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EFFECT OF NUTRITION INTERVENTION ON THE OUTCOMES OF PREGNANCY: A RURAL URBAN COMPARISON

by

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ABSTRACT

EFFECT OF NUTRITION INTERVENTION ON THE OUTCOMES OF PREGNANCY: A RURAL URBAN COMPARISON

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The present study examines the effect of nutritional intervention on two outcomes of pregnancy: birth weight of the baby and gestational age. The study further examines the difference in nutritional intervention in rural and urban areas. The research method used is ex-post facto design. Data for the study is extracted from the health records and tracking sheets of women participating in the Nutrition Intervention Project in Virginia Department of Health. Path analysis and effects analysis are used to analyze the causal and direct effect of the independent variables and each of the outcome variables. A model has been developed grounded on previous studies in order to test the path and effect of nutritional intervention on the two pregnancy outcomes.

The results indicate that nutritional intervention has a positive influence on both birth weight and gestational age. However, the intervention had a greater impact on birth weight than on gestational age. Effects analysis of birth weight and gestational age indicate that the causal effect operates both via intervening variables as well as directly between the nutritional intervention and the outcome variables. This increases our confidence in the present model. Path analysis indicate that the path from nutritional intervention to the pregnancy outcomes via health risk behaviors was strong; path from nutritional intervention to the pregnancy outcomes via nutrient intake and weight gain was weak; path from nutritional intervention to the pregnancy outcomes via health risk behaviors and weight gain was strong; path from nutritional intervention to the pregnancy outcomes via health risk behaviors, nutrient intake, and weight gain was nonexistent; path from nutritional intervention to the pregnancy outcomes via weight gain was the strongest.

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CHAPTER 1

INTRODUCTION

Tremendous physiological and biochemical changes are required during pregnancy to allow for satisfactory fetal growth and development. These changes can alter the woman's metabolic needs to the extent that it is more difficult for her to maintain nutritional status while providing for her growing fetus. The link between appropriate nutritional intake and adequate weight gain, essential to the healthy outcome of pregnancy, has been unequivocally established. Studies have demonstrated a strong association between malnutrition in pregnant women and unfavorable outcomes, particularly in the growth and development of the fetal brain (Drillen, 1970; Lubchenco, Kelivoria-Papadopoulos, & Searls, 1972; Winick, 1970). Drillen (1970) in studying the etiology and prognosis of small-for-date infants indicated that retardation was most marked in the prematurely delivered infant. Congenital anomalies are directly related to weight for gestational age at birth. Lubchenco et. al. (1972) studied the effect of gestational age and birth weight on the outcome of very low birth weight children at 10 years of age and concluded that the highest incidence of moderate to severe handicaps occurred in the smallest infants of shortest gestational age and the lowest incidence in infants of higher birth weight and gestational age. Winick (1970) indicated that undernutrition during the critical development period causes retardation in brain growth and thus the ultimate development of brain function. However, such associations are more difficult to establish in women who are not obviously undernourished. The Collaborative Study of Cerebral Palsy, a review of more than 6000 pregnancies, concluded that higher maternal weight gain during pregnancy was related to higher birth weight and to better growth and performance among infants. Studies have also shown that nutritional counseling, sometimes with food supplementation, can have direct positive effects on pregnancy outcomes.

HISTORICAL TRENDS

Improvement of maternal and fetal health and nutrition has been a public health goal since the beginning of organized medicine. Standard clinical practices, attitudes, and beliefs regarding prenatal care and nutrition have changed with the accumulation of knowledge. Over the past century, there have been substantial changes in recommendations made to women about weight gain during pregnancy. During and immediately following World War II, previously well-nourished European populations experienced severe, sudden food shortages. The impact of nutritional deprivations on birth weight was assessed in several studies (Antonov, 1947; Smith, 1947; Stein, Susser & Saenger, 1975). Compared to infants born before the famine, infants born during the famine weighed as much as 500 gm less. The rate of low birth weight defined by the World Health Organization as a birth weight less than 2500 gms, increased to 45 percent. Exposure to the famine at the earliest stages of pregnancy resulted in significantly more premature births, perinatal and neonatal deaths, and central nervous malformations (Stein et. al., 1975). Nutritional deprivation in the third trimester increased the early mortality of the cohorts born during the famine as well as retarded fetal growth.

Ribeiro, Stein, Susser, Cohen & Neugut (1982) examined the effect of maternal starvation during pregnancy on blood pressure levels, the predictor of pregnancy toxemia syndrome, during the Dutch famine of 1944 and 1945. They found significant reduction in systolic blood pressure by exposure to famine late in the second trimester and early third trimester. The average birth weights of the infants of women who were undernourished because of the long siege of Leningrad were 500 to 600 g lower than expected, with sharp increases in prematurity, stillbirth, and neonatal mortality (Antonov, 1947). These wartime experiences showed clearly that nutritional deprivation leads to substantial depressions in infant birth weight and to other negative outcomes.

Concern about the quality and quantity of the diet during pregnancy was stimulated during the 1940s by the findings of Burke, Stevenson, Worcester & Stuart (1943), that the outcome of pregnancy was related to the level of maternal nutrient intake. Women with poor intakes tended to deliver shorter and lighter infants with higher incidence of congenital malformations and higher perinatal mortality than the infants of women whose diets were adequate or who were given either food or nutrient supplementation.

Interest waned during the 1950s after McGanity, Cannon, Bridgeforth, Martin, Densen, Newbill, McClellan, Christie, Peterson and Darby (1954) reported conflicting results in their study of 2,129 delivered pregnancies. During that decade, great emphasis was placed on the restriction of weight gain during pregnancy and dietary limitation of sodium (Orstead, Arrington, Kamath, Olson and Kohrs, 1985). From 1960s through the 1970s, extensive studies once again found that the nutritional status of the mother and her dietary intake during pregnancy were among factors that influenced her weight gain and the birth weight of her infant (Phillips & Johnson, 1977; Lechtig, Yarbrough, Delgado, Habicht, Martorell & Klein, 1975; Nisander & Jackson, 1974; Naeye, 1973; Adams, Barr, and Huenemann, 1978; Weigley, 1975; McGanity, Little, Fogelman, Jennings, Calhoun, and Dawson, 1969; Singer, Westphal & Niswander, 1968; Jacobson, Burke & Smith, 1962; King, Cohenour, Calloway and Jacobson, 1972; Winick, 1971; Lechtig, Habich, Delgado, Klein, Yarbough & Martorell, 1975; and Gormican, Valentine & Satter, 1980; Trouba, Okereke, and Splett, 1992).

PURPOSE

The purpose of this paper is to examine the effects of nutritional intervention during pregnancy on the outcomes of pregnancy. Two outcomes will be specifically examined namely birth weight of the baby and gestational age at birth. The effects of nutrition intervention on protein intake, gestational weight gain of the respondent, and the level of health-risk behaviors (smoking and alcohol use) of the pregnant women will also be investigated. Although significant evidence exists indicating positive associations between protein intake and gestational weight gain in favorable pregnancy outcomes, and the negative pregnancy outcomes related to smoking and alcohol use (before and during pregnancy), there is lack of evidence of the influence of nutritional intervention on protein intake of the pregnant women during pregnancy, on reducing the health-risk behaviors, and on gestational weight gain, all of which adversely affect the outcomes of pregnancy. Demonstrating that nutritional care can positively affect health status can be cost-beneficial, since it will save substantial amount of dollars in hospital and emergency room visits. Further, if effects of nutrition are found to vary in different areas (rural versus urban), then the strategic planning of nutrition programs can be adjusted to each area.

STATEMENT OF THE PROBLEM:

Maternal nutrition is critically important to both the mother and the fetus and is an essential aspect of complete maternity care (Rosso & Kava, 1982; Phillips & Johnson, 1977). In spite of the rapidly expanding knowledge of the role of nutrition in the outcome of pregnancy (Lechtig et al., 1975; Nisander & Jackson, 1974; Naeye et al., 1973), the number of infants with low birth weights and resulting perinatal handicaps, congenital injuries, and short lives continues to be high in this country. Currently, the U.S ranks 19th among industrialized countries in infant mortality rate and low birth weight babies (Table 1). Low birth weight (LBW) is an indicator of maternal health and nutritional status during pregnancy, as well as a strong predictor of morbidity and mortality throughout infancy and childhood (McCormick, 1985).

The 1990 Objectives for the Nation (U.S. Public Health Service, 1980) emphasized reducing LBW through improved nutrition. Healthy Mothers (U.S. Public Health Service, 1982) and Preventing LBW (Institute of Medicine, 1985) emphasized the need to educate at-risk women about the importance of nutrition during their pregnancies. In Healthy People 2000 (U.S. Public Health Service, 1990), the reduction of the LBW rate was again identified as a primary goal, with nutrition and nutrition education as priority areas. Although infant mortality has decreased, the rate of decline has slowed, and infant mortality is still a significant problem for blacks and other minorities (Healthy

TABLE 1

Infant Mortality Rates and Average Annual Percent Change: Selected Countries, 1983 and 1988[1]

Country	1983	1988	Average annual
		% change	
Japan	6.2	4.8	-5.0
Sweden	7.1	5.8	-4.0
Finland	6.2	6.1	-0.3
Netherlands	8.4	6.8	-4.1
Switzerland	7.6	6.8	-2.2
Singapore	9.4	6.9	-6.0
Canada	8.5	7.2	-3.3
Hong Kong	9.8	7.4	-5.5
Germany (West)	10.3	7.5	-6.1
Denmark	7.7	7.5	-0.5
France	9.1	7.8	-3.0
Germany (East)	10.7	8.1	-5.4
Spain	10.9	8.1	-5.8
Austria	11.9	8.1	-7.4
Scotland	9.9	8.2	-3.7
Norway	7.9	8.3	1.0
Australia	9.6	8.7	-1.9
Ireland	10.1	8.9	-2.5
N. Ireland	12.1	8.9	-6.0
England & Wales	10.1	9.0	-2.3
Belgium	10.4	9.2	-2.4
Italy	12.3	9.3	-5.4
United States	11.2	10.0	-2.2
Israel	14.4	10.2	-6.7
New Zealand	12.9	10.8	-3.5

---

[1] Rankings are from lowest to highest infant mortality based on the latest data available for countries or geographic areas with at least 1 million population.

People 2000, 1991; Hogue, & Yip, 1989).

Significant differences exist in the rates of infant and neonatal deaths in rural and urban areas. LBW is higher in urban areas than in rural areas (Table 2 and Figure 1). In Virginia birth weight is higher than the national average both in urban and rural areas, and infant and neonatal deaths show similar trends (Table 3 and Figure 2). Demographic factors and resources may differ significantly between rural and urban areas (Cordes, 1989; Miller, 1990; Ross, 1989), thereby potentially affecting health care services and pregnancy outcomes.

Factors that contribute to LBW are low weight at conception, poor weight gain during pregnancy, smoking, and alcohol consumption. All of these, except weight at conception, are factors that can be modified during prenatal care. The Nutrition Surveillance System indicated in its 1992 report that 20 percent of women are underweight at conception, 39 percent have inadequate gestational weight gain, only 66 percent initiated prenatal care during the first trimester, 26.5 percent of women smoked, and 4.3 percent consumed alcohol during pregnancy (Tables 4 and 5). The number of current smokers at the initial clinic visit indicates that the number of smokers by race, which had declined during the late 1980s, is again showing an upward trend (Figure 3). Nutritional intervention during pregnancy for women especially at high-risk for delivering low birth weight infants can improve maternal diet and weight gain during pregnancy, thereby decreasing the incidence of LBW.

TABLE 2

Low Birth Weight in Urban and Rural Areas:

United States and Virginia, 1988

	1988
United States	6.9
Urban	7.5
Rural	5.8
Virginia	7.03
Urban	7.93
Rural	7.05

Source: Vital Statistics of United States, Volume I, 1988, DHHS.

FIGURE 1

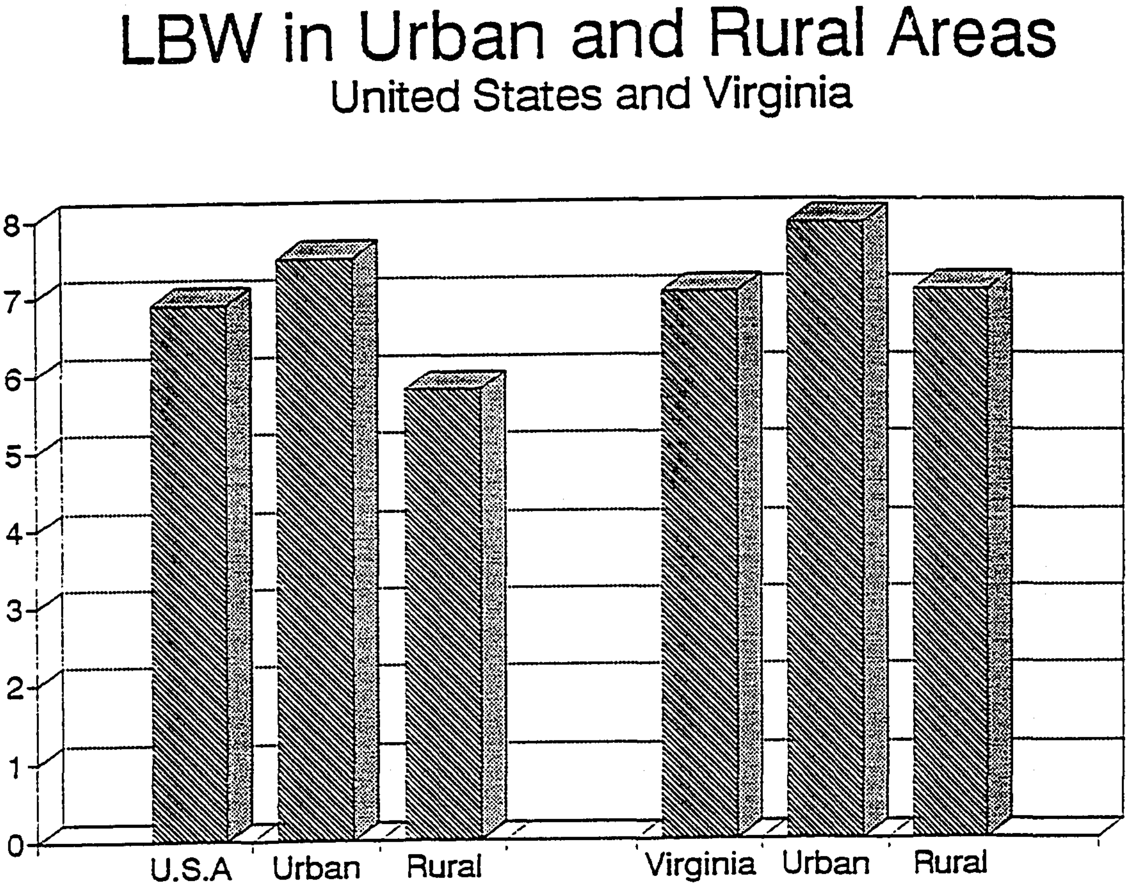

LBW in Urban and Rural Areas
United States and Virginia
8
7
6
5
4
3
2
1
0
U.S.A
Urban
Rural
Virginia
Urban
Rural

TABLE 3

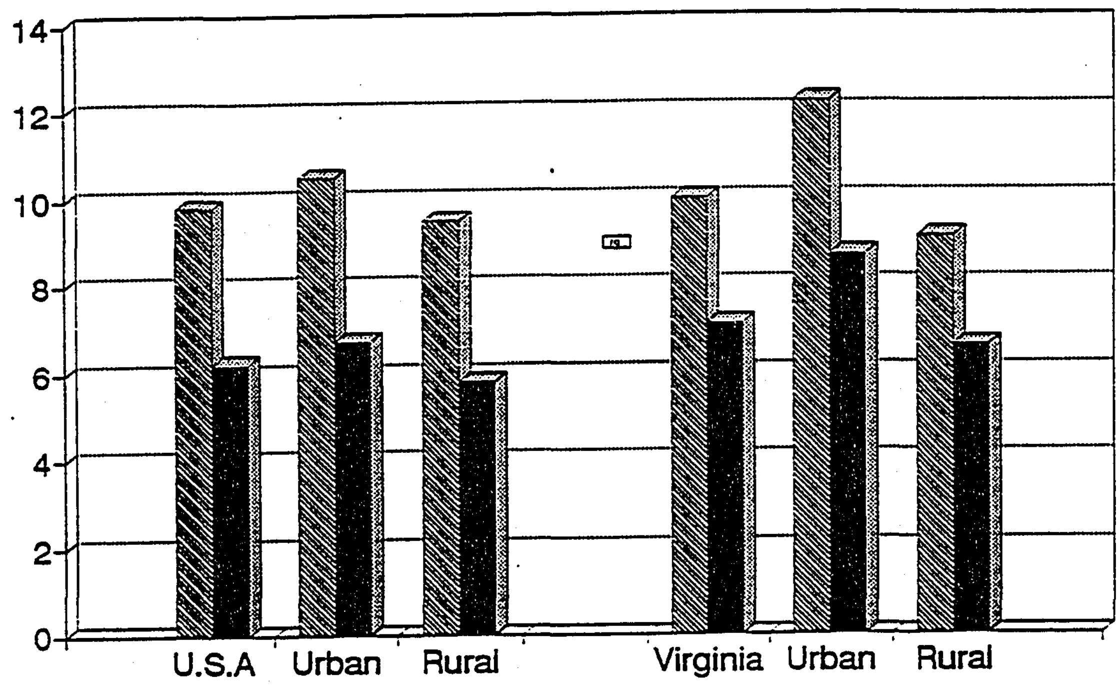
Infant and Neonatal Death Rates in Urban and Rural Areas:

United States and Virginia, 1988 & 1989.

	1988		1989	
	Infant death	Neonatal death	Infant death	Neonatal death
United States	10.0	6.3	9.8	6.2
Urban	10.7	6.9	10.5	6.7
Rural	9.6	5.4	9.5	5.8
Virginia	10.4	6.8	10.0	7.1
Urban	13.0	8.8	12.2	8.7
Rural	8.9	5.3	9.1	6.6

Source: Vital Statistics of United States, Volume II, 1988 & 1989, DHHS.

FIGURE 2



Infant and Neonatal Death Rates
United States and Virginia

TABLE 4

Weight status of women before becoming pregnant and gestational weight gain, by race/ethnicity and age - Pregnancy Nutrition Surveillance System, United States, 1990.

	Prepregnancy weight status (%)			Gestational weight gain(%)		
	Underweight	Normal	Overweight	Less	Recommended	More
Race						
White	22.4	50.2	27.4	40.4	27.5	32.1
Black	16.4	50.8	32.8	36.7	28.5	34.8
Hispanic	14.7	55.1	30.2	36.2	29.7	34.2
Native American	9.7	53.5	36.8	44.7	25.6	29.7
Asian & Others	27.1	55.6	17.3	50.5	29.9	19.5
Age (years)						
12-19	26.1	55.0	19.0	38.2	27.8	34.0
20-24	20.0	50.7	29.3	40.0	27.8	32.3
25-29	16.1	49.3	34.5	39.4	28.3	32.3
30-44	11.6	47.7	40.7	39.0	28.9	32.7
All	19.6	51.2	29.3	39.3	28.0	32.7

TABLE 5

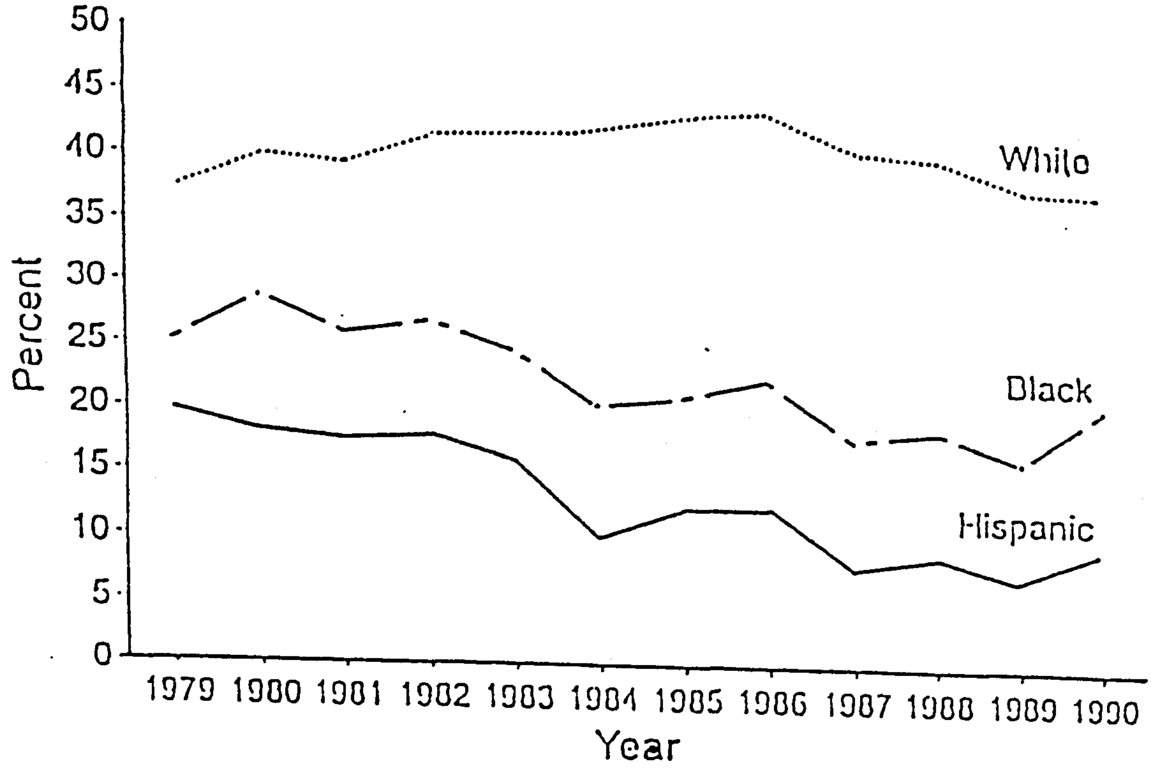
Percentage of participating women, by health-care and behavioral risk characteristics, race/ethnicity, and age - Pregnancy Nutrition Surveillance System, United States, 1990.

		Smoked		Drank Alcohol	
	Received prenatal care in first trimester	Before pregnancy	During pregnancy	Before pregnancy	During pregnancy
Race					
White	73.9	43.2	38.6	18.9	5.9
Black	60.5	20.0	20.8	8.9	2.8
Hispanic	58.5	8.4	9.4	4.3	1.2
Native American	58.8	35.9	28.8	29.3	12.0
Asian & Others	62.0	4.4	7.6	3.4	1.3
Age (years)					
12-19	61.7	29.7	22.6	10.7	2.5
20-24	66.9	32.6	26.9	15.1	4.0
25-29	69.0	33.3	29.3	15.6	5.6
30-44	67.9	30.4	27.4	14.5	5.8
All	66.2	31.7	26.4	13.9	4.3

FIGURE 3

Number of current smokers at initial clinic visit, by race/ethnicity

Pregnancy Nutrition Surveillance System, United States, 1979-1990



RATIONALE FOR THE STUDY

All of these factors indicate that the effect of nutrition education on outcome of pregnancy has not been adequately examined and described. Knowledge of maternal nutrition is useful only if introduced to and practiced by pregnant women. The ultimate quality of the product of gestation (the child) can only be as good as the quality of the ingredients that produce it (prenatal care and proper maternal nutrition) (Gold, 1969). Nutrition education and counseling during the prenatal period can provide the ideal opportunity to improve pregnancy outcomes since at that time more than any other, the pregnant woman may be highly motivated to understand and accept advice (Committee on Nutrition, 1974). Intensive nutritional counseling results in superior outcomes of pregnancy and a benefit-to-cost ratio of 1:5 when costs of intensive neonatal care were compared to nutrition counseling to mothers of underweight and generally puny newborns (Orstead et al, 1985). Nutrition is a national health policy issue (Kaufman and Vermeersch, 1981). There is a need to establish measurable objectives for nutrition programs which demonstrate that nutritional care can make an impact on health status and can be cost beneficial. Benefits of nutrition intervention can be established through a linkage between the intervention and favorable outcomes of pregnancy.

The present research seeks to determine (1) a causal relationship between nutritional intervention during pregnancy and two outcomes of pregnancy for high-risk pregnant women: birth weight of the baby and gestational age, (2) to examine if underweight and failure-to-gain pregnant women can have more favorable outcomes of pregnancy after improvement or supplementation of their diets. If so, then nutrition intervention may provide the ideal opportunity to improve the pregnancy outcomes of at-risk pregnant women in the United States, and (3) further effort will be made to examine the differences (consequences) of nutrition intervention in rural versus urban areas. As indicated earlier, significant differences exist in the rates of infant and neonatal deaths in rural and urban areas. In Virginia LBW as well as the infant and neonatal deaths are higher in urban areas than in rural areas. To the present, no study has evaluated the difference in the effect of nutrition intervention in rural versus urban areas. Relationship of nutritional intervention to pregnancy outcomes if found can help in strategic planning of nutrition programs adjusted for each area. Further, if nutritional care can be demonstrated to improve health status, the costs will be worthwhile. The results will be used in developing maternal/infant health policies and programs. The results will be important specifically to the State health department NIP program from where data is collected for this research. Thus, findings from the present research will contribute to scientific knowledge in this important area of human health. Because the present research proposes to use causal modelling to establish the linkage, it will increase in the strength of the model to be used.

