EFFECT OF WIC PROGRAM PARTICIPATION ON PREGNANCY OUTCOME OF KANSAS TEENAGERS

by

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INTRODUCTION

Nutrition has an important role in reproductive performance. A woman who is well-nourished at conception and whose diet contains the quantity, quality, and balance of nutrients to meet the increased requirements of pregnancy is likely to have fewer complications during pregnancy and delivery, to produce a healthier infant, and to be in better physical condition following delivery than a woman whose nutritional state is marginal or inadequate (1). Biological and sociodemographic factors also interact with maternal nutrition to influence the reproductive process. Nutritional guidance during pregnancy is important for all women. However, particular emphasis should be given to those women who are in poor nutritional status when they conceive, and whose circumstances hinder their ability to obtain adequate diets.

The Special Supplemental Food Program for Women, Infants, and Children (WIC) authorized by Public Law 92-433 (2) in 1972, provides food supplements to low income pregnant and lactating women, infants, and children up to 4 years of age who are at nutritional risk. The purpose of the WIC program is:

> to provide . . . supplemental foods and nutrition education . . . as an adjunct to good health care, during critical times of growth and development, to prevent the occurrence of health problems and improve the health status of these persons (3).

To be eligible for supplemental foods prospective participants must be residents of defined geographical areas, meet income guidelines, and be certified by a competent professional authority to be at nutritional risk. Determination of nutritional risk can be based on one or more of the following: a medical examination, dietary evaluation, anthropometric data, hematocrit values, hemoglobin values, or other indicators of nutritional status (4).

The WIC food packages are designed to increase nutrient intakes of iron, vitamin A, ascorbic acid, high quality protein, and calcium. These nutrients were chosen based on studies which suggested that they were lacking in the diets of the WIC program target population (5). Iron-fortified formula, infant cereal, and fruit juice are provided for infants. Eggs, milk and/or cheese, dried beans and peas or peanut butter, iron-fortified breakfast cereal, and vitamin C rich fruit juices are allowable foods for women and children. Each month, participants are issued vouchers, which are negotiable food instruments, that allow them to purchase the specified food items from authorized retail grocers.

Teenagers make up a sizeable proportion of the prenatal WIC participants. In recent years, nationwide concern about teenage pregnancy has developed. According to the Alan Guttmacher Institute (6), nearly 600,000 teenagers give birth each year in the United States, and most keep their babies. The number and rate of births declined during the 1970s for all teenagers except those under age 15, although the decline was much less steep than among women in their 20's. Despite the decrease in birthrate, the teenage birthrate in the United States is higher than those of most developed countries.

Seventeen percent of the 3.3 million births that occurred in the United States in 1978 were to teenagers, and these pregnancies represent many risks (6). The health, social, and economic consequences of teenage pregnancy are almost all adverse. Delivery of low birth weight infants and preeclampsia are the major risks associated with teenage pregnancy (7). Low birth weight is accompanied by high infant mortality and an increased rate of malformations (1). Teenage mothers are far more likely to have low birth weight infants than women in their 20's. Even with improved prenatal care, mothers aged 15 and younger are 2 times more likely to have low birth weight infants than those aged 20-24. Overall, the risk among all teenagers is about 39 percent higher than among women in their early 20's, and as the age of the mother increases the risk declines. Whatever the age of the mother, low birth weight rates among nonwhite infants are higher than those among white infants (6).

Since the inception of the WIC program in 1972, WIC legislation has required the collection and evaluation of data to determine the benefits of the nutritional assistance. There is increasing evidence that the WIC program is one of the most effective government social programs. A number of research studies (8-10) have been conducted to assess the impact of the WIC program on its participants. Results showed that the program had a positive effect on the participants' health status. Little research, however, has focused on the effects of WIC participation on teenage pregnancy outcome.

The objectives of this component of the Evaluation of the Effect of WIC Participation on Pregnancy Outcome of Kansas women were:

1) to compare selected characteristics of teenage prenatal WIC participants with those of non-WIC pregnant teenagers,
2) to investigate the effect of WIC supplemental feeding on the birth weight of infants born to teenage prenatal WIC participants,
3) to investigate the effect of selected maternal variables on the birth weight of infants born to teenage WIC and non-WIC participants,

4) to determine if the impact of each selected maternal variable differs between the WIC and non-WIC teenagers.

REVIEW OF LITERATURE

Factors Affecting Pregnancy Outcome

Dietary Quality and Other Factors

A woman's preconceptional nutritional status as well as her diet during pregnancy influence the course and outcome of pregnancy (1). Little research has been conducted in the United States to evaluate the nutritional status of adolescents during pregnancy, and only a limited number of studies have assessed maternal and environmental parameters in relation to pregnancy outcome.

