A. 1983. Specification and estimation of simultaneous equation models, Handbook of Econometrics, edited by Z. Griliches, M. Intriligator, Vol I, Chapter 7, 392 - 445.

Heckman J.J. 1979. Sample selection bias as a specification error, Econometrica, Vol. 47, no. 1, 153-161.

Heckman J. J., T. Macurdy 1985. A simultaneous equations linear probability model, Canadian Journal of Economics 18, no.1 28-37.

Helsel, D., et al. 1992. Pregnancy among the Hmong: birthweight, age, and parity, American Journal of Public Health 82, no. 10, 1361 - 1364.

Jones, A. M. 1991. An econometric investigation of low birth weight in the United States, Journal of Health Economics 10, 81-99.

Joyce, T. J., M. Grossman 1990. Pregnancy wantedness and the early initiation of prenatal care, Demography 27, no. 1, 1 -16.

Joyce, T. J. 1994. Self - selection, prenatal care, and birthweight among blacks, whites, and Hispanics in New York city, Journal of Human Resources XXIX, no. 3, 762 - 793.

Joyce, T., A. D. Recine, N. Mocan 1992. The consequences and costs of maternal substance abuse in New York city: a pooled time-series, cross-section analysis, Journal of Health Economics 11, 297 - 314.

Joyce, T., M. Grossman 1990. The dynamic relationship between low birthweight and induced abortion in New York city: an aggregate time-series analysis, Journal of Health Economics 9, 273 - 288.

Katz, S.J., Armstrong, R.W., et al. 1994. The adequacy of prenatal care and incidence of low birthweight among the poor in Washington State and British Columbia, American Journal of Public Health; 84: 986-991.

Kogan M.D., Kotelchuck M., et al 1994. Racial disparities in reported prenatal care advise from health care providers, American Journal of Public Health; 84: 82-88.

Kotelchuck, M. 1994. An evaluation of the Kessner adequacy of prenatal care index and a proposed adequacy of prenatal care utilization index, American Journal of Public Health 84: 1414-1420.

Kotelchuck, M. 1994. The adequacy of prenatal care utilization index: Its US distribution and association with low birth weight, American Journal of Public Health 84: 1486-1489.

Leigh, Paul J. 1995. Smoking, self-selection and absenteeism, The Quarterly Review of Economics and Finance 35(4), 365-386.

Li, D., et al. 1990. Secular change in birthweight among Southeast Asian immigrants to the United States, American Journal of Public Health 80, no. 6, 685 - 688.

MacKinnon, J. G., H. White and R Davidson 1983. Tests for model specification in the presence of alternative hypotheses: Some further results, Journal of Economics 21, 53 -70.

Maddala, G. S. 1983. Limited -dependent and qualitative variables in econometrics, Cambridge: Cambridge University Press.

Maddala, G. S. 1992. Introduction to Econometrics, second edition, Macmillan Publishing Company.

Martin, J.A. 1995. Birth characteristics for Asian or Pacific Islander subgroups, 1992, Monthly Vital Statistics Report, Centers for Disease Control and Prevention, Washington, DC, Vol. 43, no.10.

Moore P., Hepworth, J.T. 1994. Use of perinatal and infant health services by Mexican-American Medicaid enrollees, JAMA 272(4), 297-304.

Muller, C., et al. 1976. Reproductive efficiency as a social indicator, International Journal of Health Services, Vol. 6, no. 3, 455-473.

Panis, C. W., L. A. Lillard 1994. Health inputs and child mortality: Malaysia, Journal of Health Economics 13, 455-489.

Panis, C. W., L. A. Lillard 1995. Child mortality in Malaysia: Explaining ethnic differences and the recent decline, Population Studies 49(3), 463-479.

Peoples-Sheps, M. D., et al. 1991. Characteristics of maternal employment during pregnancy: effects on low birthweight, American Journal of Public Health 81(8), 1007 - 1012.

Rosenzweig, M. R., T. P. Schultz 1983. Estimating a household production function: heterogeneity, the demand for health inputs, and their effects on birth weight, Journal of Political Economy 91(5), 723 - 746.

Rosenzweig, M. R., K. I. Wolpin 1991. Inequality at birth: the scope for policy intervention, Journal of Econometrics 50, 205 - 228.

Singh, G. K., et al. 1994. Birthweight differentials among Asian Americans, American Journal of Public Health 84(9), 1444 - 1449.

Singh, G. K., Yu S.M. 1996. Adverse pregnancy outcomes: Differences between US and foreign-born women in major US racial and ethnic groups, American Journal of Public Health 86(6), 837-843.

Warner G.L. 1995. Prenatal care demand and birthweight production of black mothers, American Economic Review 85(2), 132-137.

Wise P.H., First, L.R., et al. 1988. Infant mortality increase despite high access to tertiary care: An evolving relationship among infant mortality, health care, and socioeconomic change, Pediatrics, 542-548.

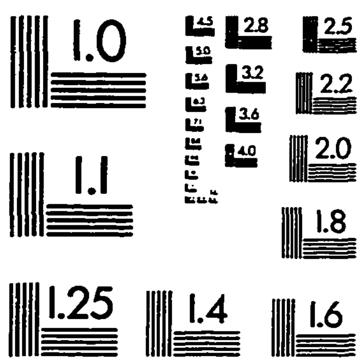
Wu, D. 1973. Alternative tests of independence between stochastic repressors and disturbances, Econometrica 41, no. 4, 733 - 750.

York, R., Williams, P., et al. 1993. Maternal factors that influence inadequate prenatal care, Public Health Nursing 10(4), 241-244.

Zhang, J. et al. 1993. Paternal smoking and birthweight in Shanghai, American Journal of Public Health 83(2), 207 - 209.

National Center for Health Statistics, U.S. Dept. of Health and Human Service. Health, United States, 1995.

IMAGE EVALUATION TEST TARGET (QA-3)



150mm

6"

APPLIED IMAGE . Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989