RESEARCH QUESTIONS

The research questions that will be addressed in the present study are:

(a) What is the effect of nutritional intervention on the outcomes of pregnancy (i.e., birth weight and gestational age) ?

(b) What is the influence of nutrition intervention on the protein, iron and vitamin intake of pregnant women?

(c) What is the relationship of gestational weight gain to birth weight and gestational age ?

(d) What is the effect of smoking habit and alcohol intake of the pregnant women on birth weight and gestational age?

(f) Is there a difference in the influence of nutrition intervention on the pregnancy outcomes in rural versus urban areas?

(e) How does birth weight differ among respondents of different Body Mass Index (BMI), race, maternal age and parity?

OPERATIONAL DEFINITION OF VARIABLES

1. Nutritional intervention is defined as the number of visits to the nutritionist. Nutritional intervention includes nutritional assessment, counseling, and regular monitoring of dietary intake and weight gain.
2. Birth weight of the baby was measured in grams, recorded at the time of birth.
3. Gestational age or Weeks of gestation was measured by the difference between the first day of the last normal menstrual period to delivery.
4. Gestational weight gain was calculated as the difference between the weight at delivery and the prepregnancy weight reported in pounds. Percent of expected weight (PEW) is another criterion used to test the validity of the variable prepregnancy weight as well as the weight gain of the respondents. It is computed by the following formula:

PEW = Present weight/Pregnancy expected weight * 100

where, pregnancy expected weight = standard weight for height + 3 + (1 * weeks of gestation - 13)

5. <u>Body Mass Index</u> of the pregnant women was calculated by the reported prepregnancy weights (in kg) divided by their square (in meters) of height.

   BMI = Prepregnancy weight (in kg)/Height (in mt)^2

6. <u>Protein intake</u> of the respondents during their pregnancy was measured in gms. Mean protein intake reported at different visits to the nutritionist will be taken as an indicator of respondent's protein intake during her pregnancy.

7. <u>Alcohol consumption</u> recorded as a yes or no, as recorded at each prenatal visit.

8. <u>Smoking</u> during pregnancy was measured as the average number of cigarettes consumed per day across the gestational period.

9. <u>Residence</u> Respondents were categorized into rural or urban areas based on the 1993 rural-urban continuum codes (Beale codes). It is a classification scheme that distinguishes metropolitan counties by size, and non-metropolitan counties by degree of urbanization and proximity to metro areas (Butler & Calvin, 1993).

10. <u>Maternal age:</u> Number of years of the respondent.

11. <u>Race:</u> Defined as white, Black and others (Spanish-American, Oriental, Indian, and other).

12. <u>Anemia:</u> Hemoglobin concentration at any stage of pregnancy below 10.0 g/dl.

13. <u>Complications:</u> Is the number of complications reported by the respondents during pregnancy.

ASSUMPTIONS

It is assumed that there exists a high interrater reliability in the interventions (standardized procedures) provided by different nutritionists to the respondents in different health departments. Since most of the information is self-reported by the respondents, it is assumed that this information is reliable and valid. It is also assumed that data entered in the tracking sheets by the nutritionists are accurate and unbiased and all the procedures followed by the nutritionist during the prenatal period have been reported in the tracking sheets.

LIMITATION OF THE STUDY

This is a retrospective study with no control groups. Samples are limited to those with complete information, which is recorded in the improved version of the tracking sheets. One major limitation of the present research is the lack of control of certain variables that might influence the outcome of pregnancy. Variables such as attitude toward the pregnancy and the presence of previous illness can influence the outcome in the pregnant women. Another important limitation in the present study is that reliability and validity of the information is only presumed and cannot be cross-checked.

Also some important prior variables, such as income, marital status and educational level of the respondent, will not be included in the model. These variables are excluded due to poor or no information in the health records and tracking sheets of the State Health Department.

Amounts of protein, iron, and vitamin intake of the respondents are recorded by the nutritionists based on a 24-hour dietary recall method and may include measurement error. A comparison between diet records of 7-day written records and 24-hour food recall by Gutherie (1971) indicated that 24-hour dietary recall tends to overstate the amount consumed. Alcohol consumption is reported as a yes or no and may be less than reported in ounces of alcohol consumed per day.

Generalizability of the findings is limited to respondents who are at high-risk. Classification of urban and rural areas is done based on Vital Statistics of the United States. Urban areas include the urban areas of the metropolitan counties and nonmetropolitan counties. Rural areas include the "balance of area," meaning it includes all those areas not considered urban i.e., rural and suburban areas.

Since complications of pregnancy were reported as open ended, there were no set criterion by which all the nutritionists reported the complications. Hence, coding of the maternal complications during pregnancy was limited to those which had a frequency of greater than 10 in the sample.

THEORETICAL FRAMEWORK

A model has been developed by the researcher, grounded on previous research, in order to test the above research questions. The model specifies that nutrition intervention (operationalized as number of visits to the nutritionist) will have a positive influence on the nutrient (Protein) intake of respondents and secondly, respondents with health risk behaviors (Smoking or alcohol consumption) will be counseled and subsequently will decrease those behaviors. Both are expected to have a positive influence on the weight gain of the respondents, leading to a desired birth weight and full-term infants (gestational age > 38 weeks). The model is provided in Figure 4.

The hypothesized independent variable is nutritional intervention (number of visits to the nutritionist) and the dependent variables are the birth weight of the infant and gestational age. The prior variables used for the model are maternal age, ethnic background, parity, weeks of gestation at first visit, prepregnancy body mass index, and the complications developed during pregnancy. Intervening variables are health-risk behaviors such as smoking and the alcohol consumption of the respondent, protein intake, and gestational weight gain. The model was developed for path analysis to interpret linear relationships among the independent variables, and between them and each of the outcome variables. Predicted directions of the relationship are indicated by arrows. In addition, associations between the independent variables and the two outcome variables will be tested for significance using multiple regression analysis. Direct and indirect causal paths, together with their signs, are indicated in the model.

CHAPTER 2

REVIEW OF LITERATURE

Inadequate nutrition during pregnancy retards human fetal growth and increases the risk of delivering a low birth weight (LBW) infant (Caliendo, 1981; Jacobson, 1977; Bergner & Susser, 1970; and Singer, Westphal & Niswander, 1968). In both developed and developing countries, low birth weight is probably the single most important factor that affects neonatal mortality, in addition to being a significant determinant of post-neonatal infant mortality and of infant and childhood morbidity (McCormick, 1985). Low birth weight increases the incidence of mental retardation, cerebral palsy, learning disabilities, visual, hearing, and neurological defects and poor growth development (Akesson, 1966; Mcdonald, 1964; Knobloch, Rider, Harper & Pasamanick, 1956; McDonald, 1962; Drillen, 1961 and Drillen, 1959). The National Collaborative Perinatal Study (Hardy, Drage & Jackson, 1979) indicated that infants who are not considered LBW (LBW defined as less than 2500 g), i.e., between 2500 and 3000 g, have a greater mortality than infants between 3000 and 3500 grams. The 2500 to 3000 g weight infants are also at risk for the same morbidity problems associated with those weighing less than 2500g.

NUTRITION INTERVENTION

Many studies have shown statistically significant improvements in infant birth weight and/or incidence of low birth weight infants in recipients of nutritional intervention compared to nonparticipant's (Corbett & Burst, 1983; Ershoff, 1983; Higgins et al., 1989; Kotelchuck, 1984; and Stockbaner, 1986; Bruce, & Tchabo, 1989). Higgins et al. (1989) reported higher birth weights and less perinatal mortality with at least four visits with the dietitian compared to one to three visits. Bruce & Tchabo (1989) reported a higher weight gain and birth weights in infants born to high-risk pregnant women who received extensive nutrition counseling from a nutritionist during their pregnancy compared to the control group which did not receive any counseling. In a recently released report, the National Academy of Sciences (NAS) subcommittee on Nutrition and Pregnancy recommended that all pregnant women receive guidance regarding a healthy diet that will promote adequate weight gain during pregnancy (NRC, 1990). Nutritional status of pregnant women has been indicated as an important factor in pregnancy outcome. It is believed that maternal weight gain reflects the mother's nutritional status and affects the infant's outcome. The Collaborative Study of Cerebral Palsy with data on approximately 10,000 children in the study found that a greater maternal gain in pregnancy was not only related to an increased infant birth weight but also to improved growth and performance during the infant's first year of life (Singer, Westphal & Niswander, 1968). Studies indicate underweight, poorly nourished mothers who fail to gain adequate weight during pregnancy have poorer outcomes in terms of their baby's birth weight (Kristal & Rush, 1984; Naeye, 1983). Results of one study suggested that women who gain less than 21 pounds are 1.5 times more likely to have a fetal death and 2.3 times more likely to have a low birth-weight infant than women gaining at least 21 pounds (Taffel, 1986).

NUTRITIONAL ASSESSMENT & WEIGHT GAIN

Nutritional assessment early in pregnancy is an essential step in clinical management. Risk factors for nutritional problems include age (less than 15 years, greater than 35 years), frequent conception, prepregnancy weight (high or low), smoking, parity, anemia, and inadequate or excessive weight gain during pregnancy. High maternal weight gain during pregnancy has been related to increased birth weight and to better growth and performance among the infants. Maternal weight gain also is an important factor in the fetal growth. Although the need for appropriate weight gain during pregnancy has long been recognized, there have been substantial changes in recommendations made to women over the past years about weight gain with the availability of new data. In the sixteenth, seventeenth, and eighteenth centuries, emphasis was placed on the maternal diet since the mother was known to be the only source of nutrients for the fetus (Rosso & Cramoy, 1979). In the nineteenth century, overeating was believed to be a cause of large babies, and, as a consequence, more difficult labors, and limitation of fetal size by restricting maternal food intake was indicated. In the 1920s in the United States, Davis (1923) reported that maternal weight gain could be used as an indicator of maternal nutritional status and that, in turn, maternal nutritional status influenced fetal growth. Mean birth weight increased with increasing gestational weight gain from approximately 3,100 g with a 15 lb gain to about 3,6000 with a 30 lb gain. Following this and other studies, documentation of gestational weight gain became an increasingly common clinical practice. Identification of excessive weight gains was emphasized as it was regarded as a clinical sign of edema and impending toxemia. Controlling weight gain during pregnancy was encouraged as a means of preventing toxemia. The maternal weight gains was restricted to no more than 15 lbs (Bingham, 1932; McIlroy and Rodway, 1937). Up to World War II, most published studies of gestational weight gains reported average gains less than 20 lbs (Hytten, 1980). In the 1960s and 1970s, several studies reported a linear relationship between maternal weight gain and birth weight (Eastman & Jackson, 1968; Nishwander et al., 1969; Simpson et al., 1975). Since 1970, after the publication of "Maternal Nutrition During the Course of Pregnancy" by the National Academy of Sciences, women were encouraged to gain a minimum of 24 pounds during pregnancy (NRC, 1970a). Since the publication of the 1970 report, several studies have shown that desirable weight gain during pregnancy varies as a function of prepregnancy weight in proportion to height (Abrams & Laros, 1986; Miller & Merritt, 1979; Naeye, 1979, 1981; Winikoff & Debrovner, 1981). In particular, the evidence suggests that in order to achieve optimal fetal growth, women with inadequate prepregnancy weight-for-height proportion may need to gain more weight during pregnancy and that women who are overweight prior to pregnancy may not need to gain as much (Borberg et al., 1978; Brown, 1988; Campbell, 1983; Brown et al., 1981).

MATERNAL NUTRITION

Most studies use maternal body mass prior to pregnancy and maternal weight gain during pregnancy as indices of maternal nutrition (Caan, Horgen, Margen, King, & Jewell, 1987; Kristal and Rush, 1985). These studies, coupled with those that have been focused exclusively on documenting the negative impact of restricting weight gain during pregnancy, often equate maternal weight gain with nutrition (Abrams & Laros, 1986; Dohrmann & Ledereman, 1986). Literature about nutrition and pregnancy both conceptually and empirically confuses nutrition and weight gain, using them interchangeably. For example, in a major review article on preconceptual and prenatal nutrition, Worthington-Roberts (1985) almost exclusively cites research on maternal weight gain. Further, although some authors explicitly identify their assumption that maternal weight gain reflects nutritional status (Sweeney, Smith, Foster, Place, Specht, Kochenour & Prater, 1985), others simply discuss nutrition in one sentence and clarify their point with data on weight gain in the next sentence (Brasel, 1985).

In reality, there are only limited data to support a relationship between nutrition and weight gain (Vobecky, Vobecky, Shapgott, Coutier, Demers, Blanchard & Black, 1983). Further, identification of relationships between specific nutrients and outcomes of pregnancy frequently are based on data using animal models or disasters such as famine or war (Weiner, 1980). Naeye (1983) has pointed out that only limited knowledge exists about the true impact of specific nutrients on pregnancy outcomes.

Attempts to identify the effect of different nutrients on pregnancy outcomes have primarily documented the impact of calorie deprivation (Ross, Nel, & Naeye, 1985), an effect which may be linked to lack of plasma volume expansion in the mother (Naeye, 1983; Worthingon-Roberts, Vermeersch & Williams, 1985). More recently the possible effect of zinc deficiencies on the incidence of preeclampsia and intrauterine growth retardation has been identified (Simmer, Iles, Slavin, Keeling, & Thompson, 1987), and possible mutagenic effects of poor nutrition prior to conception have been described (Wynn, 1987). Aaronson & Macnee (1989) found only a weak relationship between nutrition and mother's weight gain during pregnancy.

PREPREGNANCY UNDERWEIGHT STATUS

Pregnant women who are underweight for height and gestational age are at risk for delivering infants with compromised outcomes (Brown, Jacobson, Askue & Peick, 1981; Pitkin, 1977; Love & Kinch, 1965; Naeye, Blanc & Paul, 1973). Studies have also reported that infants born to underweight women (90 percent or less of ideal body weight) weigh significantly less than infants born to women of standard weight, and that underweight women are twice as likely to bear low birth weight (LBW) infants (Brown, 1981; Bjere & Bjere, 1976; Edwards, Alton, Barranda & Hakanson, 1979). Although underweight women are at risk for delivering smaller infants, studies have shown that improved nutritional status of underweight pregnant women is associated with higher infant birth weights (Gormican, Valentine & Satter, 1980; Luke, Kickinson & Petrie, 1981; Simpson, Lawless & Mitchell, 1975). A positive relationship between maternal weight gain and infant birth weight has been suggested by Abrams & Laros (1986) and Gormican et al. (1980). Abrams and Laros (1986) found that even among underweight pregnant women, each kilogram of maternal weight gain significantly increased infant birth weight. Increased incidence of pre-term labor (before 37 weeks) among underweight pregnant women has also been reported (Brown et al., 1981; Edward et al., 1979).

INFANT SEX

Data on the sex of the infant and its relationship to one or more of the outcomes were found in several studies. These studies concluded that the sex of the infant had no effect on gestational age or prematurity; however, males had a higher birth weight and lower risk of Intra Uterine Growth Retardation (IUGR) (McCormick, 1985; Saugstad, 1981; Spiers & Wacholder, 1982). Only one study (Zuckerman et.al., 1983) reported a statistically significant difference in birth weight that favored females; however, the larger study (Hingson et. al., 1982), of which this formed a part, found the opposite effect.

MATERNAL HEIGHT, WEIGHT, AND BODY MASS INDEX (BMI)

Infant birth weight has been correlated with maternal height, weight, and pre-pregnancy weight for height (Kramer, 1987). As with maternal height, maternal pre-pregnancy weight is influenced by both genetic and environmental factors. Body weight is in part genetically determined, and genes that control adiposity or lean body mass could, theoretically, be expressed in the newborn. Maternal weight prior to conception reflects nutritional stores potentially available to the growing fetus. Short stature may well be one of the causes of the increased rate of LBW in many developing countries, whether caused by a true difference in genetic potential or prior stunting during the mother's childhood. One study (Kleinman, 1990) examined whether there is an independent effect of maternal height on total weight gain. In this study, data from the 1980 NNS were analyzed by using multiple linear regression techniques to control for

Body Mass Index (BMI), age and parity, education level, alcohol use, ethnic origin, and cigarette smoking. A significant effect of height on weight gain was observed. Short women (<157 cm, or < 62 inches) gained about 1 kg (2 lb) less, on average, than did taller women (>170 cm, or > 67 inches), but there was no evidence that short women had an increased risk of LBW infants as a result of lower weight gain. Studies have reported a significant inverse relationship between maternal height and the risk of IUGR (Scott et al. 1981; Fedrick & Adelstein, 1978; Meyer et al. 1976). The prepregnancy weight for height (Body Mass Index), defined as weight by height squared, is considered a better indicator of maternal nutritional status than is prepregnancy weight alone. BMI measurements generally correlate well with accurate measurements of body fat content, such as body density or total body water (Garrow, 1983). Prepregnancy weight-for-height categories are provided in Table 6.

Table 6. Maternal classification according to Body Mass Index

Under weight	BMI < 19.8
Normal weight	BMI 19.8 - 26.0
Over weight	BMI 26.0 - 29.0
Obese	BMI > 29.0

Prepregnancy weight for height is also a predictor of gestational weight gain. A large body of evidence indicates that gestational weight gain, particularly during the second and third trimesters, is an important determinant of fetal growth. Hence, a nutritional intervention to increase the gestational weight gain even in the second or third trimester of pregnancy can be effective in decreasing the incidence of LBW newborns. The recommended total weight gain for pregnant woman by prepregnancy BMI is indicated in Table 7.

Table 7. Recommended total weight gain for pregnant woman by prepregnancy BMI

Weight for Height Category	Recommended total gain	Rate lb/4weeks
Low (BMI < 19.8)	28-40	5.0
Normal (BMI 19.8 to 26.6)	25-35	4.0
High (BMI >26.0 to 29.0)	15-25	2.6
Obese (BMI >29.0)	15	2.0

MATERNAL AGE AND PARITY

Epidemiological evidence suggests that maternal age does not modify the effect of weight gain on fetal growth. However, maternal age is reported to influence the size of the baby at birth (Kramer, 1987). Pregnancy outcomes, including birth weight and gestational age, are generally less favorable among adolescents and women over 35 years of age; age is closely associated with parity. In general, primiparous women give birth to infants who are smaller than those of multiparous women (NAS, 1990). In some studies, very young adolescents tend to have smaller babies for a given weight gain than do older women (Kramer, 1987; Humphreys, 1984). National vital statistics data provide information on the distribution of births among women of different ages and parities. Maternal age was categorized into four groups: under 18 years, 18-19, 20-29, and 30 and over. Parity was based on live order and categorized into 3 groups: primiparas, low-parity multiparas, and high-parity multiparas. High parity was defined as third- or higher-order births to mothers under age 20 and fourth- or higher-order births to mothers age 20 and over. Data on the birth weights of singleton infants born in 1960, 1971, and 1985 tabulated by race of infant, maternal age, and live birth order indicated 1985 distribution to be similar to 1960 distribution for both Whites and Blacks although there have been changes in distribution of live births according to age of the mother (NAS, 1990). However, the distribution of births according to maternal parity changed much more markedly over the same period of time. There was a reduction in the prevalence of high-parity births accompanied by a sharp increase in the proportion of first births. Babies born to adolescent mothers are more likely to be pre-term, low birth weight, require intensive care, or die at birth than infants of adult mothers (Rees & Lederman, 1992). Infants of adolescent mothers are also twice as likely as infants of adult mothers to suffer physical problems or to die after the newborn period (Stevens-Simon, & McAnarney, 1992). Comprehensive clinical programs, including nutrition services at one easily reached site, improved the unfavorable consequences of teenage pregnancy (Hardy & Zabin, 1991). The American Dietetic Association, in their position statement for the nutrition care for pregnant adolescents, indicated that pregnant adolescents have unique biological, psychosocial, and developmental vulnerabilities which put them at nutrition risk during pregnancy (ADA Reports, 1994).

No consistent relationship between maternal age and weight gain has been found in studies of U.S. women. Some report that young mothers gained more weight (Ancri et al., 1977; Endres et al., 1985; Muscati et al., 1988), whereas two report that young women gained less weight (Haiek and Lederman, 1989; Meserole et al., 1984), and some found no difference (Horon et al., 1983; Loris et al., 1985). Multiple linear regression was used to evaluate the effect of age and parity on weight gain among women who participated in the 1980 NNS (Kleinman, 1990). Primiparous women in all age groups gained about 2 lb more than multiparous women of the same age, and the risk of low weight gains was about one-third lower among primiparous women than among multiparous women. After controlling for parity, differences in weight gain by age were small. Primiparous women of all ages gained more (about 2 lb) than multiparous women of the same age.

ETHNICITY/RACE

Maternal ethnic origin has also been linked with infant birth weight. Incidence of infant mortality and low birth weight is much higher in nonwhite ethnic groups (National Center for Health Statistics, 1984; Shiono, Klebanoff, Guaubard, Berendes, & Rhoads, 1986). In general, Black and Asian women give birth to smaller infants than do Caucasian women (Kramer, 1987). Differences in the total amount of weight gained by black and white women during gestation were first reported by Eastman and Jackson (1968) in a study of clinic patients in Baltimore, Maryland, between 1954 and 1961. The total weight gain of the white women averaged 9.9 kg (21.8 lb), whereas that of the black women averaged 9.0 kg (19.8 lb). The statistical significance of this difference was not determined. The reported mean weight gains of the women of both races was the same if the prepregnancy weight was greater than 82 kg (180 lb). In two other large studies of weight gain conducted in the 1950s and 1960s, no difference in weight gain between black and white women was detected (Niswander and Jackson, 1974; Simpson, Lawless, & Mitchell, 1975). More recent studies have focused on the effect of ethnic origin on weight gain in populations including white, black, Southeast Asian, and Hispanic women. In an obstetric clinic for teenagers in San Diego, California, there was no significant difference in the mean weight gain of white, black and Hispanic mothers (Felice, Shragg, James & Hollingsworth, 1986), but Hispanic mothers tended to gain the most weight. In another study, Puerto Rican teenagers in New Jersey gained significantly less than white or black teenagers (Scholl, Salmon, Miller, Vasilenko, Furey, & Christine, 1988). Swenson, Erickson, Ehlinger, Swaney, & Carlson (1986) studied the weight gains of white, black, and other Southeast Asian pregnant adolescents and adults and found the total weight gain of the Southeast Asian adolescents and adults to be 11 lb less than that of their white and black counterparts. Different attitudes about food practices during pregnancy among Southeast Asian women may contribute to their lower weight gains. The average weight gain of white women in the 1980 NNS was significantly greater than that of black women (29.1 versus 26.8 lb) (Taffel, 1986).

After controlling for the effects of prepregnancy weight, marital status, education, and age combined with parity, white women still gained about 0.5 kg more than black women. The gestational period of white women tended to be about 0.5 week longer than that of black women. Black women also were at a 70 percent greater risk for low levels of weight gain compared with whites. Weiner & Milton (1970) reported a significant negative association between gestational age and Black race in Baltimore. Similarly, Garn et al., (1977) and Garn & Bailey (1978) found that the gestational age distribution had been shifted to the left and that there was a higher rate of prematurity among Blacks than among Whites who participated in the U.S. Collaborative Perinatal Project.

Maternal characteristics that have the greatest impact on birth weight include maternal race, smoking, height, hypertension, weight gain, any of a number of measures related to maternal obesity, such as prepregnancy weight or maternal body mass index, and a history of low-birth-weight infant (Wen, Goldenberg, Cutter, Hoffman, Cliver, 1990; Kramer, 1987; Bakketeig, Hoffman, Harley, 1979; Miller, Hassanein, Hensleigh, 1978; Anderson, Blidner, McClement, Sinclair, 1984).

HEALTH-RISK BEHAVIORS

Health-risk behaviors, such as smoking and alcohol use, have adverse effects on pregnancy outcomes. Cigarette smoking is by far the single most important modifiable factor responsible for fetal growth retardation in developed countries (Kramer, 1987). The prevalence of cigarette smoking in the general U.S. population which had declined over the past two decades and the number of smokers by race/ethnicity among pregnant women which had declined during the late 1980s are again showing an upward trend (The Nutrition Surveillance System, 1992). The 1980 National Natality Surveys indicate that the overall proportion of married mothers who smoked was 25 percent (Prager et al., 1984), the highest rates occurring among White women followed by Black and hispanic women. Smoking was also considerably more common among teenage mothers and those who had not completed high school as compared with the older or more educated mothers. Data from the 20 states in the Pregnancy Nutrition Surveillance System in 1990 indicate that the overall prevalence of smoking in pregnancy was 26 percent with higher rates up to ages 25-29.

SMOKING

Maternal cigarette smoking could affect intrauterine growth (and possibly gestational duration) through several mechanisms (Pirani, 1978). The most likely mediators are carbon monoxide and nicotine. Carbon monoxide can interfere with oxygen delivery to the fetus (Longo, 1977). Nicotine is an appetite suppressant and is believed to result in rapid increases in maternal catecholamine and consequent uterine vasoconstriction (Quigley et al., 1979) Smoking during pregnancy has a detrimental effect on fetal growth (Kramer, 1987), resulting in reduction in birth weight in the infants of smokers (Berkowitz, 1988; DHEW, 1979; DHHS, 1980). Other adverse effects include a moderately increased risk of preterm delivery (Meyer, 1976; Shino et al., 1986), perinatal mortality (DHEW, 1979; Meyer and Tonascia, 1977), and spontaneous abortion (Alberman, 1976; Kline et al., 1980). Older smokers are at an especially high risk for small-for-gestational-age births, and primiparous smokers are at an especially high risk for low birth weight and preterm delivery (Cnattingius, Forman, Berendes, Graubard & Isotalo, 1993). The adverse effect has been found to be proportional to the frequency of smoking. Furthermore, smoking cessation programs during pregnancy have been found to be effective in increasing birth weight (Sexton and Hebel, 1984).

The effect of smoking on birth weight appears to depend on the period in pregnancy when the mother smoked, and, in particular, is more marked for smoking during the last trimester. Butler et al. (1972) found that smoking after the fourth month of pregnancy was an important factor in reducing birth weight. Consistent with this finding, other studies (Papoz et al, 1982; Naeye, 1981; Rush & Cassano, 1983) reported that women who stopped smoking during pregnancy gave birth to infants of similar birth weight to mothers who never smoked or those who stopped smoking before becoming pregnant. Perhaps the most convincing evidence is that of Sexton & Hebel (1984), who reported a higher mean birth weight for infants born to smoking women who were randomly assigned to anti-smoking counselling after an average gestation of 15-weeks.

ALCOHOL CONSUMPTION

Chronic alcohol abuse during pregnancy causes fetal alcohol syndrome (FAS), which is characterized by prenatal or postnatal growth retardation, distinct facial anomalies, and mental deficiency (Rosett, 1980). In addition to FAS, alcohol has been associated with spontaneous abortion (Harlap & Shiono, 1980). Growth retardation has been observed even at lower levels of alcohol consumption (Hanson, Streissguth &

Smith, 1978; Wright, Waterson, Barrison, Toplis, Lewis, Gordon, MacRae, Morris and Murray-Lyon, 1983).

Although FAS is believed to be limited to chronic alcohol abusers, growth retardation has been observed at lower levels of alcohol consumption (approximately 30 to 60 cc, or 1 to 2 oz, of absolute alcohol daily) (Hanson, Streissguth, & Smith, 1978; Little, 1977; Wright et al., 1983). Another study showed a significantly increased risk of delivering a growth-retarded infant for women who consumed one to two drinks per day (Mills, Graubard, Harley, Rhoads, & Berendes, 1984). Other studies have demonstrated no or inconsistent associations between moderate levels of alcohol consumption and fetal growth (Brooke, Anderson, Bland, Peacock & Stewart, 1989; Kline, Stein & Hurtzler, 1987; Marbury, Linn, Monson, Schoenbaum, Stubblefield, & Ryan, 1983; Rosett, Weiner, Lee, Zuckerman, Dooling, & Oppenheimer, 1983; Tennes and Blackard, 1980). Thus, the evidence concerning the effects of low levels of alcohol consumption is both limited and inconsistent. The possibility that maternal binge drinking may adversely affect the fetus has also been suggested by data on both humans and animals (Clarren et al., 1978, 1988).

According to national surveys of women aged 18 or older, the proportion who drink alcohol at least occasionally has decreased slightly between 1971 (58%) and 1985 (55%), and the proportion who consume 30 cc (1 oz) or more of pure alcohol per day has dropped from 5 to 3 percent during the same period (NCHS, 1989). Among women aged 18 to 25, the proportion who reported that they consumed alcohol in the preceding month increased from 58 percent in 1976 to 68 percent in 1979 and then declined to 57 percent in 1988 (NCHS, 1989; NIDA, 1989).

NURTIENT INTAKE

Nutrient intake by pregnant women in the United States has been measured in relatively few studies during the last decade. On average, intakes of protein, riboflavin, vitamin B^{12}, and niacin exceed the recommended daily averages (RDAs), and there was only one report of low vitamin C intake being important too. This exception (Brennan et al., 1983a) was for the chemically analyzed vitamin C content of the foods consumed, which was substantially lower than that calculated from food composition tables.

PROTEIN

Protein is a macronutrient of major importance in human nutrition. Plant and animal proteins are composed of more than 20 amino acids which serve as a source of energy, carbon, and nitrogen. Pregnancy complicates the already complex metabolism of amino acids. Expansion of blood volume and growth of the maternal tissues require substantial amounts of protein. The growth of the fetus and placenta also places protein demands on the pregnant woman. Thus, additional dietary protein is essential for the maintenance of a successful pregnancy. Maternal protein restriction, alone and in combination with energy restriction, results in consistently decreased fetal growth in many species (Fattet et al., 1984; Pond, 1988; Rosso & Streeter, 1979). These studies demonstrate not only decreased body weight and growth but also decreased numbers of cells and a variety of biochemical changes. A particular concern is that the developing fetus may or may not adequately compensate for some of the effects of maternal protein deprivation, and that effects may even span generations.

Fetal growth cannot occur without a source of nitrogen and essential amino acids. However, it is unclear to what extent commonly occurring inadequacies in maternal protein status or intake can impair pregnancy outcome (Kramer, 1987). Although it is difficult to separate the independent effect of protein from the confounding effects of other nutritional variables, especially caloric intake, there is evidence that it has no bearing on gestational duration. Studies have found that protein supplementation had no significant effect in either gestational duration or birth weight. No significantly altered risk for prematurity was found (Rush, Stein and Susser, 1980; Lechtig, 1975; Viegas, Scott, Cole, Eaton, Needham and Wharton, 1982; Osofsky, 1975). Studies have found that protein supplementation have minimal changes in birth weight. One study reported that protein supplementation during the second and third trimesters had no effect on unselected Asian mothers in the United Kingdom, but there was a significant increase in birth weight when similar supplementation was given during the third trimester to women with poor increments in triceps skinfolds (Viegas et al, 1982). However, evidence suggests possible harm from specially formulated high-protein supplements. Rush et al. (1980) found significant increases in mortality and preterm birth rate with high-density protein supplementation of poor women in Harlem, New York. In the above study, the authors also noted a lower mean birth weight among mothers who received, on average, a protein supplement of 27.7 g/day above their normal intake, compared with those who received a calorie supplement only. Although the difference was not statistically significant for the overall group, it was significant for those mothers who delivered prematurely.

The deposition of protein is not necessarily linear throughout pregnancy. The additional protein requirement averaged over gestation is 6.0g/day, but the demand is highest (10.7 g/day) in the last trimester (NRC, 1989). On the basis of these and other considerations, a maternal protein intake of 10 g/day over the Recommended Dietary Allowance (RDA) for protein (i.e., a total of 60 g/day) is recommended throughout pregnancy.

IRON

Among healthy human beings, pregnant women and rapidly growing infants are most vulnerable to iron deficiency (Bothwell et al., 1979). During pregnancy more iron is needed primarily to supply the growing fetus and placenta and to increase the maternal red cell mass (Hallberg, 1988). Iron deficiency is common among pregnant women in industrialized countries, as shown by numerous studies in which hemoglobin concentrations during the last half of pregnancy were found to be higher in iron-supplemented women than in those given a placebo or no supplement (Dawson & McGanity, 1987; Puolakka et al., 1980b; Romslo et al., 1983; Taylow et al., 1982; Wallenburg & van Eijk, 1984). This higher hemoglobin concentration as a result of an improved iron supply not only increases the oxygen-carrying capacity, but it also provides a buffer against the blood loss that will occur during delivery (Hallberg, 1988).

Anemia is defined as a hemoglobin concentration that is more than 2 standard deviations below the mean for healthy individuals for the same age, sex, and stage of pregnancy. Iron depletion is generally described in terms of three stages of progressively increasing severity (Bothwell, Charlton, Cook, & Finch, 1979): depletion of iron stores, impaired hemoglobin production (or iron deficiency without anemia), and iron deficiency anemia. Iron deficiency during pregnancy is indicated for the second and third stages. Iron deficiency anemia refers to low serum ferritin level, low serum iron to total iron-binding capacity, low mean corpuscular volume, or an elevated erythrocyte protoporphyrin level.

Although some epidemiologic evidence suggests that anemia during pregnancy could be harmful to the fetus, the data are not conclusive (NAS, 1990). In a report of more than 54,000 pregnancies in the Cardiff area of South Wales (UK), the risk of low birth weight, preterm birth, and perinatal mortality was found to be higher when the hemoglobin concentration was in the anemic range - <10.4 g/dl before 24 weeks of gestation - compared with a midrange hemoglobin concentration of 10.4 to 13.2 g/dl (Murphy, O'Riordan, Newcombe, Coles, & Pearson, 1986). Elevated hemoglobin level of $>$ 13.2 g/dl were also associated with an increased risk of the same poor pregnancy outcomes, perhaps because such values are characteristic of women who develop preeclampsia (hypertension accompanied by generalized pitting edema or proteinuria after 20 weeks of gestation), who are similarly at risk. Garn, Ridella, Petzold, & Falkner (1981) also found a U-shaped relationship between the maternal hemoglobin or hematocrit level during pregnancy and the pregnancy outcome. When the lowest hemoglobin concentration during any stage of pregnancy was below 10.0 g/dl, the likelihood of low birth weight, preterm birth, and perinatal mortality was increased. A hemoglobin concentration that was high during pregnancy (>13.0 g/dl) was also associated with these poor pregnancy outcomes.

In most populations, iron deficiency is by far the most common cause of anemia before 24 weeks of gestation (Puolakka et al., 1980c). It seems plausible, therefore, that iron deficiency could account for the higher risk to the fetus among the anemic pregnant women. However, a cause-and-effect relationship has not been established. Iron deficiency and anemia are more common in blacks and in those of low socioeconomic status, those with multiple gestations, and those with limited education (LSRO, 1984). Any of these confounding factors could be related to a poor pregnancy outcome independently of iron deficiency.

Both iron needs and prevalence of iron deficiency increase substantially during pregnancy (Hallberg, 1988). In a paper on the worldwide prevalence of anemia written for the World Health Organization, the global prevalence of anemia was estimated at 51 percent among pregnant women (DeMaeyer & Adiels-Tegman, 1985). Most of the anemia was attributed to iron deficiency. The higher prevalence for pregnant women is consistent with the estimated high iron needs during pregnancy (Bothwell et al., 1979; Hallberg, 1988).

The most convincing evidence that pregnant women in industrialized countries often cannot meet their iron needs from diet alone comes from three careful longitudinal studies from northern European countries. Groups of iron-supplemented and unsupplemented pregnant women were followed with laboratory studies from early pregnancy at 4-week intervals (Puolakka et al, 1980b; Svanberg et al., 1976b; Taylor et al., 1982). In all these studies, the hemoglobin values in the unsupplemented group were significantly lower than those in the supplemented group after 24 to 28 weeks of gestation. The mean difference was 1.0 to 1.7 g/dl between 35 and 40 weeks of gestation. In the latter two studies, the means were more than 2 standard deviations apart during this period, indicating a high prevalence of impaired hemoglobin production because of a lack of iron in the unsupplemented group. Thus, even though there are no good prevalence data for iron deficiency during pregnancy, it is reasonable to infer that the prevalence is high.

Although no socioeconomic status group is immune from risk (Saugstad, 1981), LBW and poor dietary behavior are particular problems of economically disadvantaged groups (VandenBerg, 1981). Despite an established need for nutrition education and supplemental food program (Goldberg & Meyer, 1990), the Women, Infants, and Children (WIC) program requires some nutrition education, and evaluations of the behavioral impact of nutrition education among pregnant women have not been conducted (Boyd & Windsor, 1993).

SUMMARY

Althogh the quantity of research on the adverse pregnancy outcomes (LBW and preterm births) over the last two decades is impressive, few studies have controlled for most of the confounding variables in their analysis. Compared with the extensive amount of literature on birth weight there are relatively few studies that report the relationship between prenatal variables and gestational duration. Further, comparative studies on the effect of interventions programs in rural versus urban areas are not existent.

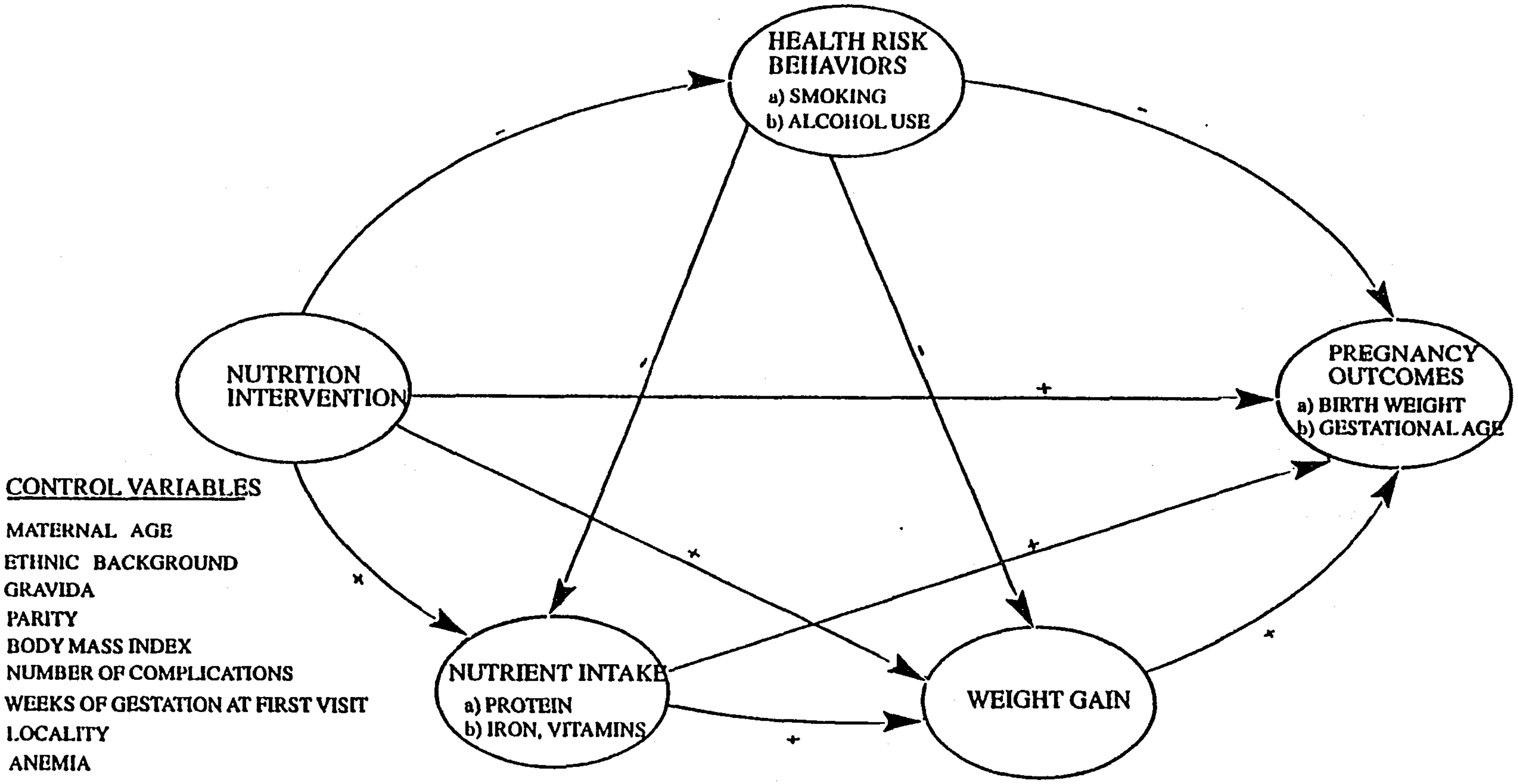
CHAPTER 3

THEORETICAL FRAMEWORK

A model was developed, grounded on previous research, in order to test the research questions. The model was based on the schematic model developed by the National Academy of Sciences, 1990 and on the works of Mitchell and Lerner, 1989 & Orstead et. al., 1985. The above specified models could not be used for the present study due to lack of information on several variables in those models. Hence, concepts from these models were put together to develop the present model. The model specifies that nutrition intervention (operationalized as number of visits to the nutritionist) will have a positive influence on the nutrient (protein, iron and vitamin) intake of respondents and secondly, respondents with health risk behaviors (smoking, alcohol problem) will be counselled to decrease those behaviors. Both are expected to have a positive influence on weight gain of the respondents leading to a favorable pregnancy outcomes (desired birth weight and full-term infants i.e., gestational age > 38 weeks). The model is indicated in Figure 4.

The independent variable was the nutritional intervention (number of visits to the nutritionist) and the dependent (outcome) variables were the birth weight of the infant and gestational age. The prior variables for this model were maternal age, ethnic background, gravida, parity, prepregnancy body mass index, anemia, weeks of gestation at first visit and number of complications during pregnancy. Intervening variables were health risk behaviors such as smoking and alcohol problems of the respondent, protein

MODEL



CONTROL VARIABLES

MATERNAL AGE
ETHNIC BACKGROUND
GRAVIDA
PARITY
BODY MASS INDEX
NUMBER OF COMPLICATIONS
WEEKS OF GESTATION AT FIRST VISIT
LOCALITY
ANEMIA

FIGURE 4

intake, vitamin and iron intake, and gestational weight gain. All statistical analyses were performed using the Statistical Package for Social Science (SPSSx) program. Path coefficients were also indicated in the overall model to interpret linear relationships among the independent variables and between them and each of the outcome variable according to the path diagram. Direct and indirect causal paths were indicated in the model along with their signs. In addition, associations between the independent variables, and the two outcome variables were tested for significance using multiple regression analysis.

DESIGN

The present study is an ex post facto design and a retrospective study. Health care records were requested of women participating in the Nutrition Intervention Project (NIP) from the State Health Department headquartered at Richmond. The advantage of using respondents from the NIP project for the present study was that the respondents are getting nutritional intervention as a part of the prenatal care in the health departments. Hence, all respondents were ensured of getting nutritional intervention. Respondents were eligible to participate in the program if they meet all three of the following criteria namely they:

(a) are defined as patients by the public health department,

(b) are underweight at their visit to the clinic. The criteria used to classify a pregnant woman as underweight are as follows. The percentage of ideal body weight for the weeks of gestation was calculated according to the

Metropolitan Life Insurance Weight Tables (1959) and the standard for expected pregnancy weight gain from the American College of Obstetricians and Gynecologists (ACOG) (1985). Underweight was defined as 90% or less of ideal body weight for gestational age. These values were obtained from the standard weight-for- height Table for women (Table 8).

(c) fail to gain weight. The failure-to-gain classification was defined as lack of or below average weight gain for three consecutive monthly visits.

RURAL-URBAN CLASSIFICATION

Respondents were categorized into rural or urban areas based on the 1993 rural-urban continuum codes, from a classification scheme that distinguishes metropolitan counties by size, and nonmetropolitan counties by degree of urbanization and proximity to metro areas (Butler & Calvin, 1993). This scheme was originally developed by Hines, Brown, and Zimmer (1975). The report provides a one-digit code for each of 10 classifications for all U.S. counties. The classifications describe counties by degree of urbanization and nearness to a metro area. The rural-urban continuum codes are:

Urban (Metropolitan counties)

0	Central counties of metro areas of 1 million population or more
1	Fringe counties of metro areas of 1 million population or more
2	Counties in metro areas of 250,000 to 1 million population
3	Counties in metro areas of fewer than 250,000 population

Rural (Nonmetropolitan counties)

4 Urban population of 20,000 or more, adjacent to a metro area

5 Urban population of 20,000 or more, not adjacent to a metro area

6 Urban population of 2,500 to 19,999, adjacent to a metro area

7 Urban population of 2,500 to 19,999, not adjacent to a metro area

8 Completely rural or less than 2,500 urban population, adjacent to a metro area

9 Completely rural or less than 2,500 urban population, not adjacent to a metro area

The counties and cities with the codes are provided in the Appendix B. The counties and cities that fell under rural according to these codes are Accomack County, Amelia County, Caroline County, Bath County, Brooking George County, Buena Vista County, Buckingham County, Charlotte County, Cumberland County, Caroline County, Floyd County, Franklin City, Franklin County, Frederick County, Giles County, Harrisonburg City, King and Queen County, Lexington City, Montgomery County, Nelson County, Northampton County, Orange County, Nottoway County, Page County, Prince Edward County, Pulaski County, Richmond County, Saltville County, Shenondoah County, Smyth County, Staunton City, Waynesboro City, Westmoreland County, Winchester County, and Wythe County.

The counties and cities that fell under urban areas according to these codes are: Arlingon County, Alexandria City, Amherst County, Charles City County, Charlottesville City, Chesapeake City, Chesterfield County, Clarke County, Danville City, Fairfax City, Fairfax County, Falls Church City, Fauquier County, Fluvanna County, Fredericksburg City, Gloucester County, Goochland County, Greene County, Hampton City, Hanover County, Henrico County, Isle of Wight County, James City County, King George County, Loudoun County, Manassas City, Matthews County, New Kent County, Newport News City, Norfolk City, Petersburg City, Portsmouth City, Prince William County, Roanoke City, Spotsylvania County, Stafford County, Suffolk City, Virginia Beach City, Warren County, Williamsburg City, York County.

In 1985, the Divisions of Public Health and Maternal and Child Health of the Commonwealth of Virginia instituted a perinatal nutrition intervention program to improve the nutritional status of underweight pregnant women, thereby reducing the incidence of LBW infants. This program, which continues to be implemented by Maternal and Child Health nutritionists in public health departments throughout the Commonwealth, provides intensive nutrition education and follow-up to underweight pregnant women and to women who have failed to gain weight for three consecutive visits.

Nutrition intervention

Once the initial screening into the NIP program is done the pregnant woman is referred to the Nutritionist. The intervention provided by the nutritionist includes:

1. Dietary assessment: The nutritionist takes a 24-hour dietary recall and a food frequency using the WIC 329 form (Appendix A1) and the Food Frequency using the Nutr 003 form (Appendix A2). From the recall and food frequency information, the average daily grams of protein consumed are then calculated.
2. Dietary Counseling: Information from the patient's present intake is used to

discuss the need to add additional foods to her diet. The goal is to have a balanced diet within her ethnic and cultural food choices that will support a weight gain of about 1.25 to 1.5 lbs per week. A plan is made with the patients for the required amount and the number of times she will eat each day.

3. Regular monitoring and check up: An appointment is also made for a return visit in two weeks. In the subsequent visits, dietary intake and weight are regularly monitored. The patient's weight is plotted in the prenatal weight grid (Appendix A3) to check if she has achieved the desired weight gain.

SOURCE OF DATA

Data for the present research were obtained from the tracking sheets of the NIP Program. The data compiled at the State Health Department at Richmond were used. Since 1992 the updated tracking sheets in the NIP Program provide more information about the respondent compared to the previous ones. Information includes hemoglobin and hematocrit level during the first, mid and last prenatal visits, prepregnancy weight, height, weight gain in pounds, and the number of iron and vitamins supplements consumed. This information was useful for the present research in the calculation of BMI, anemia, and weight gain in pounds during the visits. Hence, those respondents that had information in the updated version of the tracking sheets were used for the present study. All names were removed from the tracking sheets for reasons of confidentiality and each respondent was given an ID number. Data were obtained from the tracking sheets from March 1992 to September 1994. The amount of protein consumed by the respondents was calculated from the 24-hour dietary recall survey. The previous and updated versions of the tracking sheets, dietary recall, and food frequency forms are provided in Appendix A4 and A5.

Tracking sheets contained information on certain demographic variables such as maternal age, ethnic background, parity, gravida, prepregnancy weight, and height. Also available was information on prenatal factors such as number of visits to the nutritionist, week of gestation at different visits, weight gain of the mother from the initial visit to the last visit, infant birth weight, sex, weeks of gestation during delivery, protein supplements during the prenatal period, amount of vitamin and iron supplements taken, and complications (if any) reported during the prenatal period. The 24-hour dietary recall survey of the food consumed by the respondent was completed by the nutritionists. These two forms contained the necessary raw data for operationalizing the dependent and independent variables for this study.

Consideration was also given to the amount of time over which the data would be collected. A practical consideration was the sheer cost in time, effort, and money to obtain the data plus the availability of completed comparable records. Considering these factors, a two-year time period was selected for the present study.

Sample

The women participating in the NIP program under the Virginia Public Health Department, and who had given birth between 1992 and 1994, were used as the sample for this study. Statewide data for two years provided a reasonable sample size in each group, allowed for a better comparison of rural versus urban difference, and the resulting large sample size allowed random errors of measurement to cancel out. A total of 1,284 respondents met the criteria of attending the health department and complete information reported in the updated version of the tracking sheet.

Enrollment of respondents into the NIP program varies from first trimester to the third trimester of pregnancy, depending on the time of the first visit to the clinic, inappropriate prepregnancy weight, or inadequate weight gain during pregnancy. Respondents entering the NIP program during the latter part of the third trimester were not included in the study because they benefited little from the intervention compared to those who enrolled early. The intervention will have less favorable effect on the pregnancy outcomes because the fetus would have undergone considerable development and the intervention would not produce the desired effect on either birth weight of the baby or gestational age. Thus, those respondents who get the intervention after 30 weeks of gestation were omitted.

Collection of Data

Permission to obtain data for this study from the NIP project has been granted by the State Health Department at Richmond. In addition, the Nutritionist at the State Health Department agreed to provide further information from the tracking sheets about those respondents who have developed complications during pregnancy. The 1992 to 1994 data were used to ensure the availability of data from all county health departments (which are sent to Richmond for compilation). Numerical coding procedures were used for transferring the data from the tracking sheets to computer codes. The coded data were then analyzed using the Statistical Package for Social Science Package in the Main Frame in Old Dominion University.

Definition of Terms

Certain terms were basic to the understanding of this study. They were:

Nutritional intervention was defined as the number of visits to the nutritionist. Nutritional intervention include nutritional assessment, counseling, and regular monitoring of dietary intake and weight gain.

Tracking Sheet was a structured form the nutritionists used to record selected demographic and prenatal information of the respondents.

24-Hour Dietary Recall was a structured form used to record information on food eaten by the respondents.

Birth weight of the baby was measured in grams, recorded at the time of birth.

Gestational age or Weeks of gestation was measured by the difference between the first day of the last normal menstrual period to delivery.

Gestational weight gain was calculated as the difference between the weight at delivery and the prepregnancy weight reported in pounds. Percent of expected weight (PEW) is another criterion used to test the validity of the variable prepregnancy weight as well as the weight gain of the respondents. It is computed by the following formula:

$$PEW = \text{Present weight}/\text{Pregnancy expected weight} * 100$$

where, pregnancy expected weight = standard weight for height + 3 + (1 * weeks of gestation - 13)

Body Mass Index of the pregnant women were calculated by the reported prepregnancy weights (in kg) divided by their square (in meters) of height.

BMI = Prepregnancy weight (in kg)/Height (in mt)^2

Protein intake of the respondents during their pregnancy were measured in grams. Mean protein intake reported at different visits to the nutritionist will be taken as an indicator of respondent's protein intake during her pregnancy.

Alcohol consumption were recorded as a yes or no, recorded at each prenatal visit.

Smoking during pregnancy was measured as the average number of cigarettes consumed per day across the gestational period.

Number of Complications: was measured by the different complications reported by the respondents across the gestational period.

Residence: Respondents were categorized into rural or urban areas based on the Beale codes.

Maternal age: Number of years of the respondent.

Race: Defined as White, Black and Others (Spanish-American, Oriental, Indian, and others).

Anemia: Hemoglobin concentration during any stage of pregnancy below 10.0 g/dl.

STATISTICAL ANALYSIS

All statistical analyses were performed using the Statistical Package for Social Science (SPSSx). Descriptive statistics were calculated for all the variables for rural and urban areas and are presented in Table10 and Table 11. Pearson's product-moment correlations were calculated for the interval level variables and indicate the magnitude, significance, and the direction of association between the outcome variables and the prenatal variables.

The multivariate analyses of the present study were multiple regression analysis, effects analysis, and path analysis. These analyses were performed for both the urban and rural respondents and comparisons were made between the two. Multiple regression analysis was done for both the outcome variables of birth weight and gestational age. Data was checked for the assumptions of multiple regression.

Effects analysis or "decomposition of effects" developed by Hauser and Alwin (1979) was used in this study. The data were analyzed with standardized partial regression coefficients. The effects analysis indicated the bivariate, causal, and direct effects of the independent variable on each outcome variable as well as the spuriousness due to prior and intervening variables in the model.

Path analysis was performed on the model to interpret the linear relationships among the independent variables and each outcome variable. Path analysis indicated the path coefficients with direction (positive or negative), magnitude, and the route, and which intervening variable is more important in the model and if there is (are) single (multiple) paths that operate in the model. Multiple regression, effects analysis, and path analysis have different uses for the study in the sense that each gives different levels of detail. Hence, one builds upon the other.

CHAPTER 4

RESULTS

Distribution of respondents in rural and urban areas is indicated in Table 9. About three-fourths of the respondents were from the urban areas and one-fourth from the rural areas.

TABLE 9. Distribution of Respondents by Area

Area	Number (%)
Urban	947 (73.9)
Rural	335 (26.1)

CHARACTERISTICS OF RESPONDENTS IN URBAN AREAS

Descriptive statistics of respondents in urban areas is indicated in Table 10. Two-thirds of the 947 respondents were underweight (< 90% of ideal body weight according to the Metropolitan Life Insurance tables (1969). Fifty five percent had under-nutrition (protein intake less than recommended dietary intake of 74 grams/day). Less than one-third of the women experienced some sort of complication during the pregnancy. Twenty-two percent of respondents smoked cigarettes and only two percent consumed alcohol regularly during pregnancy.

Table 10. Descriptive Statistics of study variables in Urban Areas (N=947)

Variables	Mean	SD	Range
Birth Weight (g)	3049.60	548.10	940-5075
Weight gain (in lbs)	13.90	10.33	-11-50
Number of Visit	4.30	2.19	1-13
Weeks gestation	38.70	2.20	27-43
Protein intake (g)	73.21	25.38	20-167
Maternal age (yrs)	22.68	5.44	13-43
Parity	0.91	1.17	0-7
PEW (at last visit)*	91.09	13.53	67-177
Hemoglobin	11.41	1.10	7.6-15.5
Program Weeks	14.43	7.67	0-33
Gravida	2.18	1.47	0-9
Body Mass Index	20.58	4.59	13-49.3
Number of Complications	0.55	0.86	0-5
Cigarette Smokers (%)	22.20		
Alcohol Users (%)	2.10		
Race (%)			
Black	42.40		
White	29.60		
Other	26.30		
Hispanic	1.70		

*NOTE: PEW = Percent of expected weight of mother.

The number of visits varied, ranging from 1 to 13 with a mean of 4.70 for urban areas. This mean represents the average number of visits needed for pregnant women to have a favorable outcome of pregnancy as reported by Higgins et al. (1989). However, one-third of the respondents had less than four visits to the nutritionists. Weight gain during pregnancy also varied greatly, ranging from -11.0 lbs to 50.0 lbs. The women in the urban areas did not gain the amount of weight that is generally recommended during pregnancy. Only 43 percent (n=407) gained between 90 to 110 percent of their expected weight. Birth weight also varied greatly, ranging from 940 to 5075 g. However, approximately 84% of newborns in urban areas were in the normal range i.e., 2500 - 4000 g. 14.0 percent of babies in urban areas were in the low birth weight category. The mean protein intake of 76.2 g per day in urban areas is comparable to the 1980 Recommended Dietary Allowance of 74 g/day. Rush et al. (1988) also reported a higher intake of protein in low-income women even before participation in the WIC program.

Maternal age varied from 13 to 43 years with a mean of 23 years. Mean gestational age was 39 weeks indicating that average births were full-term babies. However, respondents in urban areas had a higher percentage of preterm deliveries (21 %) than in rural areas. The mean number of complications (0.56) during pregnancy was lower among respondents in urban areas than in rural areas. A little less than two-thirds of respondents did not report any complications during pregnancy. Mean hemoglobin level of 11.4 g/dl indicated that average respondents in the urban areas were not anemic. The percentage of respondents using alcohol was generally low (2%). However, the percentages of respondents who smoked during pregnancy (22%) was high.

CHARACTERISTICS OF RESPONDENTS IN RURAL AREAS

Two-thirds of the 335 respondents were underweight (< 90% of ideal body weight according to the Metropolitan Life Insurance tables (1969). Forty six percent had under-nutrition (protein intake less than recommended dietary intake of 74 grams/day). Respondents in rural areas had more complications during pregnancy than in urban areas. A little less than one-half of the women experienced some sort of complication during the pregnancy. Also, a higher percentage of respondents smoked during pregnancy than in urban areas. Thirty-seven percent of respondents smoked cigarettes and four percent consumed alcohol regularly during pregnancy.

The number of visits varied, ranging from 1 to 10. Number of visits in rural areas had a lower mean (3.64) compared with a mean of 4.30 for urban areas. This mean represents the average number of visits needed for pregnant women to have a favorable outcome of pregnancy as reported by Higgins et al. (1989). Weight gain during pregnancy also varied greatly, ranging from -7.50 lbs to 48.0 lbs. Only 33% (n=109) gained between 90 to 110 percent of their expected weight as compared to 43 percent (n=407) in urban areas. More than half (57.7 percent) of respondents gained less than 90 percent of their expected weight. Birth weight also varied greatly, ranging from 737 to 4536 g. However, 82% of the newborns in rural areas were in the normal range i.e., 2500 - 4000 g, and 15.5 percent of the infants were in the low birth weight category. The mean protein intake of 77.4 g per day in rural areas is comparable to the

Table 11. Descriptive Statistics of study variables in Rural Areas (N=335)

Variables	Mean	SD	Range
Birth Weight (g)	3023.60	560.30	737-4536
Weight gain (in lbs)	13.90	10.33	-7.5-48
Number of Visit	3.63	1.90	1-10
Weeks gestation	38.80	2.45	20-43
Protein intake (g)	77.40	25.07	24-190
Maternal age (yrs)	20.69	4.60	13-41
Parity	0.61	0.97	0-6
PEW (at last visit)*	91.09	13.53	67-177
Hemoglobin (g/dl)	11.67	1.14	8.7-14.3
Program Weeks	13.27	8.77	0-34
Gravida	1.79	1.16	0-9
Body Mass Index	20.47	5.05	14.6-43.9
Number of Complications	0.87	0.98	0-5
Cigarette smokers (%)	37.40		
Alcohol Users (%)	3.90		
Race (%)			
Black	23.00		
White	71.00		
Other	6.00		

*NOTE: PEW = Percent of expected weight of mother.

1980 Recommended Dietary Allowance of 74 g/day. Maternal age varied from 13 to 41 years with a mean of 21 years in rural areas. Respondents were slightly younger in rural areas than in urban areas. One-quarter (24.2%) of the respondents were under 18 years of age. Mean gestational age was 39 weeks indicating that average births were full-term babies. However, 18% of the respondents had preterm delivery. The mean number of complications during pregnancy was higher among respondents in rural areas than in urban areas. Mean hemoglobin levels was 11.6 g/dl indicated that average respondents were not anemic. The percentages of respondents who smoked during pregnancy was higher (37%) in rural than in urban areas. The percentage of respondents using alcohol was higher (4%) as compared to the urban areas.

Comparision of the Rural and Urban respondents on selected maternal characteristics are given in Table 12 to Table 19. The distribution of maternal age is indicated in Table 12 and Figure 5. Maternal age was categorized into four groups: under 18 years, 18 to 19 years, 20 to 29 years, and 30 and over. Rural areas have higher percentages of respondents in the under 18 year and 18 to 19 years age groups whereas urban areas have higher percentages of respondents in the 20-29 and 30 years and higher age groups. The distribution of ethnic origin of respondents is given in Table 13 and Figure 6. Ethnic origin was categorized into four groups: Black, White, Hispanic and others. Rural areas have higher percentage of respondents who are whites (71%). Urban areas have higher percentages of Black respondents (42.4%). Hispanics, very few in the sample, were concentrated in the urban areas (1.7%).

Table 12. Distribution of Maternal age by Area

Age Category	Number (%) in Urban Area	Number (%) in Rural Area
Under 18 years	150 (15.8)	81 (24.2)
18 to 19 years	163 (17.3)	83 (24.8)
20 to 29 years	518 (54.7)	153 (45.6)
30 years and over	116 (12.2)	18 (5.4)

Table 13. Ethnic Origin of the Respondents

Category	Number (%) in Urban Area	Number(%) in Rural Area
Black	402 (42.4)	77 (23.0)
White	280 (29.6)	238 (71.0)
Hispanic	16 (1.7)	0 (00.0)
Other	249 (26.3)	20 (6.0)

DISTRIBUTION OF MATERNAL AGE

Rural vs Urban

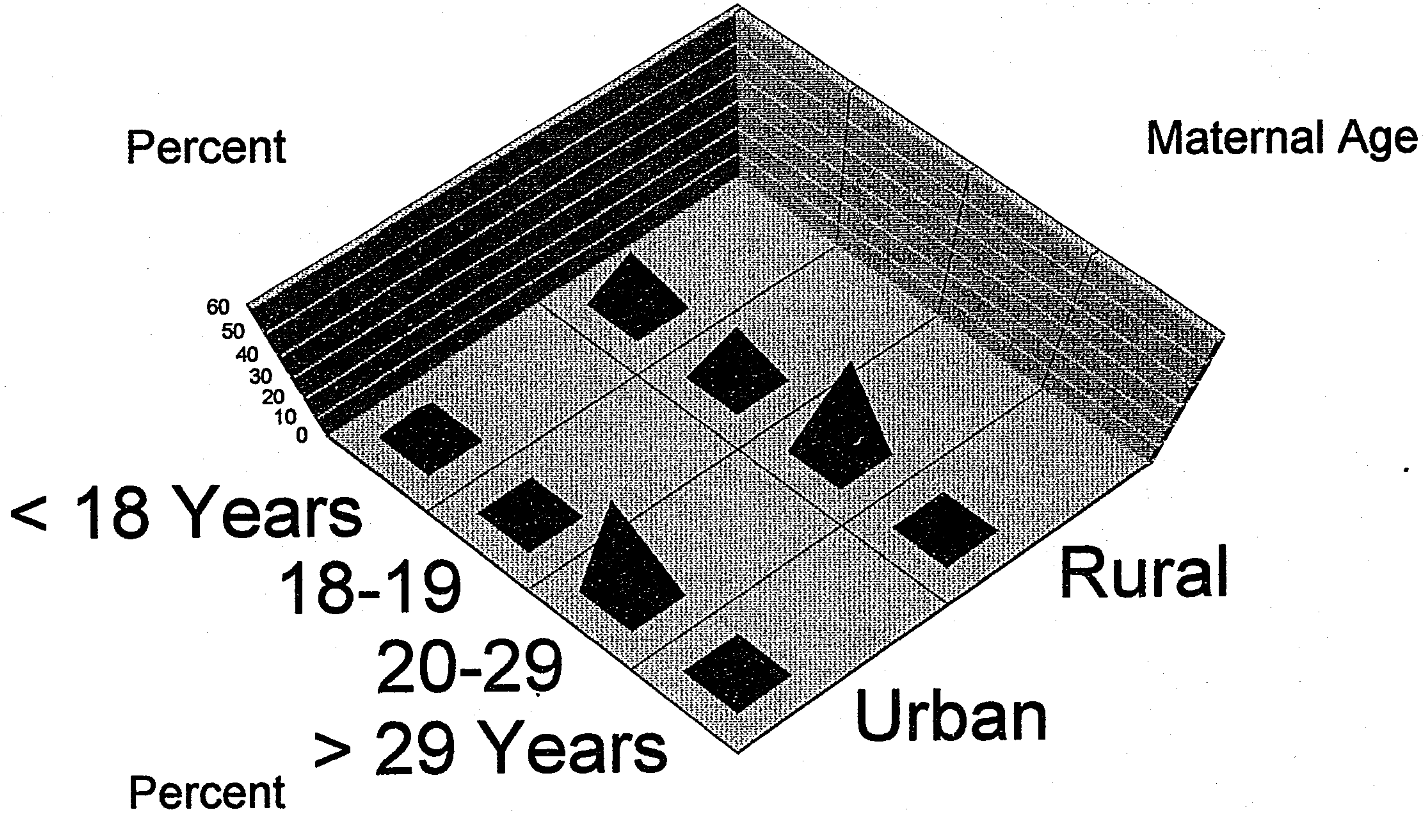


FIGURE 5

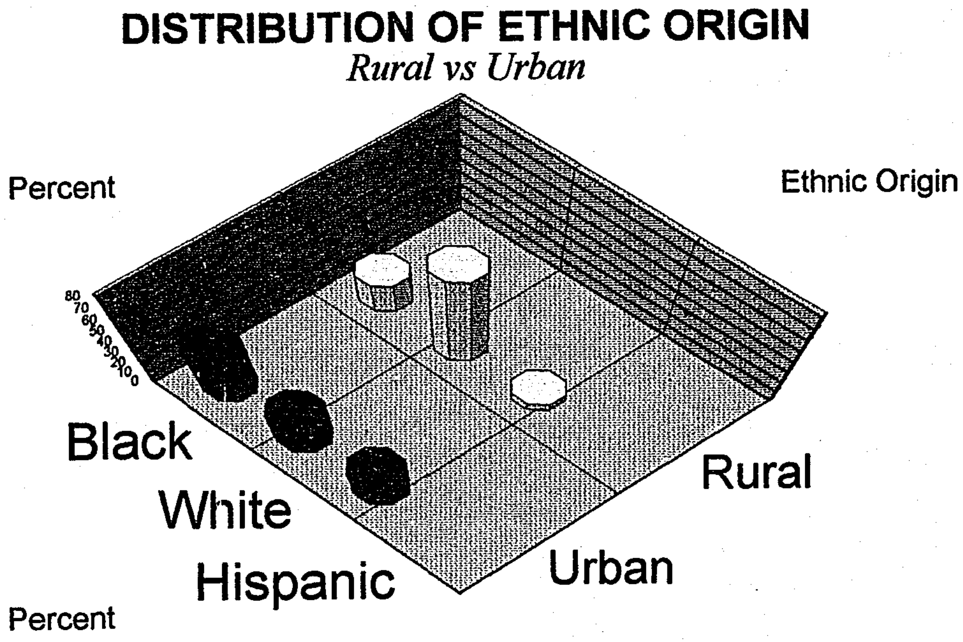

DISTRIBUTION OF ETHNIC ORIGIN
Rural vs Urban
Percent
Ethnic Origin
80
70
60
50
40
30
20
10
0
Black
White
Hispanic
Rural
Urban
Percent

FIGURE 6

Distribution of parity is indicated in Table 14 and Figure 7. Maternal parity was categorized into three groups: primiparous, low parity multiparous and high parity multiparous. High parity was defined as third- or higher-order births to the respondents. Rural areas have higher percentages of respondents who are primiparous. Urban areas have higher percentages of respondents in low and high parity groups.

Distribution of prepregnancy Body Mass Index is indicated in Table 15. Body Mass Index was categorized into four groups: underweight (less than 90% of standard or BMI < 19.8), Normal (90 to 120% of standard or BMI 19.8 to 26.0), Overweight (120 to 135% of standard or BMI 26 to 29), Obese (greater than 135% of standard or BMI > 29.0). Rural areas have higher percentages of respondents in the underweight category. Urban areas have a higher percentage of respondents in the normal and overweight categories. In general, there were few respondents in the overweight and obese categories in both rural and urban areas.

The number of complications during pregnancy is indicated in Table 16. Respondents in rural areas have more complications compared to those in urban areas. In the urban areas a high percentage of respondents has no complications. Respondents who smoked during pregnancy are indicated in Table 17. Higher percentage of respondents in rural areas smoked during pregnancy as compared to urban areas.

The distribution of birth weight of babies is indicated in Table 18. Birth weight of the babies was categorized into four groups: Very Low Birth Weight (VLBW - less than 1500 g), Low Birth Weight (LBW - 1500 to 2500 g), Normal (2500 to 4000 g), and High (more than 4000 g). Incidence of VLBW and LBW infants in urban areas was

Table 14. Distribution of Maternal parity by Area

Category	Number (%) in Urban Area	Number (%) in Rural Area
Primiparous	459 (48.5)	202 (60.3)
Low parity	406 (42.9)	115 (34.4)
High parity	82 (8.7)	18 (5.4)

Table 15. Distribution of Body Mass Index by Area

Category	Number (%) in Urban Area	Number (%) in Rural Area
Underweight (less than 90% of standard or BMI < 19.8)	578 (61.0)	221 (66.1)
Normal (90 to 120% of standard or BMI 19.8 to 26.0)	252 (26.7)	78 (23.3)
Overweight (120 to 135% of standard or BMI 26 to 29)	61 (6.4)	14 (4.1)
Obese (Greater than 135% of standard or BMI > 29.0)	56 (5.9)	22 (6.5)

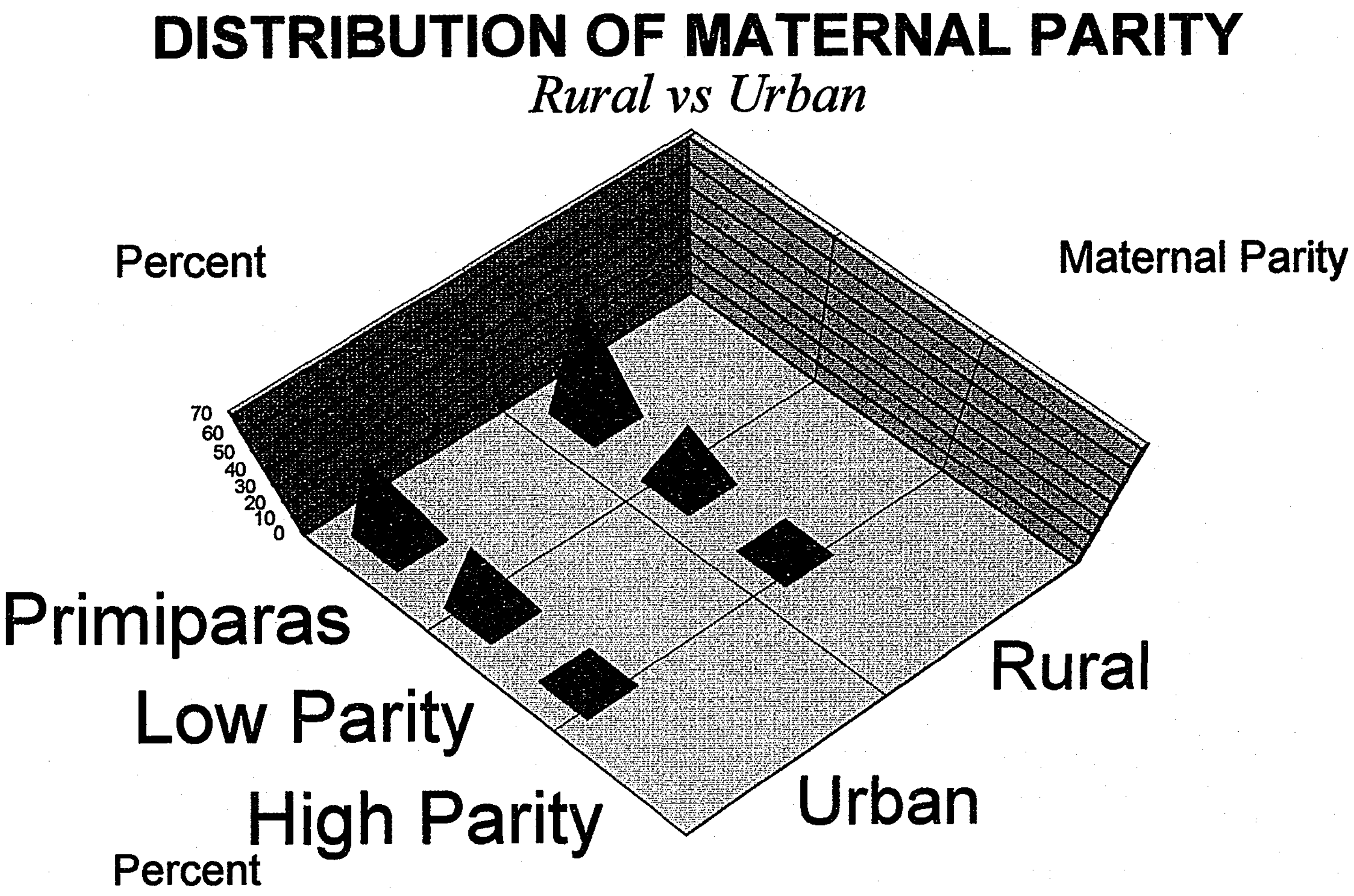

DISTRIBUTION OF MATERNAL PARITY
Rural vs Urban
Percent
Maternal Parity
70
60
50
40
30
20
10
0
Primiparas
Low Parity
High Parity
Rural
Urban
Percent

FIGURE 7

Table 16. Number of Complications during Pregnancy

Number of Complications	Number (%) in Urban Area	Number (%) in Rural Area
0	594 (62.7)	156 (46.6)
1	226 (23.9)	95 (28.4)
2	91 (9.6)	60 (17.9)
3	26 (2.7)	22 (6.6)
4	9 (1.0)	1 (0.3)
5	1 (0.1)	1 (0.3)

Table 17. Respondents who smoked during pregnancy

Category	Number (%) in Urban Area	Number (%) in Rural Area
Yes	210 (22.2)	125 (37.4)
No	737 (77.8)	210 (62.6)

slightly lower than in rural areas.

The distribution of gestational age of babies is indicated in Table 19. Gestational age of the babies was categorized into three categories: Preterm (less than 37 weeks), Normal (38 to 40 weeks), and Postterm (more than 40 weeks). Respondents in urban areas have higher rate of preterm births and lower normal birth rates as compared to rural areas.

Effect of racial/ethnic origin on mean gestational age or rate of prematurity indicated a significant increase in the risk of prematurity among blacks than whites in urban areas. Association between race and gestational age was significant in urban areas (chi-square = 28.5, p =0.0007). In rural areas there was no significant association found between race and gestational age (p =0.39). Distribution of preterm births by maternal BMI indicated a significant increase in the risk of prematurity among those in the underweight category (Figure 8). The association was significant in both urban and rural areas.

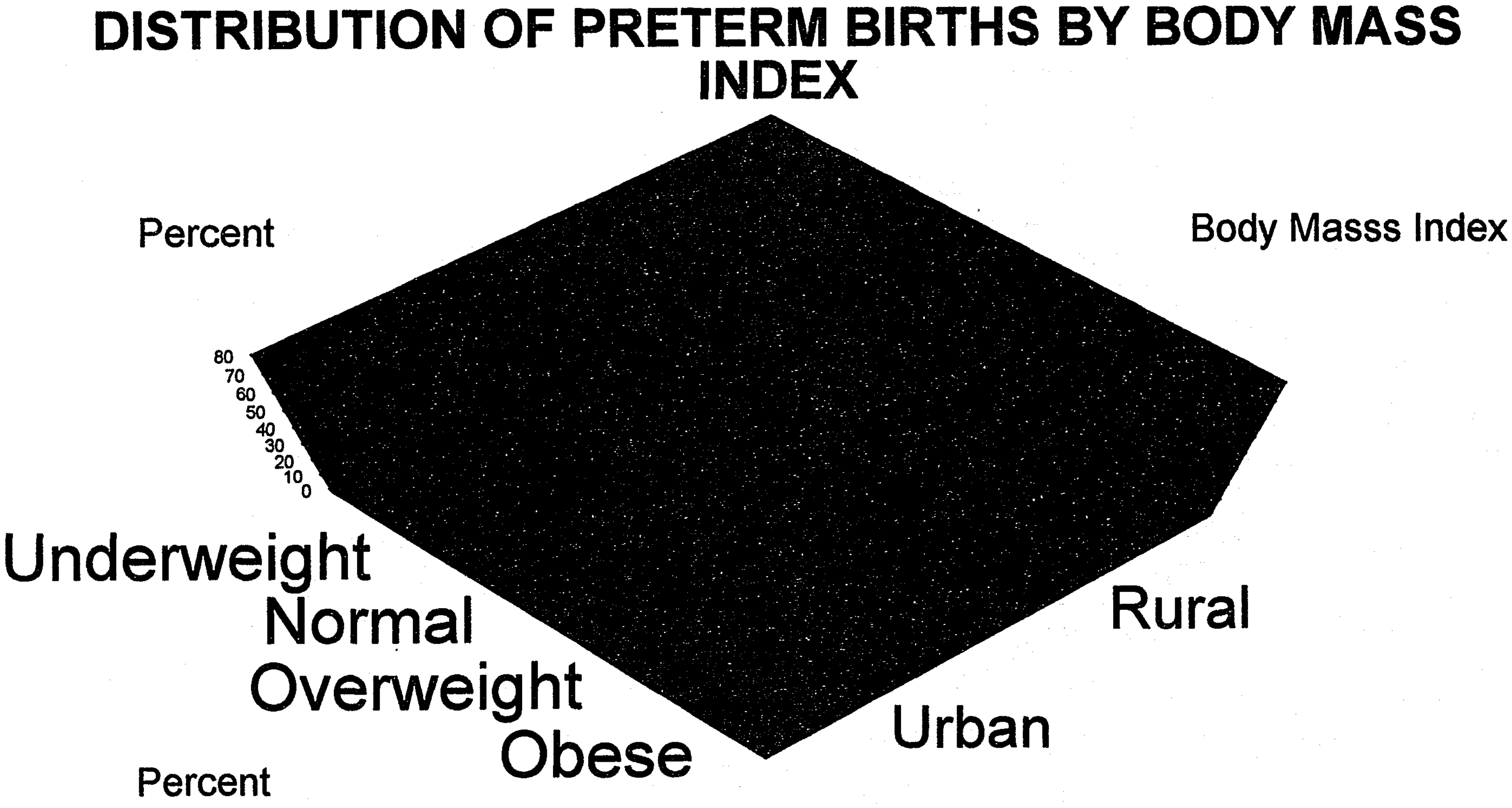
No significant association was found between the age groups and gestational age in both rural and urban areas. However, when controlled for the racial groups, there was a significant association (p=0.02) among hispanics in urban areas and for those in the other category in rural areas. A significant association was found between the different racial groups and incidence of LBW in both rural and urban areas (Figure 9). Although no significant association was found between birth weight and age groups, when controlled for racial groups, incidence of LBW babies was high among blacks adolescents (Chi-square = 23.4, p=0.005) in urban areas. There was a significant

Table 18. Birth weight of Babies

Category	Number (%) in Urban Area	Number (%) in Rural Area
VLBW	13 (1.4)	5 (1.5)
LBW	106 (11.2)	47 (14.0)
Normal	799 (84.4)	276 (82.4)
High	29 (3.0)	7 (2.1)

Table 19. Gestational age of Babies

Category	Number (%) in Urban Area	Number (%) in Rural Area
Preterm	197 (20.8)	60 (17.9)
Normal	631 (66.6)	237 (70.8)
Postterm	119 (12.6)	38 (11.3)



DISTRIBUTION OF PRETERM BIRTHS BY BODY MASS INDEX

FIGURE 8

DISTRIBUTION OF LOW BIRTH WEIGHT BY RACE

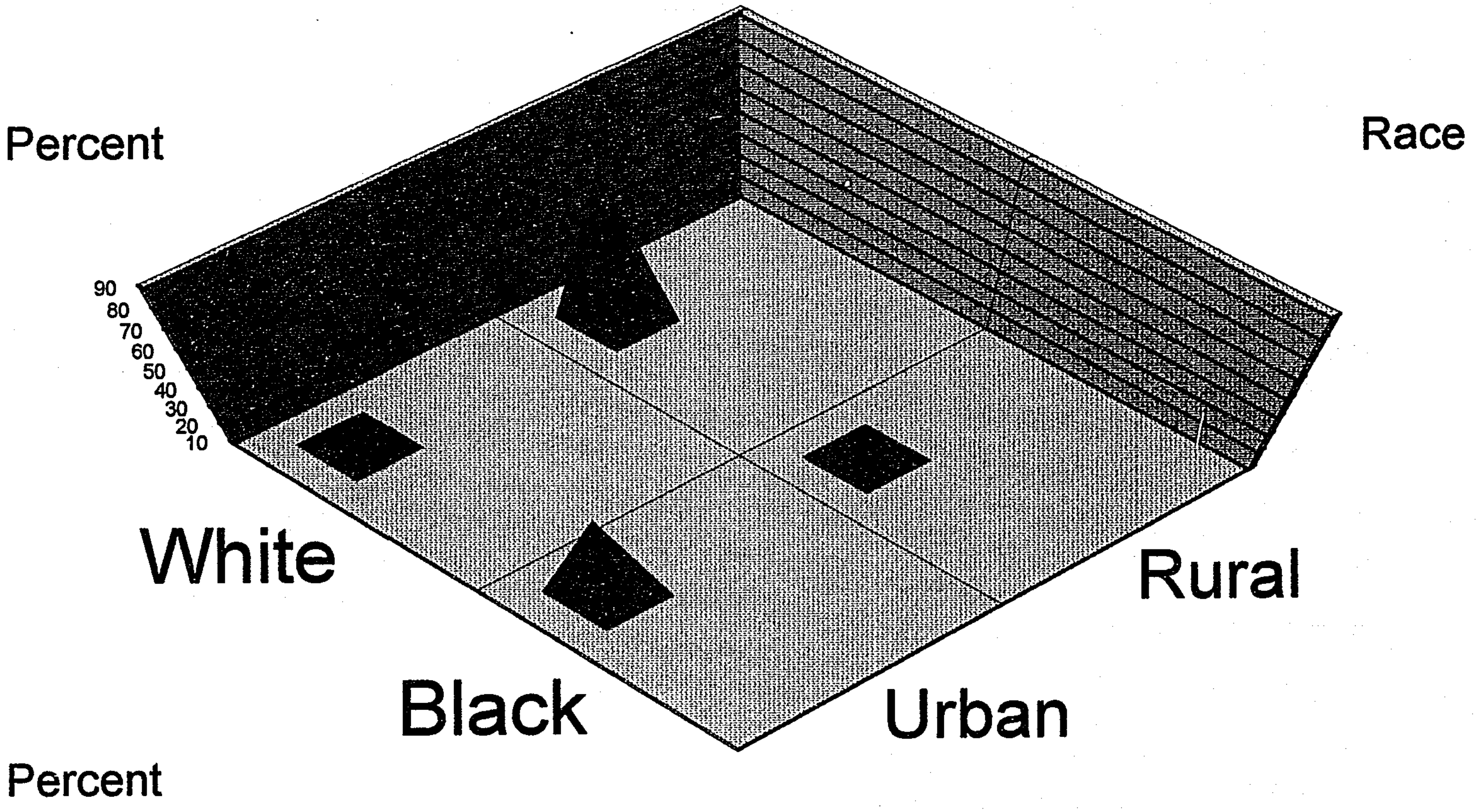


FIGURE 9

association between age and incidence of LBW babies. However, when controlled for cigarette smoking during pregnancy, the relationship did not hold. A significant association was also found between maternal BMI and incidence of LBW (Figure 10)

A significant realtionship was found between the different racial groups and gestational age in urban areas (chi-square = 28.5, p=.0007) but not in the rural areas. Preterm births was generally higher among adolescents in urban areas. A strong association found between age and parity (chi-square = 242.6 and 73.5 in urban and rural areas respectively, $p < 0.0005$) in both urban and rural areas. This is expected as primiparae tend to be younger than multiparae. This realtionship was strong for blacks, whites, and those in the other categories but not for hispanics in urban areas and for blacks and whites in rural areas. In general, primiparous respondents had higher incidence of LBW babies (Figure 11). The association between parity and birth weight was significant in both rural (chi-square = 13.1, p=0.01) and urban areas (chi-square = 13.4, p=0.009). However, controlling for age the association between parity and birth weight was significant for only the 20 to 29 years age group both in urban (chi-square = 11.6, p=0.02) and rural areas (chi-square = 20.6, p=0.0003). Incidence of LBW was higher among respondents who smoked during pregnancy. Respondents who smoked during pregnancy in urban areas, rate of LBW was highest in the 20-29 year category in both blacks and whites (Figure 12). Respondents who smoked during pregnancy in rural areas, rate of LBW was highest in the 18-29 year category in blacks and 20-29 year category in whites (Figure 13).

DISTRIBUTION OF LOW BIRTH WEIGHT BY MATERNAL BODY MASS INDEX

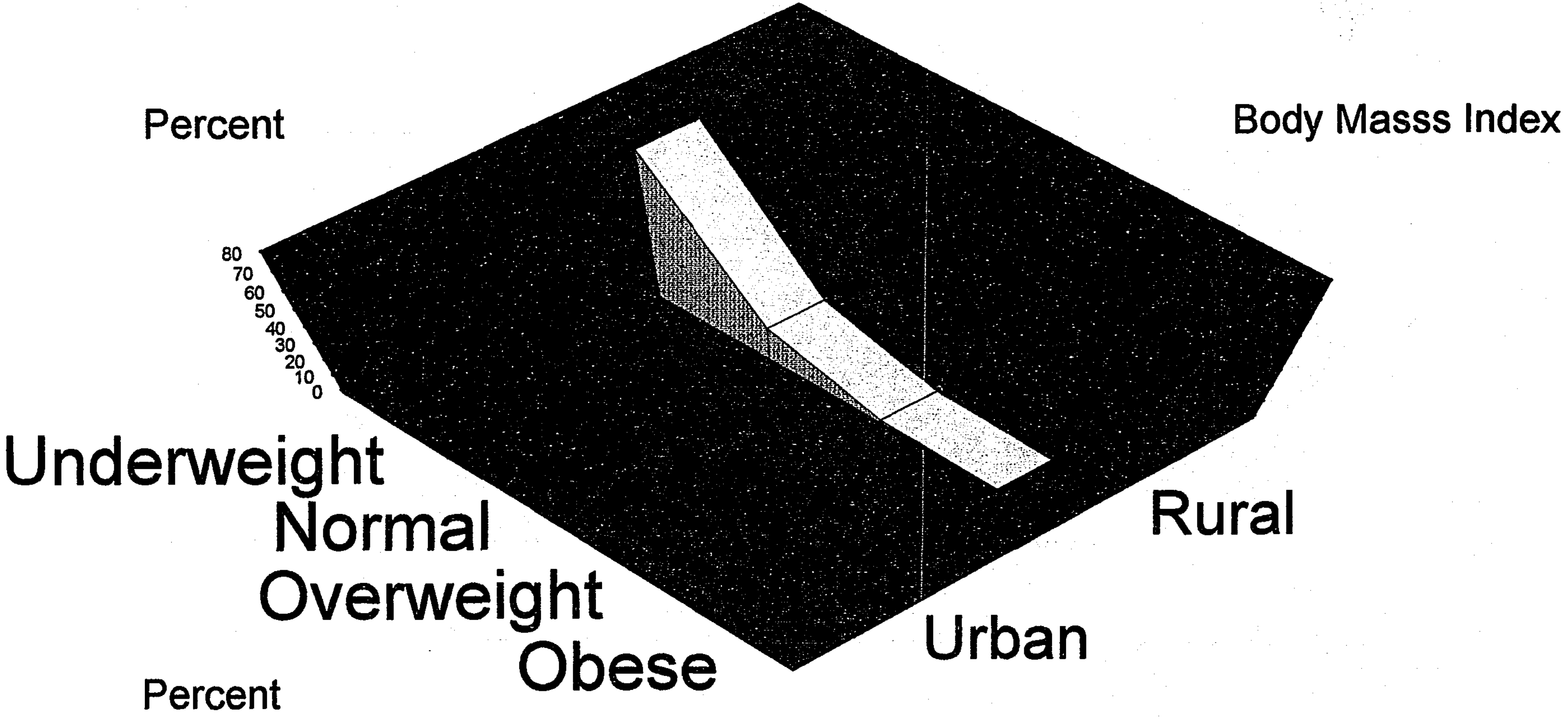


FIGURE 10

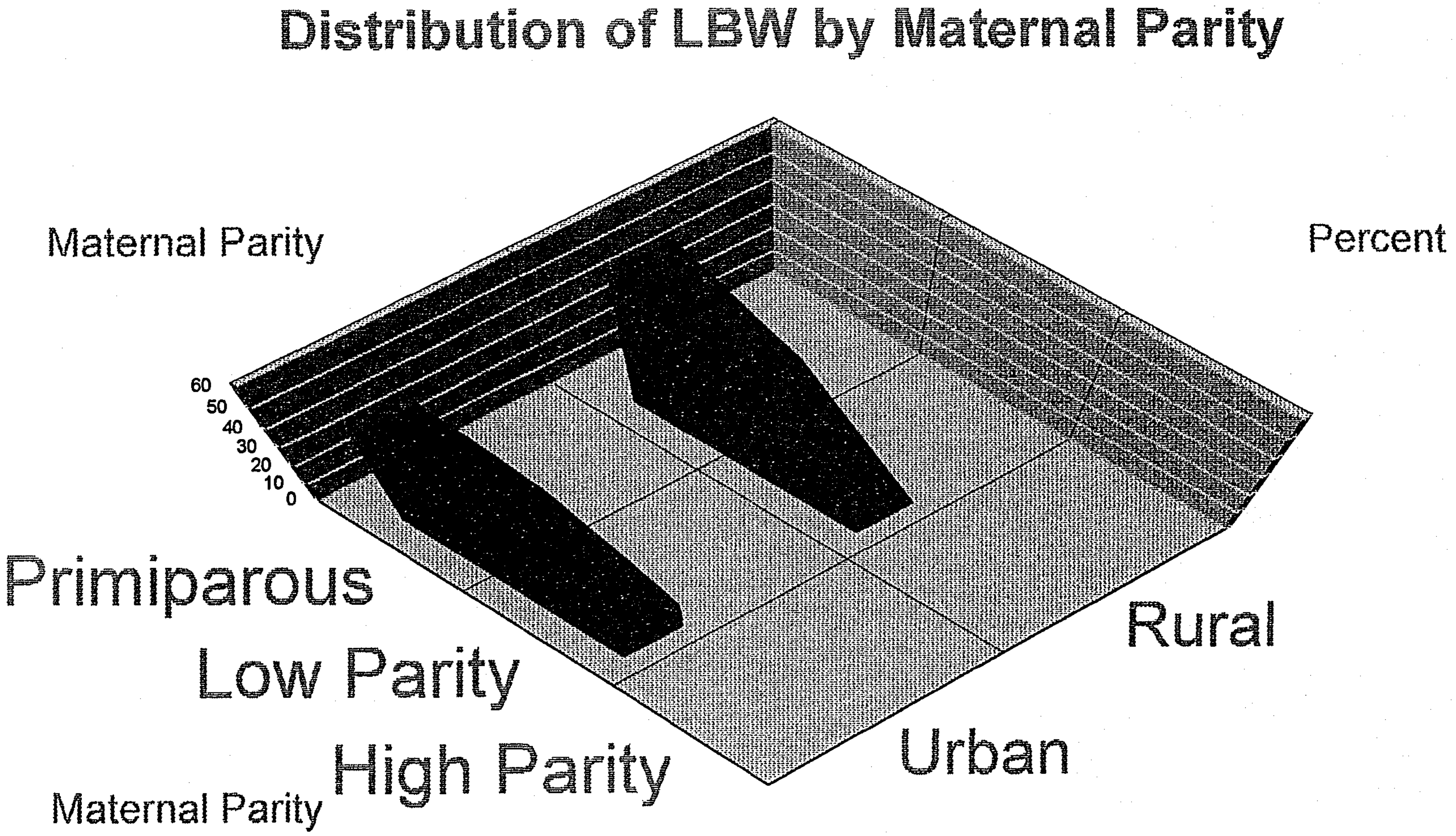

Distribution of LBW by Maternal Parity
Maternal Parity
Percent
60
50
40
30
20
10
0
Primiparous
Low Parity
High Parity
Maternal Parity
Rural
Urban

FIGURE 11

Percent of LBW in Respondents who smoked by Age & Race in Urban Areas

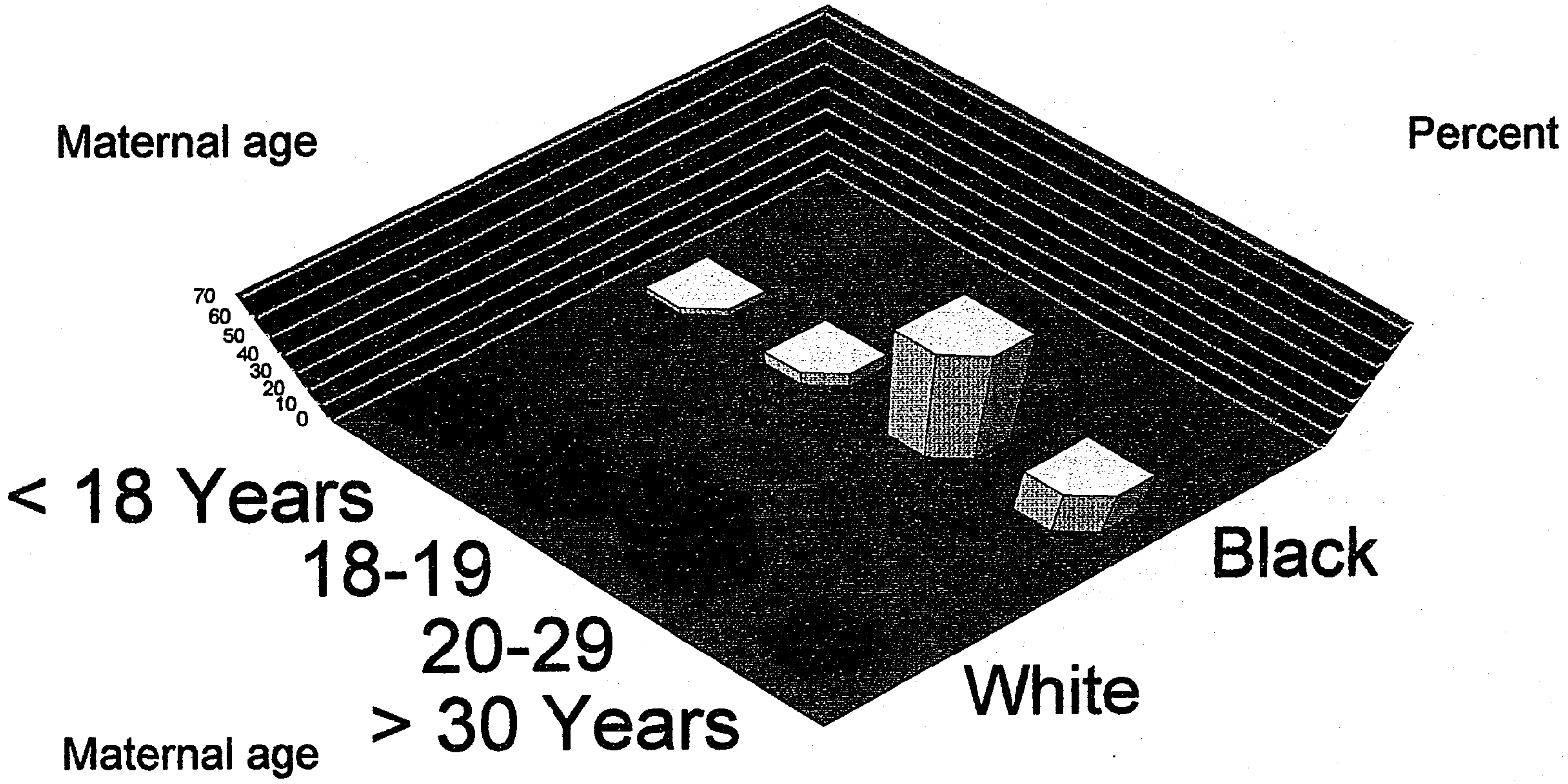


FIGURE 12

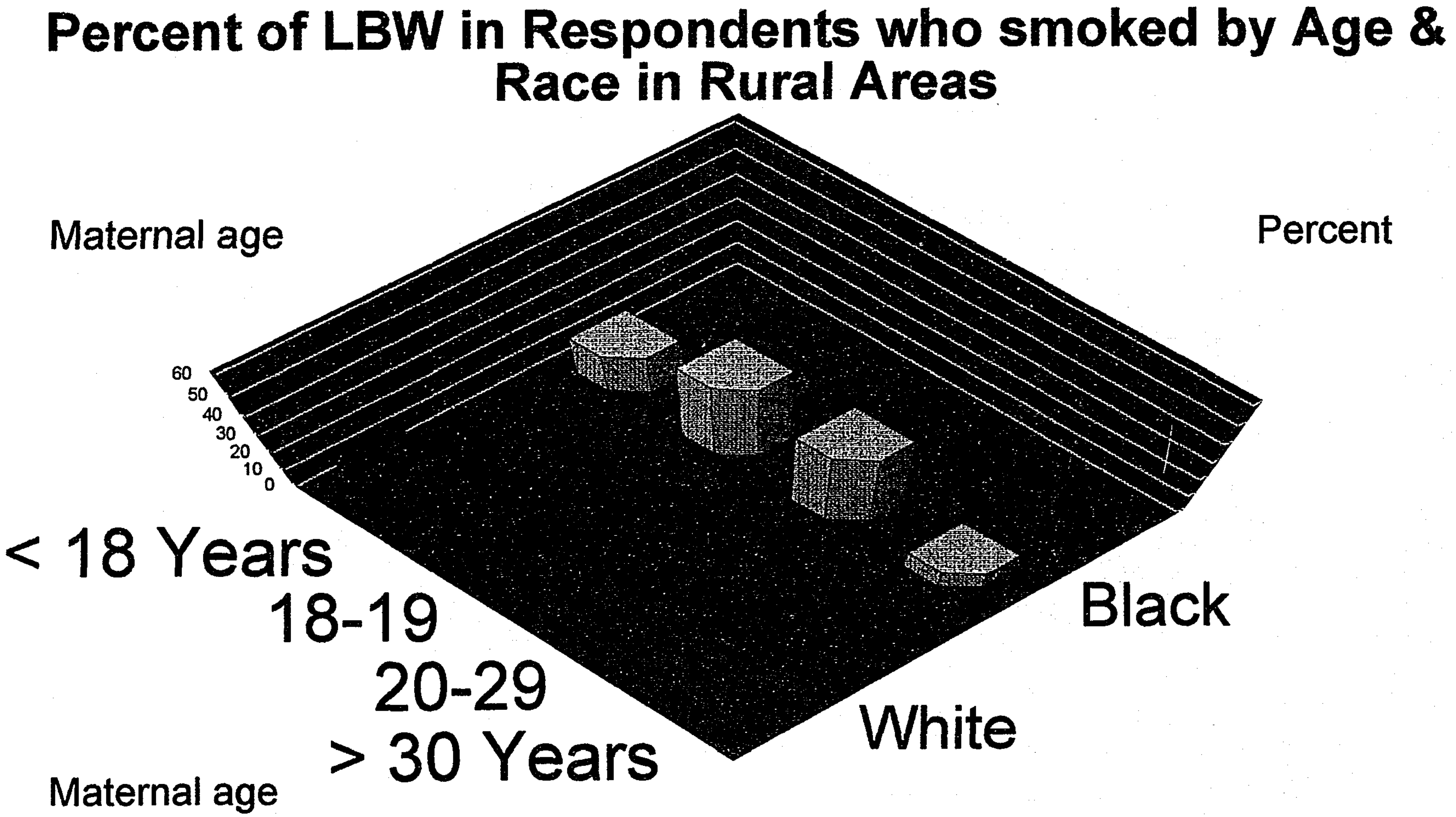

Percent of LBW in Respondents who smoked by Age & Race in Rural Areas
Maternal age
Percent
60
50
40
30
20
10
0
< 18 Years
18-19
20-29
> 30 Years
Black
White
Maternal age

FIGURE 13

FACTORS RELATED TO OUTCOME OF PREGNANCY

A Pearson's correlation analyses of the prenatal variables to the outcomes of pregnancy revealed a positive association of number of visits, weeks of gestation, percent of expected weight, Body mass index, weight gain, and iron supplements with birth weight of baby, all of which were significant at the 0.01 probability level. Number of vitamin supplements taken during pregnancy was positively associated with birth weight of the baby at the 0.05 probability level. A significant negative association ($p < 0.01$) was found with the presence of anemia, complications during pregnancy and smoking during pregnancy.

Gestational age was positively associated with number of visits to nutritionist, birth weight, percent of expected weight, body mass index, and weight gain and negatively associated with anemia of mother, and presence of complications during pregnancy, all of which were significant at the 0.01 probability level. Number of iron supplements taken during pregnancy was positively correlated to gestational age at 0.05 level of significance. Correlation coefficients of the variables are given in Table 20.

OUTCOME OF PREGNANCY: BIRTH WEIGHT

Multivariate regression analysis of number of visits to the nutritionist on birth weight, controlling for age, race, gravida, weeks of gestation at first visit, number of complications, parity, smoking during pregnancy, alcohol intake, weight gain, body mass index, locality, presence of anemia, number of iron and vitamin supplements, weight of the respondent at last visit, and protein intake are indicated in Table 21. Dummy

TABLE 20. Correlation of birth weight and gestational age to the independent variables.

	Bwt	PEW	Protn	Gravida	Parity	BMI	Smoke	Alch	Nvisit	Wkgest	Age	Race	Comn	Anemia	Locale
Bwt	1.00														
PEW	0.19**	1.00													
Protein	-0.04	-0.03	1.00												
Gravida	-0.02	0.01	0.03	1.00											
Parity	0.00	0.00	0.00	0.83**	1.00										
BMI	0.08**	0.80**	-0.10**	0.06*	0.09**	1.00									
Smoke	-0.09**	-0.07*	0.02	0.20**	0.17**	-0.04	1.00								
Alcohol	-0.03	0.10**	0.02	0.10**	0.04	0.08**	0.08**	1.00							
Numvisit	0.18**	0.07*	0.02	-0.05	-0.05	-0.03	-0.03	-0.06*	1.00						
Wksgest	0.67**	0.12**	-0.05	-0.02	-0.02	0.08**	-0.02	0.02	0.17**	1.00					
Age	0.03	0.10**	-0.07*	0.52**	0.52**	0.16**	0.13**	0.12**	0.05	0.01	1.00				
Race	0.05	-0.07*	0.17**	-0.04	-0.06*	-0.15**	0.39**	-0.00	-0.07**	0.04	-0.14**	1.00			
Comn	-0.17**	0.06*	-0.02	0.02	-0.001	0.13**	0.03	0.11**	0.05	-0.08**	0.002	-0.09	1.00		
Anemia	0.09**	0.09**	0.10**	-0.01	-0.04	-0.00	0.07*	0.02	0.30**	0.08**	-0.07*	0.09**	0.04	1.00	
Locale	-0.02	-0.02	0.07*	-0.12**	-0.11**	-0.01	0.13**	0.05	-0.22**	0.02	-0.16**	0.37**	-0.15**	0.01	1.00

variables were created for the variables race, anemia, locality (rural vs urban), sex of the and alcohol intake. Results of the regression analysis indicate that weight gain during pregnancy, number of visits to the nutritionist, weight of the respondent before delivery, number of complications during pregnancy, smoking habit, race, parity, protein intake, number of iron supplements, weeks of gestation at first visit, and sex of the baby are significantly related to the birth weight of the baby ($p < 0.05$). The number of complications during pregnancy has the largest negative impact on the birth weight of the baby (beta = -0.18), followed by mother's smoking (beta = -0.11), protein intake (beta = -0.06), and sex of the baby (beta = -0.05). This indicates that as the number of complications increased the incidence of LBW babies increased among the respondents. Respondents who smoked during pregnancy had a higher percentage of LBW babies as compared to those who did not, in both urban and rural areas. Among respondents who smoked in rural areas, rate of LBW was highest among the 20-29 year category in Whites and among the 18-29 year category in Blacks. Among respondents who smoked in urban areas, rate of LBW was highest among the 20-29 year category both in Whites and Blacks. The detrimental effects of smoking on birth weight of the baby have been established in many studies (Kramer, 1987; Pierce et al., 1989; Kleinman & Madans, 1985). Kleinman and Madans estimated that elimination of smoking would reduce the incidence of low birth weight by 11% for those with more than 12 years of education and by 35 % for those with less than 12 years of education. LBW was highest among women in the underweight category (BMI < 19.8) both in urban and rural areas. Female babies had low birth weights more often than male babies and respondents with

Table 21. Regression of Birth weight on nutritional intervention, controlling for all other variables.

Variables	Regression Coeff	SE	BETA	P-VALUE
Weight gain	10.02	1.71	0.19	.000
Weight at last visit	4.96	0.62	0.22	.000
Number of complications	-112.20	16.42	-0.18	.000
Number of Visit to Nutritionist	26.36	8.37	0.09	.001
Smoke	-12.59	3.32	-0.11	.000
Race	128.70	34.25	0.12	.000
Parity	32.75	13.99	0.06	.019
Protein Intake	-1.60	0.63	-0.06	.010
Sex of baby	-64.23	29.76	-0.05	.031
Number of Iron supplements	42.70	21.74	0.05	.049
Weeks of gestation at first visit	4.36	2.62	0.04	.097
Alcohol	15.94	99.25	0.004	.872
Anemia	-15.14	37.73	0.011	.688
Number of vitamin supplements	17.36	53.64	0.009	.746
Locality	53.14	38.75	0.042	.170
Maternal age	1.73	3.49	0.016	.619
BMI	-6.13	5.58	-0.049	.272
Gravida	-12.97	19.84	-0.032	.513
Constant	1923.60	243.20		.000
$R^2 = .193$				

F-value =13.168, $p < 0.0001$

NB: $p = .000$ indicates that $p < .0001$

high protein intake had low birth weight babies as compared to respondents with low protein intake.

Weight at the last visit was positively associated with birth weight (beta = 0.22) followed by weight gain (beta = 0.19), race (beta = 0.12), number of visits to the nutritionist (beta = 0.10) parity (beta = 0.06) and intake of iron supplements (beta = 0.05). This indicates that as the number of visits to the nutritionist increased, the birth weight of the baby increased. Also, with greater weight gain during pregnancy, birth weight of the baby increased. Weight at last visit had the largest positive relationship to the birth weight of the baby. Whites had heavier babies as compared to non white (blacks, hispanics, and others) respondents and respondents who took iron supplements during pregnancy had higher birth weight babies as compared to those who did not.

Coefficient of determination (R^2) of the model was 0.19, indicating that 19 percent of the variance in birth weight was collectively explained by all the independent variables used in the model. The overall model was significant ($F = 13.16$, $p < 0.0001$). The variables that were not significant in the model were maternal age, alcohol intake, anemia, number of vitamin supplements, locality (rural/urban), BMI, and Gravida.

EFFECTS ANALYSIS

Effects analysis or "decomposition of effects" developed by Alwin and Hauser (1975) was used in this study. It is a powerful extension of the elaboration principles (for causal understanding) proposed by Paul F. Lazarfeld (1965). For this study, the data have been analyzed with standardized partial regression coefficients: numbers that ranged from 0.00 to +/- 1.00 that estimate slopes (change in the dependent variable per unit change in the independent variable) in the coinage of standard deviations. Standardized beta helps explain the variance in the dependent variable and makes possible the comparisons between the different independent variables with different units of measure.

PREGNANCY OUTCOME: BIRTH WEIGHT

The bivariate (nothing controlled) coefficient for number of visits and birth weight is + 0.193. This indicates that the higher the number of visits to the nutritionist, the higher is the birth weight of newborn infant.

When the priors (race, maternal age, gravida, parity, presence of anemia, body mass index, locality, weeks of gestation at first visit, and number of complications) and intervenors (protein intake, iron and vitamin intake, smoking, alcohol intake, and weight gain) are all controlled, the net coefficient was + 0.101. In Lazarsfeldian terms:

Unexplained (net)	+ 0.101	(52.3%)
Explained (0.193-0.101)	+ 0.092	(47.7%)
Total (bivariate)	+ 0.193	100%

When the analysis is elaborated by introducing the fifteen test variables, about one-half (47.7%), of the association can be explained. Thus, most of the association between nutritional intervention and birth weight is due to prior and intervening variables in the model.

In order to learn how much of the correlation is spurious versus causal or by the causal portion, how much is produced by the intervening variables, an additional run was done for nutritional intervention and birth weight, controlling for all priors but not controlling for any intervenors. This gave the causal effect of nutritional intervention on birth weight because all priors were controlled, leaving both direct and indirect effects via intervenors in the model. The causal coefficient in the present data between nutritional intervention and birth weight = 0.217. The suppressor variables have a negative effect in this model. Hence, by controlling for prior variables, the strength of the relationship between nutritional intervention and birth weight was increased, although only slightly.

From these three coefficients, two more coefficients were calculated: the spurious correlation due to priors, which was obtained by subtracting the causal coefficient from the bivariate coefficient (0.193 - 0.217 = -0.024) and the indirect correlation due to intervenors obtained by subtracting the direct coefficient (all test factors controlled) from the causal coefficient (controlling all priors) i.e., 0.217 - 0.101 = 0.116. Table 22 indicates the Effects Analysis in tabular form.

The total effect of visits to the nutritionist on birth weight is + 0.193, all of which is causal plus 0.024 units more, which was suppressed due to the prior variables used in the model. We would expect a unit change in nutritional intervention to produce a 0.217 change in birth weight of the infant, even though the cross-sectional difference was 0.193.

Table 22. Effects Analysis of Birth weight on nutritional intervention

	Controlling		
Effect	All priors	All intervenors	Correlation
(A) Total (bivariate)	no	no	0.193
(B) Causal	yes	no	0.217
(C) Direct	yes	yes	0.101
(D) A-B= Spurious due to priors			-0.024
(E) B-C= Indirect, due to intervenors			0.116

A little more than one-half of the causal effect (0.116 of .217 points or 53%) operates via the intervening variables: protein intake, iron and vitamin supplements, smoking, alcohol intake, and weight gain. But 10 points (52% of the total, 47% of the causal) remain after the intervening variables have been controlled. Hence, among babies matched on protein intake, smoke, alcohol, and weight gain, those mothers with more visits to the nutritionist had higher birth weights. None of the correlation was spurious based on available priors. However, prior variables were suppressor variables and after being controlled in the model, the correlation between nutritional visits and birth weights of babies increased.

The three coefficients of effects analyses tell a surprisingly full story, but they do not tell the whole story. For example, we still do not know how the intervening variables work, i.e., whether each of them mediates the effect of nutritional intervention on birth weight or, perhaps, the linkage is through health risk behaviors (smoking and alcohol intake), increased nutrient intake (protein, iron and vitamin intake), or weight gain. Also unknown are the relative effects of the prior variables in the model. Path analysis was used to tease out the fine-grain detail of exactly how each variable and causal structure contributes in the model. Paths are indicated by one-way arrows and their magnitudes, either positive or negative numbers that summarize the total effect on the dependent variable of a unit change in independent variable after it has rippled through the model. For this study, the path coefficients used are the standardized partial regression coefficients, numbers that ranged from 0.00 to +/- 1.00. Path analysis gives the value of each path linking nutritional intervention and birth weight and thus gives a more exact answer as to which path is the strongest and which paths have less emphasis.

Figure 14 indicates the link between the variables with coefficients of each arrow in the path. The value of a path (the change in Xj per change in Xi) is found by multiplying the coefficients of each arrow in the path.

Table 23 lists all the forward paths and their values in the model. The algebraic expressions in Table 23 can be quite informative, with two intervenors each two-term path tells independent effect of one intervenor. The three-term path gives their joint effect. Figure 15 indicates the path diagrams with standardized regression coefficients, controlling for prior variables in the model.

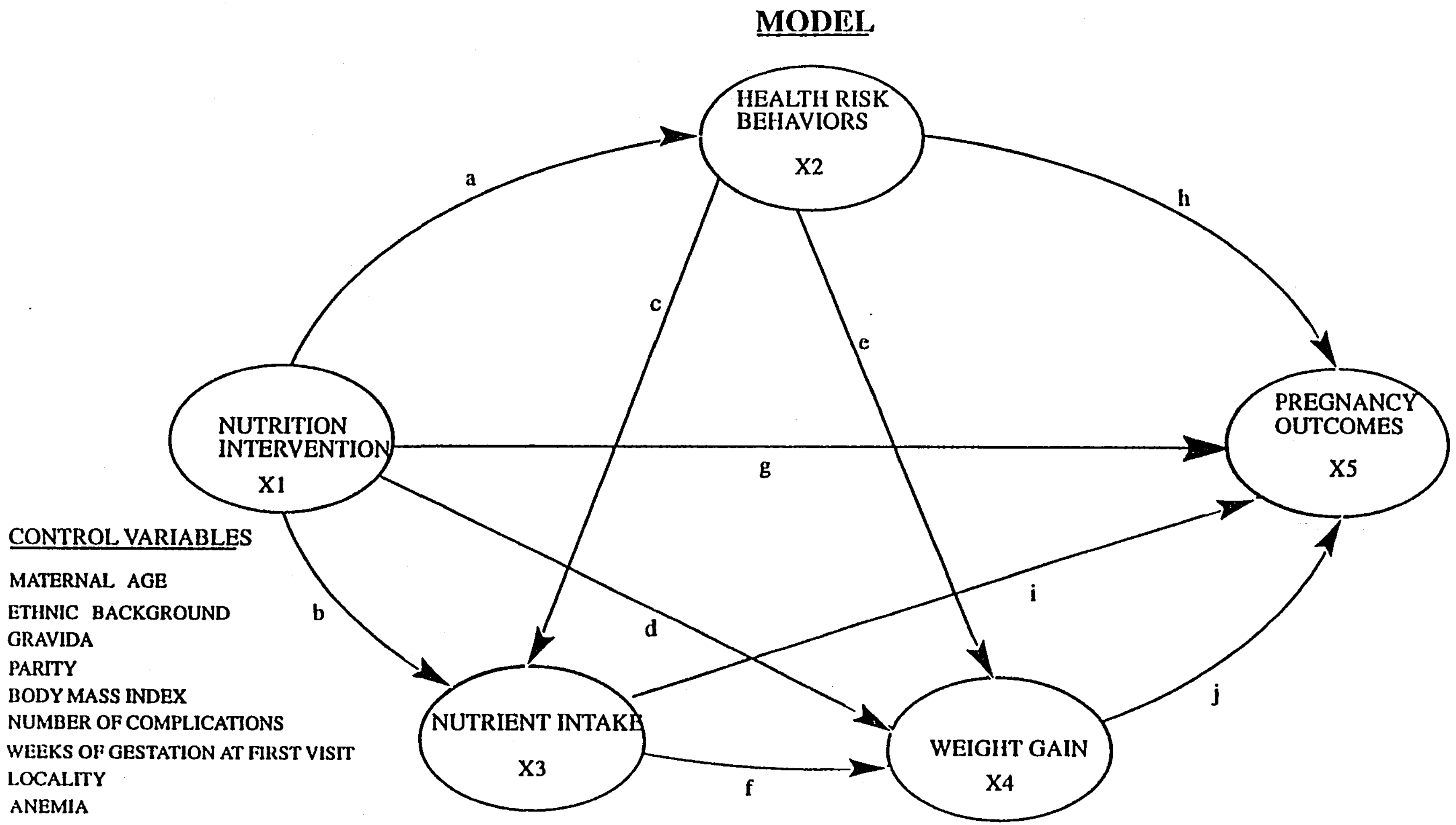

MODEL
HEALTH RISK BEHAVIORS
X2
NUTRITION INTERVENTION
X1
PREGNANCY OUTCOMES
X5
NUTRIENT INTAKE
X3
WEIGHT GAIN
X4
a
b
c
d
e
f
g
h
i
j
CONTROL VARIABLES
MATERNAL AGE
ETHNIC BACKGROUND
GRAVIDA
PARITY
BODY MASS INDEX
NUMBER OF COMPLICATIONS
WEEKS OF GESTATION AT FIRST VISIT
LOCALITY
ANEMIA

FIGURE 14

Table 23. Causal Paths in the Model

Xi to Xj		Paths
1	2	a
1	3	b + a*c
2	3	c
1	4	d + a*e + b*f+ a*c*f
2	4	e + c*f
3	4	f
1	5	g + a*h + b*i + d*j + a*c*i + a*e*j + b*f*j + a*c*f*i
2	5	h + e*j + c*i + c*f*j
3	5	i + f*j
4	5	j

MODEL

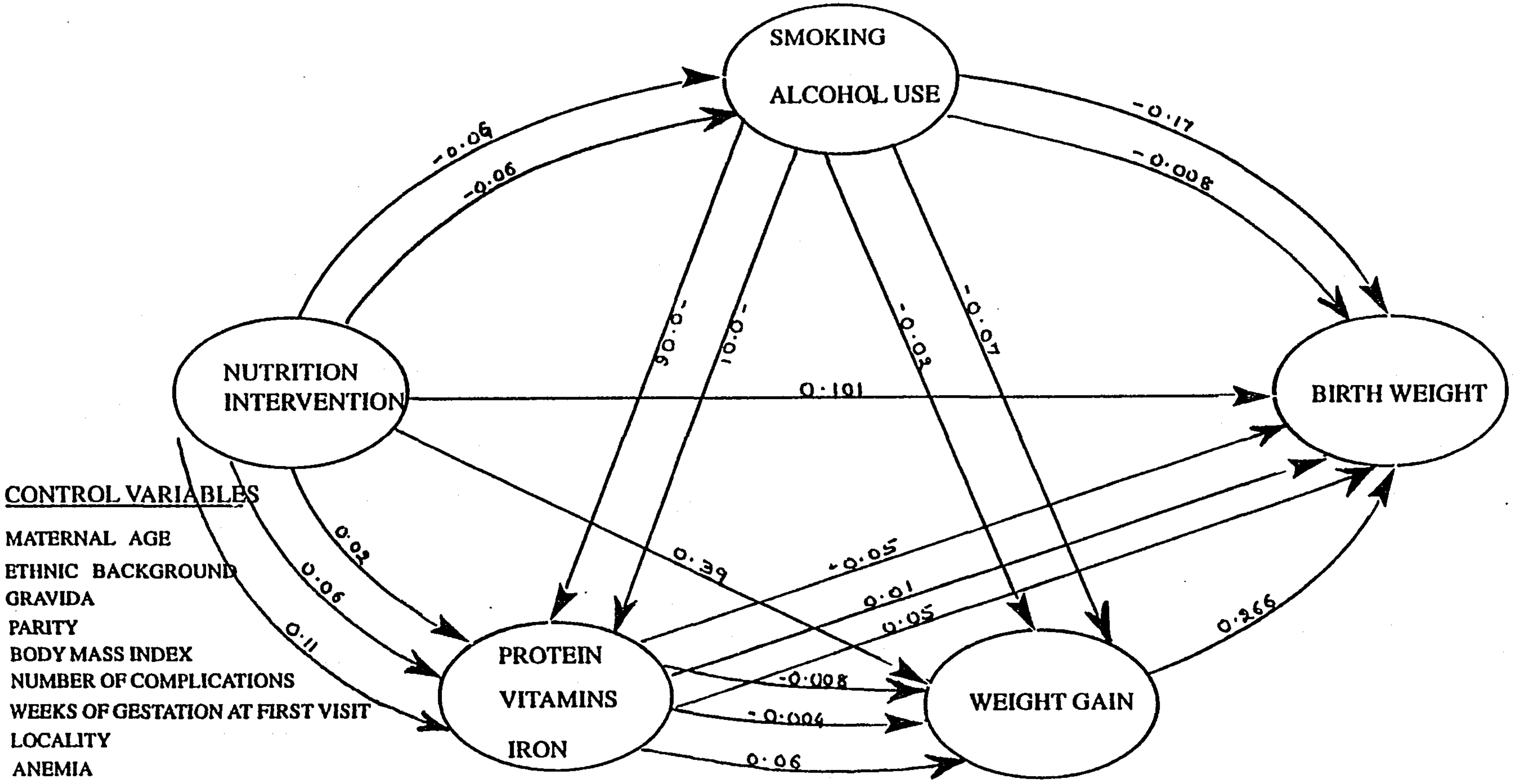


FIGURE 15

The path coefficients in the model for maternal prenatal variables related to birth weight revealed a positive association between nutritional intervention and weight gain, iron intake and birth weight and maternal age, and between weight gain and birth weight, iron intake and birth weight. BMI was negatively associated with birth weight, indicating a lower birth weight of babies by mothers who had higher prepregnancy weight for height. The path from nutritional intervention to birth weight via nutrient intake and weight gain is not strong. Even though a strong association exists between weight gain and birth weight, the link back to nutritional intervention via nutrient intake is not strong. A weak association exists between protein intake and either nutritional intervention or weight gain, indicating that path was not promising. Similarly, a weak association exists between intake of vitamin supplements and either nutritional intervention or weight gain, indicating that path was not promising. However, a moderately strong association exists between intake of iron supplements and either nutritional intervention or weight gain, indicating that the path from nutritional intervention to birth weight via iron intake and weight gain look promising. The path from nutritional intervention to birth weight via health risk behaviors and weight gain looks strong. The path from nutritional intervention to birth weight via smoking and weight gain does look promising. As the number of visits to the nutritionist increased, the smoking habits of respondents decreased, and a decrease in the smoking habit resulted in increase in maternal weight gain. An increase in maternal weight gain resulted in an increase in birth weight of the baby. Thus, a decrease in the smoking habit resulted in an increase in the birth weight of the baby. However, the path from nutritional intervention to birth weight via alcohol use and weight gain does not look promising, because of the weak association that exists between alcohol use and weight gain.

The path from nutritional intervention to birth weight via weight gain looks the strongest. A strong association exists between weight gain and both birth weight and nutritional intervention. As the number of visits to the nutritionist increased, respondents gained more weight, which resulted in an increase in the birth weight of the baby. The path from nutritional intervention to birth weight via health risk behaviors, nutrient intake, and weight gain looks weak as a low association exists between health risk behaviors and nutrient intake and between nutrient intake and weight gain.

Confidence in the model is reinforced because nutritional intervention not only has a direct effect on birth weight of the baby but also influences it through the intervening variables, as was hypothesized. Nutritional intervention influences birth weight through intervening variables, i.e., through health risk behaviors, such as decrease in smoking habit, increase in nutrient intake, i.e., iron supplements, and weight gain, all of which have positive influences on the birth weight of the baby. However, the hypothesis that nutritional intervention will have a positive influence on protein intake and consequently on weight gain and birth weight was not supported in the path analysis.

Table 24 displays the paths for nutritional intervention and birth weight. The strongest path, +0.10, is from nutritional intervention to weight gain to birth weight. Although the remaining six effects are small (none bigger than 0.01), they add up to 0.018. Thus, nutritional intervention influences birth weight in large measure through its contribution to the birth weight.

Table 24. Decomposition of Paths from Nutritional intervention to Birth weight in the Model

			Via	
Path	Coefficients	Health Risk Behaviors	Nutrient Intake	Weight gain
a*h	-0.09*-0.17 = 0.0153	+	-	-
b*f*j	0.11*0.06*0.266 = 0.0017	-	+	-
d*j	0.39*0.266 = 0.1037	-	-	+
b*i	0.11*0.05 = 0.005	-	+	-
a*c*f*j	-0.09*-0.06*0.06*0.266 = 0.00008	+	+	+
a*c*i	-0.09*-0.06*0.05 = -0.002	+	+	-
a*e*j	-0.09*-0.07*0.266 = 0.0016	+	-	+

Total indirect = 0.116

Direct = 0.101

Total = 0.217

OUTCOME OF PREGNANCY: GESTATIONAL AGE

Multivariate regression analysis of number of visits to the nutritionist on gestational age, controlling for other variables are indicated in Table 25. Regression analysis indicated that number of visits to the nutritionist, weight before delivery, number of complications during pregnancy, weight gain during pregnancy, locality, smoking habit, weeks of gestation at first visit, race, protein intake, and sex of the baby are significantly related to the gestational age of the baby ($p < 0.05$). Protein intake and sex of the baby were related to the gestational age of the baby at $p < 0.10$ level of significance. The number of complications during pregnancy had the largest negative effect on the gestational age of the baby (beta = -0.11), followed by mother's smoking (beta = -0.09), protein intake (beta = -0.01), and sex of the baby (beta = -0.05). These results indicate that as the number of complications increased, the incidence of preterm babies increased. Respondents who smoked had more preterm births than those who did not. Male babies had more preterm births than female babies, and respondents with high protein intake had more preterm births than mothers with low protein intake.

The number of visits to the nutritionist had the largest positive effect on the gestational age of the baby (beta = 0.16), followed by weight at the last visit (beta = 0.13), weeks of gestation at first visit (beta = 0.11), weight gain (beta = 0.09), and race (beta = 0.08). These results indicate that as the number of visits to the nutritionist increased, the gestational age of the baby increased. Also, with greater weight gain during pregnancy, the frequency of preterm births was reduced. Weight at last visit

Table 25. Regression of the Gestational age on nutritional intervention, controlling for all other variables.

Variables	Regression Coeff.	SE	BETA	PVALUE
Number of Visit to Nutritionist	0.18	0.04	0.16	.000
Weight at last visit	0.01	0.04	0.13	.004
Number of complications	-0.28	0.07	-0.11	.000
Locality	0.45	0.17	0.08	.007
Weeks of gestation at first visit	0.04	0.01	0.11	.000
Weight gain	0.02	0.008	0.09	.017
Smoke	-0.48	0.17	-0.09	.005
Race	0.38	0.16	0.08	.019
Sex of baby	0.22	0.13	0.04	.086
Protein Intake	-0.004	0.002	-0.05	.073
Parity	0.008	0.109	0.003	.938
Number of Iron supplements	0.16	0.104	0.04	.113
Alcohol	0.64	0.43	0.04	.139
Anemia	0.17	0.16	0.03	.295
Number of vitamin supplements	-0.14	0.234	-0.017	.561
Maternal age	0.007	0.015	0.017	.615
BMI	0.006	0.024	0.012	.794
Gravida	0.025	0.08	0.015	.769
Constant	33.62	1.05		.000
$R^2 = .10$				

F-value =6.79, $p < 0.0001$

NB: $p = .000$ indicates that $p < .0001$

affected gestational age in a positive way. White women had fewer preterm births than non-whites (blacks, hispanics, and others) respondents.

Coefficient of determination (R^2) of the model is 0.10, indicating that only 10 percent of the variance in gestational age was collectively explained by all the independent variables used in the model. The overall model was significant ($F = 6.79$, $p < 0.0001$). The variables that were not significant in the model were maternal age, alcohol intake, anemia, number of vitamin supplements, iron intake, BMI, parity, and gravida.

EFFECTS ANALYSIS

The bivariate (nothing controlled) coefficient for number of visits and gestational age was + 0.174 indicating that the number of visits to the nutritionist was inversely related to preterm births.

When the priors (race, maternal age, gravida, parity, presence of anemia, body mass index, locality, weeks of gestation at first visit, and number of complications) and intervenors (protein intake, iron and vitamin intake, smoking, alcohol intake, and weight gain) were all controlled, the net coefficient was + 0.164. In Lazarsfeldian terms:

Unexplained (net)	+ 0.164	(94.3%)
Explained (0.193-0.101)	+ 0.01	(5.7%)
Total (bivariate)	+ 0.174	100%

When the analysis is elaborated by introducing the 15 test variables, it explained only 5.7% of the association. Thus, most of the association between nutritional intervention and birth weight was not due to the prior and intervening variables in the model but rather between nutritional intervention and gestational age.

An additional run controlling for all priors but not controlling for any intervenors gave the causal effect of nutritional intervention on gestational age. The causal coefficient between nutritional intervention and gestational age was 0.229. The prior variables had a negative effect in this model; hence, controlling for prior variables increased the strength of the relationship between nutritional intervention and gestational age.

The spurious correlation due to prior variables was obtained by subtracting the causal coefficient from the bivariate coefficient (0.174 - 0.229 = -0.055) and the indirect coefficient due to intervening variables was obtained by subtracting the direct coefficient (all test factors controlled) from the causal coefficient (controlling all priors) (0.229 - 0.164 = 0.065). Table 26 indicates the Effects Analysis in tabular form:

Table 26. Effects analysis of gestational age on nutritional intervention

	Controlling		
Effect	All priors	All intervenors	Correlation
(A) Total (bivariate)	no	no	0.174
(B) Causal	yes	no	0.229
(C) Direct	yes	yes	0.164
(D) A-B= Spurious due to priors			-0.055
(E) B-C= Indirect, due to intervenors			0.065

The total effect of visits to the nutritionist on gestational age was + 0.174 all of which was causal plus 0.055 units more which was suppressed due to prior variables used in the model. It is expected that a unit change in nutritional intervention would produce a 0.229 change in the gestational age of the infant, even though the cross-sectional difference is 0.174.

A little more than one-fourth of the causal effect (0.065 of .229 points or 28%) operated via the intervening variables: protein intake, iron and vitamin supplements, smoking, alcohol intake, and weight gain. Sixteen points (95% of the total, 73% of the causal) remained after the intervening variables were controlled. Hence, among babies matched on protein intake, smoke, alcohol, and weight gain, those with mothers with more visits to the nutritionists had babies with higher gestational age. None of the correlations was spurious based on available priors. However, prior variables were suppressor variables and after being controlled in the model, the correlation between nutritional visits and gestational age increased.

Figure 16 indicates the path diagrams with standardized regression coefficients, controlling for prior variables in the model. The path coefficients in the model for maternal prenatal variables related to gestational age revealed a positive association between nutritional intervention and weight gain, iron intake and both gestational age and maternal age, between weight gain and gestational age, and between iron intake and gestational age. The path from nutritional intervention to gestational age via nutrient intake and weight gain is not strong. Even though a strong association exists between weight gain and gestational age, the link back to nutritional intervention via nutrient intake is not strong. A weak association exists between nutritional intervention and protein intake, and protein intake and weight gain indicating that path from nutritional intervention to gestational age via protein intake and weight gain do not look promising.

MODEL

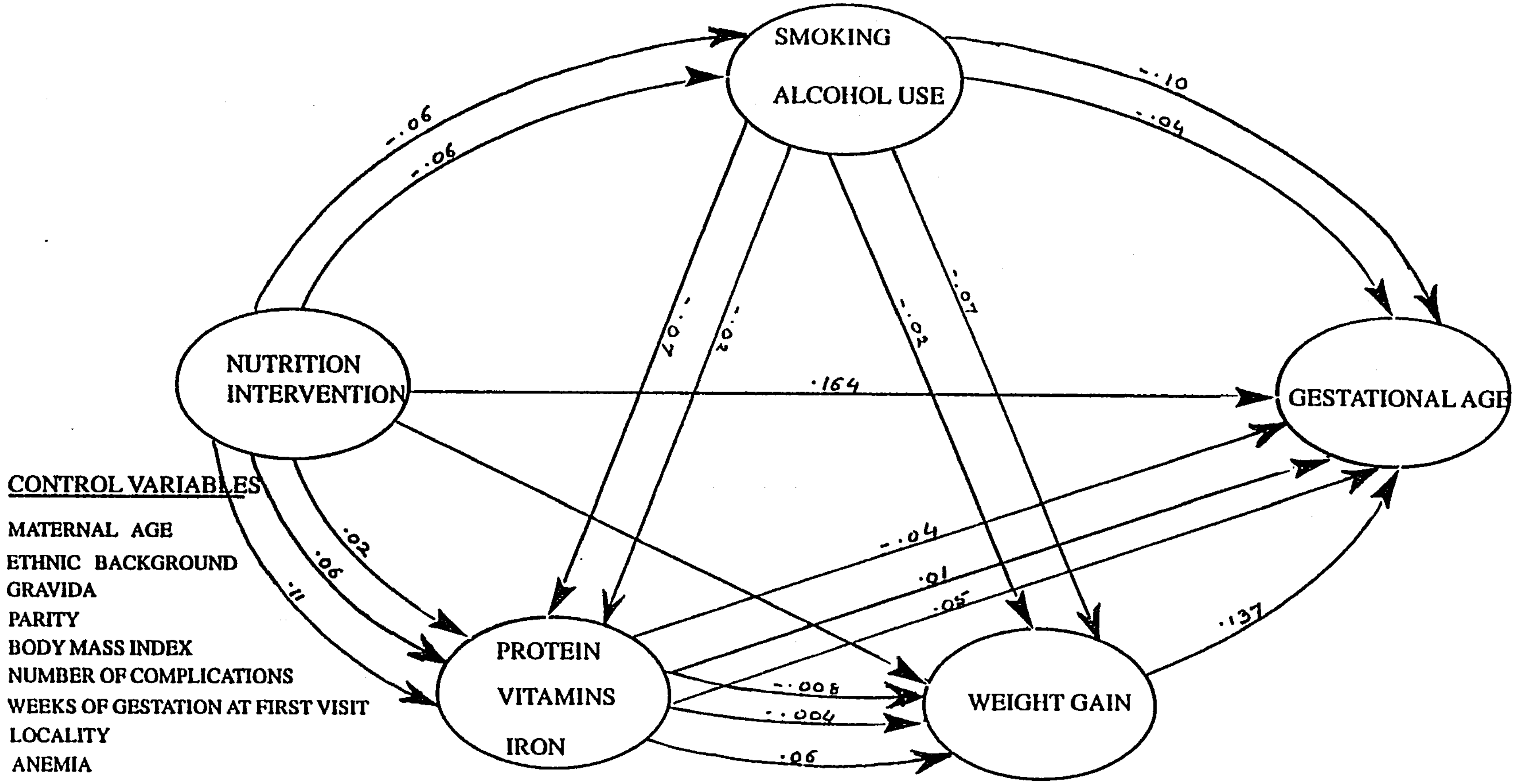


FIGURE 16

Similarly, a weak association exists between intake of vitamin supplements and either nutritional intervention or weight gain, indicating that path was not promising. However, a moderately strong association exists between intake of iron supplements and either nutritional intervention or weight gain, indicating that path from nutritional intervention to birth weight via iron intake and weight gain look promising. The path from nutritional intervention to gestational age via health risk behaviors and weight gain was strong. The path from nutritional intervention to gestational age via smoking and weight gain was promising. As the number of visit to the nutritionist increased, the smoking habits of respondents decreased. A decrease in the smoking habit resulted in an increase in weight gain. Increase in weight gain resulted in an increase in gestational age of the baby. A decrease in the smoking habit also resulted in an increase in the gestational age of the baby. However, the path from nutritional intervention to gestational age via alcohol use and weight gain does not look promising because a weak association (standardized beta = -0.02) exists between alcohol use and weight gain. This may be because very few respondents (2.6%) in this study consumed alcohol during pregnancy.

The path from nutritional intervention to gestational age via weight gain was the strongest. A strong association existed between nutritional intervention and weight gain, and between weight gain and gestational age. As the number of visits to the nutritionist increased, respondents gained more weight, which resulted in an increase in the gestational age of the baby. The path from nutritional intervention to gestational age via health risk behaviors, nutrient intake, and weight gain was weak because a weak association existed between nutrient intake and either health risk behaviors or weight gain.

Confidence in the model was reinforced because nutritional intervention not only had a direct effect on gestational age of the baby but also influenced it through the intervening variables as was hypothesized. Nutritional intervention influenced gestational age through intervening variables, i.e., through health risk behaviors such as a decrease in smoking habit, and increase in nutrient intakes, i.e., iron supplements and weight gain, all of which have positive influences on the gestational age of the baby. However, the hypothesis that nutritional intervention will have a positive influence on protein intake and consequently on weight gain and gestational age was not supported in path analysis.

Table 27 displays the paths for nutritional intervention and gestational age. The strongest path, +0.05, is from nutritional intervention to weight gain to gestational age. Although the remaining six effects are small (none bigger than 0.006), they add up to 0.012. Thus, nutritional intervention influences gestational age through its contribution to the gestational age.

Table 27. Decomposition of Paths from Nutritional intervention to Gestational age in the Model

			Via	
Path	Coefficients	Health Risk Behaviors	Nutrient Intake	Weight gain
a*h	-0.06*-0.10 = 0.006	+	-	-
b*f*j	0.11*0.06*0.137 = 0.0009	-	+	-
d*j	0.39*0.137 = 0.053	-	-	+
b*i	0.11*0.05 = 0.005	-	+	-
a*c*f*j	-0.06*-0.07*0.06*0.137 = 0.00003	+	+	+
a*c*i	-0.06*-0.07*0.05 = -0.0002	+	+	-
a*e*j	-0.06*-0.07*0.137 = 0.0005	+	-	+

Total indirect = 0.065

Direct = 0.164

Total = 0.229

CHAPTER 5

DISCUSSION AND CONCLUSION

Zero-order correlation between birth weight and other prenatal variables indicated a moderately positive association between birth weight and the percent of expected weight, BMI, number of visits to the nutritionist, and weeks of gestation. In other words, respondents with more number of visits to the nutritionist had higher birth weight babies. Increase in weight gain during pregnancy decreased the risk of LBW. Respondents who were overweight had a lower risk of LBW. A high positive correlation (r=0.56) was found between nutritional intervention and weight gain indicating that respondents with more number of visits to the nutritionist gained significantly more weight than those who had less number of visits. The results of this study demonstrate that nutritional intervention for underweight and failure-to-gain pregnant women increases maternal weight gain and infant birth weight.

A moderately negative association was found between birth weight and presence of anemia, complications during pregnancy and smoking during pregnancy. The findings of adverse effects of maternal smoking on the birth weight of the baby is consistent with previous studies. Effects of maternal smoking results in a reduction in birth weight among infants of smokers (Abel, 1980; Berkowitz, 1988; DHEW, 1979; DHHS, 1980). The effect of smoking on birth weight appears to depend on the period of pregnancy when the mother smoked, and, in particular, is more marked for smoking during the last trimester. Butler, Goldstein & Ross (1972) found that smoking after the fourth month of pregnancy was critical in reducing birth weight. Women who stopped smoking during pregnancy gave birth to infants of similar birth weight to those who did not or those who stopped smoking before becoming pregnant (Papoz, 1982; Naeye, 1981; Rush &

Cassano, 1983).

Higher incidence of LBW babies among respondents who had various complications during pregnancy is expected. The complications that were reported by the respondents include frequent conception, having previous LBW babies, weight loss/poor weight gain, anemia, intra uterine growth retardation, and gestational diabetes in the respondents. Studies have found lower birth weights among women with a prior history of LBW (Kennedy, 1982; Rush, 1972). Kennedy (1982) and Rush (1972) reported that a history of prior LBW pregnancy was associated with a decrease of 138.6 and 112.8 g in birth weight respectively. Many studies reported lower birth weights or increased LBW rates among women with short pregnancy intervals (Pachuri & Marwah, 1970; Scholl, 1984; Erickson & Bjerkedal, 1978). Erickson & Bjerkedal (1978) reported lower birth weights for births following a pregnancy interval <1 year. Studies have reported a significant negative effect of low gestational weight gain on gestational age and birth weight (Hingson, 1982; Picone, 1982; Scott, 1981). Horon (1983) reported that gestational weight gain less than or equal to 9.1 kg had an adjusted birth weight that was 120.8 g lower than those with weight gains of 9.5 to 13.6 kg.

A negative association between presence of anemia in the respondents and LBW is consistent with previous studies. Studies have indicated a link between maternal anemia at full term and low birth weight (Lieberman, Ryan, Monson & Schoenbaum, 1987; Macgregor, 1963), but interpretation of the results is complicated by the fact that the hemoglobin concentration normally rises in the third trimester of pregnancy if sufficient iron is available (Puolakka, Janne, Pakarinen, and Vihko, 1980; Taylor, Mallen, McDougall and Lind, 1982). An association between a low maternal hemoglobin concentration at delivery and low birth weight can be expected since lower hemoglobin values are characteristic of an earlier stage of gestation.

Gestational age was positively associated with number of visits to nutritionist, birth weight, percent of expected weight, body mass index, number of iron supplements taken, and weight gain. Positive correlation between consumption of iron supplement and gestational age is consistent with the results of Hingson (1982). Iron supplementation in the prenatal period could be beneficial, especially for women having iron-deficiency anemia. Positive correlation between nutritional intervention and gestational age indicates that respondents with more visits had a lower incidence of preterm births. Respondents who had a higher weight gain and those who gained the desirable weights for gestational age had a lower risk of preterm births. This result is consistent with Berkowitz (1981) and Miller & Merritt (1979) who had reported a positive effect of gestational weight gain on gestational age. Respondents with higher BMI had lower incidence of preterm births. This is consistent with results of Hingson (1982) which has reported a positive correlation between pre-pregnancy weight and gestational age.

Gestational age was negatively associated with anemia of mother, and presence of complications during pregnancy. When the lowest hemoglobin concentration during any stage of pregnancy is below 10.0 g/dl, the likelihood of low birth weight, preterm birth, and perinatal mortality increases. A greater risk of prematurity among respondents that reported complications during pregnancy is consistent with previous results. Guzick (1984), Kaminski (1973), and Mamelle (1984) found an increased risk of prematurity among women with a prior history of premature infants. Guzick (1984) also reported an increased risk for preterm births among those respondents who had a history of prior spontaneous abortion.

A strong association found between age and parity in urban and rural areas is expected as primiparae tend to be younger than multiparae. This relationship attained significance for blacks, whites, and those in the other category but not for hispanics in urban areas and for blacks and whites in rural areas. In general respondents with high parity had higher incidence of LBW babies. The association between parity and birth weight was significant in both rural and urban areas. However, when age was controlled, the association between parity and birth weight was significant for only the 20 to 29 years age group both in urban and rural areas.

Higher percentages of respondents in the older age group were multiparous and in the adolescent age group were primiparous. Percentage of births to high parity mothers accounted for only 12.2% in urban areas and 5.4% in rural areas. High parity births accounted for only 8.2% of black and 8.9% of whites births in urban areas. Percentage of high-parity births has reduced substantially among white and blacks in the United States from 1960 to 1985 (National Center for Health Statistics, 1990) and the results of this study indicates that the trend continues. However, Hispanics and other racial groups in this sample had higher percentage of high parity births compared to Blacks and Whites (12.5% and 22.5% respectively). In the rural areas high parity births accounted for only 5.2% of black and 5.0% of White births. Here also, respondents in the other racial group category had a higher percentage of high-parity births (10%) compared to Blacks and Whites.

The risk of delivering a LBW infant was highest for underweight women (BMI < 19.8) in rural and urban areas. This is consistent with the findings of Kim, Hingerford, Yip, Kuester, Zyrkowski, & Trowbridge (1992) which reported underweight women LBW infant for under weight women is about 1.5 times higher than for women who are normal weight. They also had the highest risk for delivering preterm babies.

Blacks had a significantly increased risk of prematurity and LBW infants than whites in urban areas. Especially, incidence of LBW babies was high among black adolescents. This result is consistent with previous studies (Horon, 1983; Showstack, 1984). Association between race and gestational age was significant in urban areas but not in rural areas. A lack of significant association found between the respondents' age groups and gestational age in both rural and urban areas is as expected. Studies have found that age had no significant effect on mean gestational age and no altered risk for prematurity (Polednak, 1982; Berkowitz, 1981; Miller & Merritt, 1979). However, when controlled for the racial groups, a significant association was found among hispanics in urban areas and for those in the other category in rural areas.

There was no significant difference in birth weight between the different age groups, but when controlled for ethnic origin, this relationship was significant for blacks in urban areas. Significant differences in the incidence of prematurity was found between the different racial groups in urban areas but not in the rural areas. Preterm births were generally higher among adolescents in urban areas.

No significant association between protein intake and birth weight or gestational age indicates that increased dietary protein intake did not have an impact on decreasing the incidence of LBW and preterm births. This is inconsistent with previous studies which had found a significant positive correlation between protein intake and birth weight (Metcoff, 1981). The reason why protein intake was not significantly associated with birth weight may be due to a measurement error. As the procedure goes, the nutritionist calculates the amount of protein consumed by the respondent based on the average amount of food consumed estimated from a 24 hour Dietary recall. Needless to say, measurement error can occur during the dietary recall, type and amount of food consumed, and in the calculation of protein from the foods consumed.

The sex ratio in the infants was almost the same in both urban and rural areas (1:1). The sex of the infant had no effect on gestational age or prematurity. This is consistent with previous studies which found that the sex of the infant had no effect on gestational age (Spiers & Wacholder, 1982; Saugstad, 1981; Niswander, 1977; WHO, 1980). No significant association between maternal age and birth weight & gestational age in this study is also consistent with previous studies.

Regression analysis indicated that when prior and intervening variables in the model were controlled, nutritional intervention was positively associated with birth weight. The variables that were significant in the model were weight of the respondent at last visit, number of complications during pregnancy, smoking habit, race, parity, protein intake, number of iron supplements, weeks of gestation at first visit, and sex of the baby. The number of complications during pregnancy had the largest negative impact on the birth weight of the baby followed by mother's smoking, protein intake, and sex of the baby. The number of complications increased the risk for LBW among the respondents. Respondents who smoked had a higher risk of LBW. Female babies had a greater incidence of low birth weight as compared to male babies. Previous studies also found males had a higher birth weight and lower risk of IUGR (Hingson, 1982). Respondents with high protein intake had LBW as compared to low protein intake. Previous studies have also noted a lower mean birth weight among mothers who received, on average, a protein supplement above their normal intake (Rush, 1980; Osofsky, 1975).

Weight at last visit had the largest positive impact on the birth weight of the baby. Respondents who attained their desirable weight gain by the end of the pregnancy were more likely to deliver full-term normal infants. Whites had higher birth weight babies as compared to non whites (blacks, hispanics, and others), and respondents who took iron supplements during pregnancy had higher birth weight babies as compared to those who did not. Coefficient of determination (R^2) of the model was 0.19 indicating that only 19 percent of the variance in birth weight was explained by all the independent variables used in the model. The low R^2 of the model may be due to many factors that can impact birth weight of the baby which were not controlled in this study. These are demographic factors (socioeconomic status, income, educational level, marital status), nutritional factors (caloric intake, energy expenditure, and physical activity), Obstetric factors (pregnancy interval, intrauterine growth and gestational duration in prior pregnancies, prior stillbirth or neonatal death) and toxic exposures (caffeine and coffee consumption, drug use), which can impact pregnancy outcomes.

Regression analysis of gestational age on nutritional intervention controlling for other variables in the model indicated a positive association between the two variables. More visits to the nutritionist decreased the risk of preterm births. The variables that were significant in the model were weight at last visit, number of complications during pregnancy, weight gain during pregnancy, locality, smoking habit, weeks of gestation at first visit, race, protein intake, and sex of the baby. Number of complications during pregnancy had the largest negative impact on the gestational age of the baby, followed by maternal smoking, protein intake, and sex of the baby. Respondents having more complications had an increased risk of preterm births. Respondents who smoked had an higher incidence of preterm births as compared to those who did not. This is consistent with previous studies which found maternal smoking during pregnancy to be at moderately increased risk of preterm delivery (Fedrick & Anderson, 1976; Meyer et al, 1976). Respondents in urban areas had higher LBW babies than rural areas, and respondents with lower weight gain had a greater risk of preterm births. Studies have reported that a high gestational weight gain reduces the rate of prematurity (Miller & Merritt, 1979). Whites had a lower risk of preterm births as compared to blacks, hispanics and other racial groups and respondents who were seen by the nutritionist for a longer period had a lower risk of preterm births. Respondents in urban areas had a higher risk of preterm births than rural areas. This is expected as urban areas have a higher incidence of LBW and infant and neonatal deaths both in the State of Virginia and USA. However, controlling for other variables in the regression model, no significant difference in the risk of LBW was found among respondents in the rural and urban areas.

Coefficient of determination (R^2) of 0.10 indicated that only 10 percent of the variance in gestational age was collectively explained by all the independent variables used in the model. Thus there are many factors that might influence the duration of gestation that were not included in this study. Some of these factors are obstetric factors, demographic and psychosocial factors, and nutritional factors and toxic exposures.

The effects analysis indicates a causal relationship between nutritional intervention and birth weight of infants, and nutritional intervention and gestational age. Effects analysis of both the outcome variables indicate that intervening variables accounted for a significant amount of the causal effect (53% for birth weight and 28% for gestational age). Some of the cross-sectional correlation is spurious due to prior variables (12% for birth weight and 31% for gestational age). So most of the causal effect between the nutritional intervention and outcome variable(s) operates indirectly via intervening and prior variables. This increases our confidence in the present model as the indirect effects of nutritional intervention hypothesized through decrease in health risk behaviors and increase in nutrient intake and weight gain was supported by the present study.

However, the path diagram for both the outcome variables indicated that the hypothesized path from nutritional intervention to outcome variables(s) via nutrient intake and weight gain was not present. Even though a strong association existed between weight gain and outcome variables, the link back to nutritional intervention via nutrient intake was very weak. A weak association (negative) existed between nutrition intervention and protein intake, and protein intake and weight gain. Similarly the link between nutritional intervention to weight gain via intake of vitamin supplements was very weak. However, the link between nutritional intervention to weight gain via intake of iron supplements existed indicating that nutritional intervention can have a positive impact on the pregnancy outcomes among the respondents by an increase in the intake of iron supplements (there by decreasing the risk of anemia), weight gain, and consequently pregnancy outcomes. The path from nutritional intervention to birth weight via health risk behaviors and weight gain was strong. Nutritional intervention decreased the prevalence of smoking among the respondents which had a positive impact on weight gain and pregnancy outcomes. Decrease in the smoking habit also resulted in an increase in birth weight of the baby. However, the path from nutritional intervention to birth weight via alcohol use and weight gain was not promising as a weak association existed between alcohol use and weight gain.

The path from nutritional intervention to pregnancy outcomes via weight gain was the strongest. As the number of visits to the nutritionist increased, respondents gained more weight which resulted in normal, full-term births. The path from nutritional intervention to outcome variables via health risk behaviors, nutrient intake, and weight gain looks weak as the link between health risk behaviors and nutrient intake and between nutrient intake and weight gain is non existent. The hypothesis that nutritional intervention will have a positive influence on protein intake and consequently on weight gain and birth weight was not supported in the path analysis. The reason protein intake did not have any influence in the model may be due to a measurement error as has been indicated above.

Nutritional intervention had a greater impact on the pregnancy outcome birth weight than on gestational age. Weight gain had a positive association with gestational age indicating that respondents with lower weight gain had an increased risk of preterm babies. This result is convergent with the result of Berkiwitz (1981) who reported a four fold increased risk of preterm delivery in women with inadequate weight gain compared with that in women with adequate weight gain. The overall regression model was significant for both the outcomes, birth weight and gestational age. Although the overall model was significant for gestational age very little variance was explained (10%) in the model. A study by Mitchell & Lerner did not find a significant relationship between gestational age and prenatal variables. The reason why the model in the present study might have attained statistical significance may be due to the large sample size since statistical significance is a function of sample size. In both the models, a negative association was found between the two outcome variables and smoking habits, race, and parity. A positive association was found between the outcome variables and weight gain, nutritional intervention and maternal age.

Results of this study is convergent with other studies that have found a positive impact of four or more visits to the dietitian with birth weight of babies (Higgins et al, 1989). Nutrition assessment and intervention in pregnancy is an essential part of adequate prenatal care. Prenatal nutrition care services should be available to identify women at nutritional risk, to provide nutritional care in the form of counseling, and to monitor and treat nutrition related risk factors that lead to poor pregnancy outcome.

RECOMMENDATIONS

The positive influence of nutrition on pregnancy outcome has long been recognized. However, little attention has been paid to the management of pregnant women, particularly the higher-risk women i.e., the underweight or failure-to-gain pregnant women, concerning their nutritional needs. These women need careful dietary counseling and follow-up to help achieve desired weight gain and favorable pregnancy outcomes. Interventions should be specific for this high-risk population and aimed at quantitatively modifiable determinants of pregnancy outcomes like anti-smoking efforts, delayed child-bearing in young adolescents, improved maternal education, selective improvements in nutrition, and socioeconomic conditions. Public health authorities also need to consider issues such as cost-effectiveness, acceptability by different ethnic groups, and political feasibility while planning any intervention program.

Cigarette smoking is a major modifiable factor responsible for adverse pregnancy outcomes. Thus, successful efforts to convince mothers to stop or reduce cigarette smoking will reduce the incidence of LBW in this high-risk population. As indicated by this study, nutrition intervention decreased the smoking behavior among the respondents during pregnancy. Nutritional intervention, especially if begun early in gestation, could reduce the risk of LBW and preterm births, and improve the outcomes. Strategy should be made to provide prenatal care early in pregnancy since these women are at high-risk for delivering LBW and preterm infants. As indicated by this study, the average weeks of gestation at first vist to the clinic was eighteen weeks in rural areas and twenty weeks in urban areas. Providing intervention early during pregnancy can help in reducing negative pregnancy outcomes in this population.

During pregnancy a women may be particularly receptive to guidance regarding behaviors that may influence her health and that of her developing fetus. Guidance and counseling regarding a healthy diet will promote adequate weight gain. A comprehensive initial prenatal examination will help to set the desirable gestational weight gain and the rate of gain for the respondents according to their BMI, balanced diet consistent with ethnic, cultural and financial considerations. Periodic prenatal care will allow health care workers to identify potential problems and provide early interventions.

These findings suggest that the aid of an nutritionist to provide nutrition counseling and follow-up to pregnant women can have a positive outcome. Generalization of the results from this study are limited to a population that is at risk and participants of NIP program. Results of this study should be used to improve nutrition intervention which will translate into healthier infants and cost savings to the health care system.

SUGGESTIONS FOR FUTURE RESEARCH

The present study examined the effects fo nutritional intervention on the outcomes of pregnancy. There are many factors that were not controlled in this study that influences pregnancy outcomes. These include demographic and psychological factors like socio economic status, education, occupation and income of the respondents, marital status, maternal psychological factors (stressful life changes and events, anxiety, mental illness, and unwanted pregnancy); obstetric factors like pregnancy interval, intra uterine growth retardation (IUGR), and history of prior spontaneous abortion/still birth; and toxic exposures like use of drugs and caffeine. An investigation of nutritional intervention on pregnancy outcomes controlling for these variables would be valuable in determining the influence of nutritional intervention on the pregnancy outcomes.

The present research was for designed for pregnant women who were at-risk for delivering LBW and preterm babies. Nutritional intervention with the pregnant women in general will increase the understanding of the effect of nutritional intervention on the outcomes of pregnancy. Generalizability of the results will be increased if consistent results are found in the general population as well.

This study examined the effect of nutritional interventin on the birth weight of the baby and gestational age, both of which are short-term outcomes. A study of the effect of nutritional intervention on long-term health outcomes like mortality and morbidity of the infant, growth and performance of the baby, as well as nutritional status of the mother, lactation performance and illness of mother will provide further understanding to the topic.

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TABLE 8

TABLE OF STANDARD WEIGHT FOR HEIGHT FOR WOMEN
(Height Without Shoes)

Height Without Shoes	Standard Weight	Underweight 90% Standard Weight	Overweight 120% Standard Weight	Obese 135% Standard Weight
4'9"	104	94	125	140
4'10"	107	96	128	144
4'11"	110	99	132	148
5'0"	113	102	136	153
5'1"	116	104	139	157
5'2"	118	106	142	159
5'3"	123	111	148	166
5'4"	128	115	154	173
5'5"	132	119	158	178
5'6"	136	122	163	184
5'7"	140	126	168	189
5'8"	144	130	173	194
5'9"	148	133	178	200
5'10"	152	137	182	205
5'11"	156	140	187	211
6'0"	160	144	192	216

Division of Public Health Nutrition
State Department of Health
Richmond, Virginia
October, 1990

APPENDIX A1

24-HOUR DIET RECALL

NAME ______________________ AGE __________ HEAD START __________

VITAMIN SUPPLEMENT: Yes________ No ________ School Breakfast ______ Lunch ______

Record all food and beverages consumed in the past 24 hours, including amounts, time, and method of preparation.

Evaluate above recall by counting each serving of the following groups:

FOOD GROUP	Child 1-3	Child 4-6	Pregnant Teenager	Pregnant Woman	Adult	Lactating Woman	Servings Eaten	Servings Lacking
(First food named is the standard serving size)	DAILY RECOMMENDED SERVINGS							
MILK - equivalents of 288 mg. Ca. & 8 gm. protein 1 cup milk — 1½ cup ice cream, pudding 2 slices cheese — 1 cup yogurt 1¾ slices cube cheese — 1½ cup cottage cheese ¾ cup custard — 1 (3¾ oz.) can sardines	2-3 (16-24) oz.	2-3	4	4	2 4 non-pregnant teen	4		
MEAT - equivalents of 14 gm. protein 2 oz. meat, fish, poultry — 2 slices cheese 4 slices bologna 4 T. peanut butter — ½ cup cottage cheese 2 eggs — 6 oz. tofu	Two ½ size servings	Three ½ size servings	4	3-4	2-3	2-3		
VEGETABLES & FRUIT *Vitamin A equivalents 4000-5000 IU* ½ cup greens — 1 cup broccoli ½ cup spinach — 1 cup apricots ½ cup carrots — 1 cup cantaloupe ½ cup sweet potatoes — (¼ medium) ½ cup mixed vegetables — 2 cups tomatoes	½ serving	½ serving	1	1	1	1		
Vitamin C equivalents of 60 mg. ½ cup orange juice, grapefruit juice ½ cup fortified pineapple juice 1 orange — 1 grapefruit ½ cantaloupe 2 tomatoes — 1½ cup tomato juice ½ cup broccoli, brussels sprouts 1 cup cabbage (raw)	1 serving	1 serving	2	2	1	2		
Other fruit or vegetables	Two ½ size servings	2	2	2	2	2		
BREAD & CEREAL - 70 Kcal equivalents & 2 gm. protein 1 slice bread — ½ English muffin ½ cup cooked rice — 4" pancake ¾-1 cup dry cereal — 1 biscuit 5 crackers — corn bread 1½" x 2" x 1½" ½ frozen waffle — ½ cup cooked cereal, grits ½ hot dog or hamburger bun ½ cup cooked macaroni, spaghetti, noodles	Four ½ size servings	4	4	4	4	4		

If a fraction of the above amounts were eaten, count as that fraction of a serving. Total Lacking ________

holic Beverages ______________________ Non-food items eaten (paint, clay, etc.) ______________________

Evaluation: Document if more than 3 servings missing, all of one food group missing, nutrient deficiencies, excess fat, sugar, salt, omission of 2 meals/day, inappropriate patterns, pica, etc.________________________________

____

____

________ (Date) ________________ (CPA) ________ (Title)

WIC 329 (Revised 4/91)

APPENDIX A2

Dietary History Worksheet
Food Frequency List

Name ______________________

B d ______________________

How Often Do You Eat These Foods?	Times Day or Week (SPECIFY)	Usual Daily Amount		Grams Protein Daily
Milk and Yogurt, Type			Cups, Fluid	
Cheese, Type (s)			oz.	
Ice Cream and Puddings				
Sardines				
Meats, Fish, Poultry			oz.	
Eggs			no.	
Tofu			oz.	
Peanut Butter			oz.	
Dried Beans & Peas			oz.	
Breakfast Cereal				
Spaghetti, Macaroni, Noodles, Rice, Grits, Yock				
Bread, Types				
Crackers			servings	
Greens, Broccoli				
Carrots, Sweet Potatoes				
Canteloupes, Apricots			servings	
Citrus Fruits & Juices				
Vitamin C Fortified Juices				
Cabbage, Brussel Sprouts			servings	
Tomatoes				
All other, including Potato			servings	
	Total, Fruit & Vegetables		servings	
Any Other: Chips, Sweets				
Soda, Kool Aid				
		Total Protein		

		Absolute Alcohol			Absolute Alcohol
Beer	12 oz.	1/2 oz.			
Wine	5 oz.	1/2 oz.			
Hard Liquor	1 1/2 oz.	1/2 oz.			oz./da

Evaluation Using 24 hour recall and Food Frequency List

Protein ________ grams daily		Vitamin B12 Rich Servings	________ daily (Min.4)	
Vitamin C Rich Servings ________ daily (min.1)		Calcium Rich Servings	________ daily (min.4)	
Low Nutrient Density Calories	Low	Moderate	High	
Total Calories	Low	Moderate	High	

Date ________________ Interviewer ________________________

Nutr003 1984

APPENDIX A3

Virginia Department of Health

Prenatal Weight Grid

Date ____________________

Name ____________________

Age ____________________

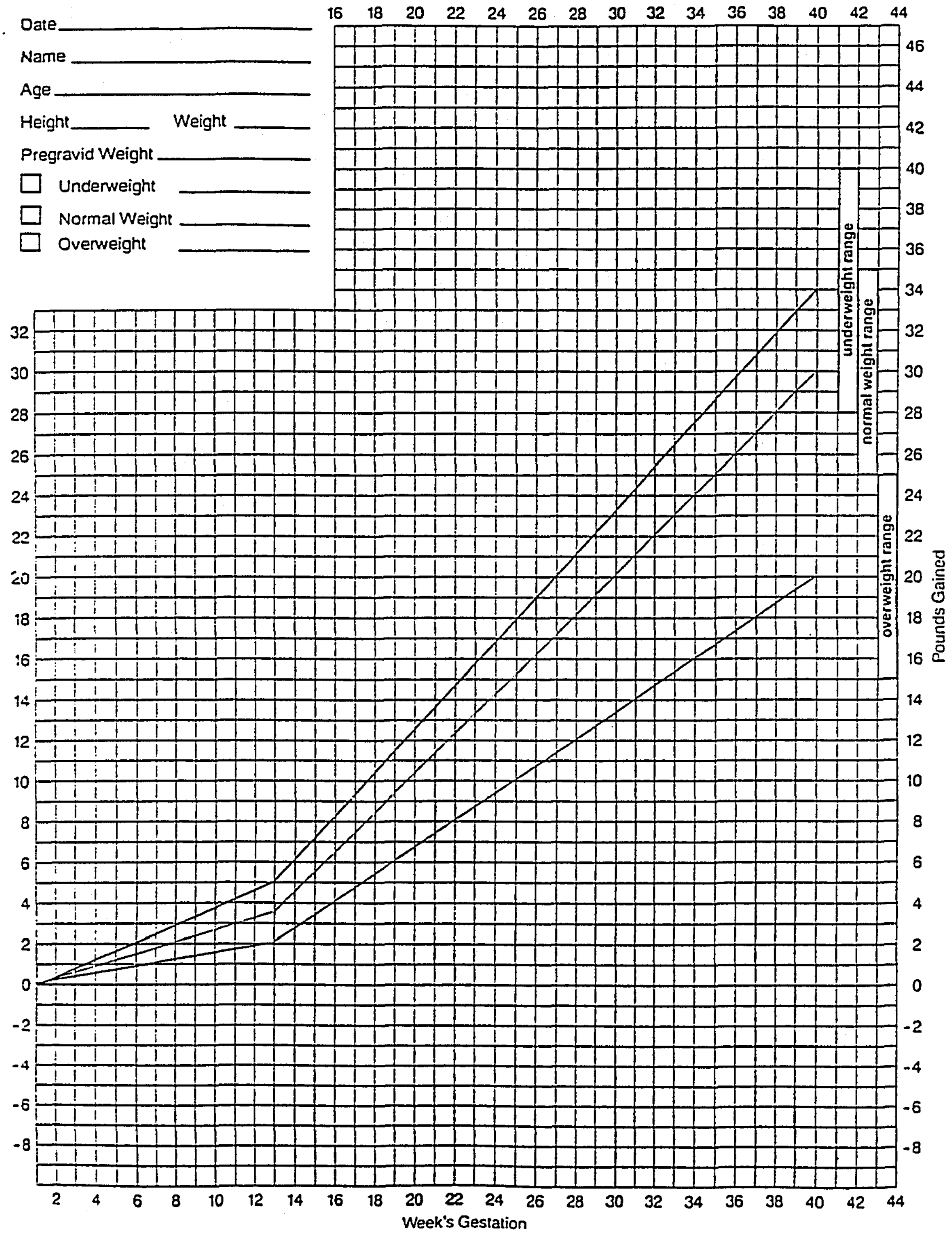
Height ________ Weight ________

Pregravid Weight ________________

☐ Underweight __________

☐ Normal Weight __________

☐ Overweight __________



APPENDIX A4

Perinatal Nutrition Project Master Tracking Form (NutrUU6)

I.D. 1	Age at Conception 2	Race 3	G P 4	Height Frame S M L 5	Weight 1st v. Wks. gest % E.W. 6	Weight Mid v. Wks. gest. % E.W. 7	Weight last v. Wks. gest. % E.W. 8	Protein 1st v. mid v. last v. 9	Smoking 1st v. mid v. last v. 10	Alcohol 1st.v. mid v. last v. 11	On WIC 12	Compli- cations 13	No. visits to Nutr. 14	Birth weight Wks. gest. 15	Sex 16

APPENDIX A5

Nutrition Intervention Tracking Sheet

District ______________________ Clinic Site ______________
Name ____
Birthdate ______________________ ID # ______________
Standard Weight ______________________ Phone ______________

	Age at Conception	Race	Gravida	Para	Height	Pre-Pregnancy Weight		EDC
Date								
Weeks Gestation								
Weight								
% Exp. Weight								
Protein Intake Gms								
Smoking Amt. No. Per Day								
Alcohol Avg. Amt. Day								
Vitamin Supp. Name & Amt.								
On WIC Yes -- No								
Complications Specify								
Hbg.								
Hct.								
Breastfeed?								
Scheduled Return to Nutritionist								
Signature								
		# Nutrition Visits	Date of Delivery	Wt. Last Visit	Birthweight	Gestational Age at Delivery		Sex

a. State Health Dept.
CHS-7 Rev 10/78

FLOW SHEET

APPENDIX B

JURISDICTION	BEALE	PLANNING DISTRICT NAME
Accomack County	7	Eastern Shore
Albemarle County	3	Thomas Jefferson
Alexandria City	0	Northern Virginia
Alleghany County	6	Fifth
Amelia County	8	Piedmont
Amherst County	3	Central Virginia
Appomattox County	8	Central Virginia
Arlington County	0	Northern Virginia
Augusta County	4	Central Shenandoah
Bath County	9	Central Shenandoah
Bedford City	3	Central Virginia
Bedford County	3	Central Virginia
Bland County	9	Mount Rogers
Botetourt County	3	Fifth
Bristol City	2	Mount Rogers
Brunswick County	8	Southside
Buchanan County	9	Cumberland Plateau
Buckingham County	8	Piedmont
Buena Vista City	5	Central Shenandoah
Campbell County	3	Central Virginia
Caroline County	3	RADCO
Carroll County	7	Mount Rogers
Charles City County	2	Richmond Regional
Charlotte County	3	Piedmont
Charlottesville City	3	Thomas Jefferson
Chesapeake City	0	Southeastern Virginia
Chesterfield County	2	Richmond Regional
Clarke County	4	Lord Fairfax
Clifton Forge City	5	Fifth

JURISDICTION	BEALE	PLANNING DISTRICT NAME
Colonial Heights City	2	Crater
Covington City	6	Fifth
Craig County	8	Fifth
Culpeper County	1	Rappahannock-Rapidan
Cumberland County	8	Piedmont
Danville City	3	West Piedmont
Dickenson County	9	Cumberland Plateau
Dinwiddie County	2	Crater
Emporia City	6	Crater
Essex County	8	Middle Penninsula
Fairfax City	0	Northern Virginia
Fairfax County	0	Northern Virginia
Falls Church City	0	Northern Virginia
Fauquier County	1	Rappahannock-Rapidan
Floyd County	8	New River
Fluvanna County	3	Thomas Jefferson
Franklin City	6	Southeastern Virginia
Franklin County	6	West Piedmont
Frederick County	4	Lord Fairfax
Fredericksburg City	0	RADCO
Galax City	7	Mount Rogers
Giles County	9	New River
Gloucester County	1	Middle Penninsula
Goochland County	2	Richmond Regional
Grayson County	9	Mount Rogers
Greene County	3	Thomas Jefferson
Greensville County	6	Crater
Halifax County	6	Southside
Hampton City	0	Peninsula

JURISDICTION	BEALE	PLANNING DISTRICT NAME
Hanover County	2	Richmond Regional
Harrisonburg City	5	Central Shenandoah
Henrico County	2	Richmond Regional
Henry County	4	West Piedmont
Highland County	9	Central Shenandoah
Hopewell City	2	Crater
Isle of Wight County	1	Southeastern Virginia
James City County	0	Peninsula
King and Queen County	8	Middle Penninsula
King George County	1	RADCO
King William County	6	Middle Penninsula
Lancaster County	9	Northern Neck
Lee County	9	LENOWISCO
Lexington City	6	Central Shenandoah
Loudoun County	1	Northern Virginia
Louisa County	8	Thomas Jefferson
Lunenburg County	9	Piedmont
Lynchburg City	3	Central Virginia
Madison County	8	Rappahannock-Rapidan
Manassas City	0	Northern Virginia
Manassas Park City	0	Northern Virginia
Martinsville City	4	West Piedmont
Matthews County	1	Middle Penninsula
Mecklenburg County	7	Southside
Middlesex County	8	Middle Penninsula
Montgomery County	4	New River
Nelson County	8	Thomas Jefferson
New Kent County	2	Richmond Regional
Newport News City	0	Peninsula

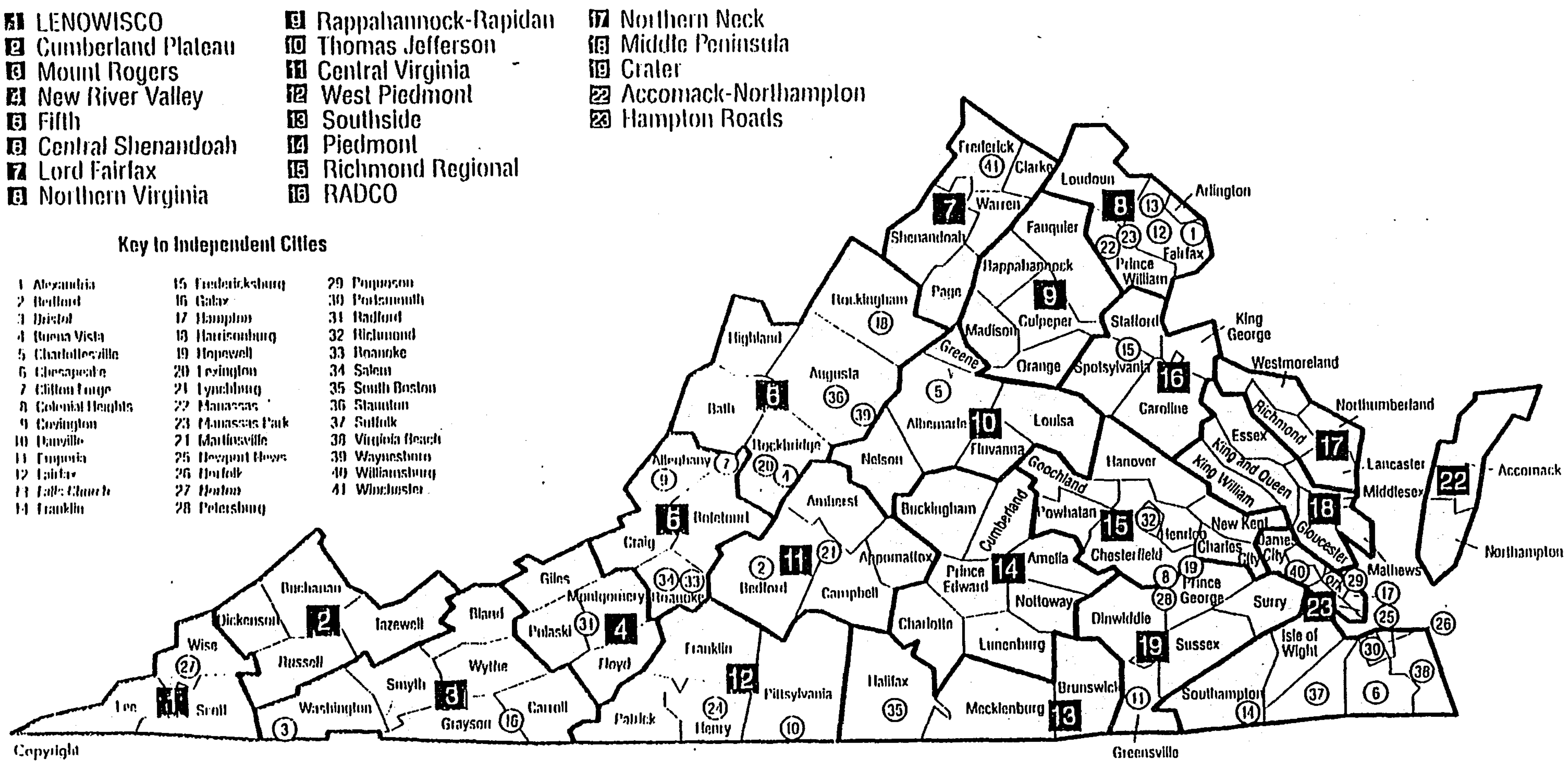
JURISDICTION	BEALE	PLANNING DISTRICT NAME
Norfolk City	0	Southeastern Virginia
Northampton County	9	Eastern Shore
Northumberland County	9	Northern Neck
Norton City	7	LENOWISCO
Nottoway County	6	Piedmont
Orange County	6	Rappahannock-Rapidan
Page County	6	Lord Fairfax
Patrick County	9	West Piedmont
Petersburg City	2	Crater
Pittsylvania County	3	West Piedmont
Poquoson City	0	Peninsula
Portsmouth City	0	Southeastern Virginia
Powhatan County	2	Richmond Regional
Prince Edward County	7	Piedmont
Prince George County	2	Crater
Prince William County	0	Northern Virginia
Pulaski County	7	New River
Radford City	4	New River
Rappahannock County	8	Rappahannock-Rapidan
Richmond City	2	Richmond Regional
Richmond County	9	Northern Neck
Roanoke City	3	Fifth
Roanoke County	3	Fifth
Rockbridge County	6	Central Shenandoah
Rockingham County	5	Central Shenandoah
Russell County	6	Cumberland Plateau
Salem City	3	Fifth
Scott County	2	LENOWISCO
Shenandoah County	6	Lord Fairfax

JURISDICTION	BEALE	PLANNING DISTRICT NAME
Smyth County	6	Mount Rogers
South Boston City	6	Southside
Southampton County	6	Southeastern Virginia
Spotsylvania County	0	RADCO
Stafford County	1	RADCO
Staunton City	4	Central Shenandoah
Suffolk City	0	Southeastern Virginia
Surry County	8	Crater
Sussex County	8	Crater
Tazewell County	7	Cumberland Plateau
Virginia Beach City	0	Southeastern Virginia
Warren County	1	Lord Fairfax
Washington County	2	Mount Rogers
Waynesboro City	4	Central Shenandoah
Westmoreland County	6	Northern Neck
Williamsburg City	0	Peninsula
Winchester City	4	Lord Fairfax
Wise County	7	LENOWISCO
Wythe County	7	Mount Rogers
York County	0	Peninsula

Virginia Planning District Commissions (PDCs)

☐ RURAL

☐ URBAN



1 LENOWISCO
2 Cumberland Plateau
3 Mount Rogers
4 New River Valley
5 Fifth
6 Central Shenandoah
7 Lord Fairfax
8 Northern Virginia
9 Rappahannock-Rapidan
10 Thomas Jefferson
11 Central Virginia
12 West Piedmont
13 Southside
14 Piedmont
15 Richmond Regional
16 RADCO
17 Northern Neck
18 Middle Peninsula
19 Crater
22 Accomack-Northampton
23 Hampton Roads

Key to Independent Cities

1	Alexandria
2	Bedford
3	Bristol
4	Buena Vista
5	Charlottesville
6	Chesapeake
7	Clifton Forge
8	Colonial Heights
9	Covington
10	Danville
11	Emporia
12	Fairfax
13	Falls Church
14	Franklin
15	Fredericksburg
16	Galax
17	Hampton
18	Harrisonburg
19	Hopewell
20	Lexington
21	Lynchburg
22	Manassas
23	Manassas Park
24	Martinsville
25	Newport News
26	Norfolk
27	Norton
28	Petersburg
29	Poquoson
30	Portsmouth
31	Radford
32	Richmond
33	Roanoke
34	Salem
35	South Boston
36	Staunton
37	Suffolk
38	Virginia Beach
39	Waynesboro
40	Williamsburg
41	Winchester