In 1972, King et al. (11) conducted a study of 18 pregnant teenagers (group I), 13-18 yr of age, in San Francisco to identify their socio-economic characteristics, assess their dietary intake, and evaluate their clinical course and outcome of pregnancy. Dietary and social histories were obtained by interview, and food intake was estimated from 3-day food records at the 7th and 9th months of pregnancy. The 1968 Recommended Dietary Allowances (RDA) were the basis for evaluating the quality of dietary intake. The pregnancies of 34 other teenage girls (group II) were also evaluated from medical records to determine if the pregnancies of the girls in group I represented a sample typical of teenage pregnancies. For comparison, 5 never-pregnant girls (group III) of the same age group kept two, 3-day food intake records during a 2 wk period.

Pregnant teenagers in group I generally were more than 2 years post menarche, unmarried at conception, lived with families, relatives, or friends, and were of various racial backgrounds. Pregnant teenagers consumed more food during pregnancy than the non-pregnant adolescents. Calcium, iron, vitamin A, and energy were the nutrients most poorly supplied by diets during pregnancy, while protein intake was most nearly adequate with all pregnant girls consuming at least two-thirds of the allowance.

The total weight gain of girls in group I ranged from 27 ± 9 lb, while the total weight gain of girls in group II ranged from 30 ± 9 lb. Complications during pregnancy including clinical edema, rapid or inadequate weight gain, anemia, proteinuria, and glycosuria were found in 85% of the pregnant girls in the combined groups. Undesirable pattern of weight gain during pregnancy was the chief complication recorded in the medical charts. The birth weight of the infant was associated positively ($p < 0.01$) with the weight gain of the mother during pregnancy in both groups, and in group I the girls weighing the least prior to pregnancy gained the most weight ($p < 0.01$). Maternal age, height, and recorded dietary energy and nutrient intake did not influence birth weight or maternal weight gain.

Seiler and Fox (12) used a 3-day diet record to evaluate the diets of 30 pregnant and 32 non-pregnant Nebraska girls 16 yr of age and younger and of comparable socioeconomic status. The course and outcome of pregnancy was studied, and possible correlations between dietary adequacy and obstetric factors were investigated. The 1968 RDA was the basis for evaluating the quality of dietary intake, and medical records were the source of data regarding obstetric performance.

Based on the 1968 RDA, food intakes of pregnant girls were poorer than those of the non-pregnant group. Calcium, iron, and vitamin A were least adequately supplied by foods eaten by 50% or more of both pregnant and non-pregnant teenagers. Although dietary supplements improved the diets of some of the pregnant girls, few reported taking them during the major part of pregnancy.

Obstetric data indicated that preeclampsia was the most prevalent complication of pregnancy occurring in 26.7% of the pregnant group. Total weight gains during pregnancy ranged from 15 to 43 lb with a mean of 26 lb. There were no low birth weight (LBW) infants born to the adolescents in this study. Quality of diet was correlated with length of gestation and hemoglobin level of the mother and infant. No significant correlations were found between caloric intake and preeclampsia, weight gain and preeclampsia, or caloric intake and weight gain.

In Vermont, Ancri et al. (13) studied factors influencing the pregnancy outcome of 98 women divided into 4 age groups: 26 women were 12-17 yr of age, 22 were 18-19, 24 were 20-24, and 26 were 25-32. The women were mostly Caucasian, and obtained prenatal care from private physicians, a low-cost clinic, or within the home for unwed mothers in which they lived. Data on age of mother at conception, maternal weight gain, gestational age at delivery, protein and calorie intake during the third trimester, infant birth weight, and Apgar scores (general condition of the newborn soon after birth rated at 1 and 5 min) were collected.

A significantly higher amount of weight was gained during pregnancy by the youngest group of women, and the oldest women had the lowest weight gain. The amount of weight gained was a function of length of gestation. A later delivery period produced a higher weight gain, while less weight was gained with shorter pregnancies. Maternal calorie intakes in the third trimester did not influence weight gain. Mean calorie intakes were below and mean protein intakes above the 1974 RDA.

The mean birth weight of infants born to women 18-19 yr of age was significantly less than those of 25-32 yr olds. Infant birth weight was correlated with the mother's age and length of pregnancy. Maternal weight gain or mean protein and calorie intake were not correlated with infant birth weight. About 10% of the infants weighed 2500 g or less at birth, and all of these low birth weight infants were delivered between 31 and 38 wk gestation. There were no significant differences among 5 min Apgar scores by either pregnancy length or age group.

The impact of diet quality and other maternal and environmental factors on infant birth weight were examined by Phillipps and Johnson (14). Data were collected on 32% (N=47) of the eligible study population which included women who gave birth in a rural Wisconsin county between February and May 1974. The women ranged in age from 16 to 35 yr with a mean age of 26 yr. Estimates of dietary intake were obtained by having the women record their food intake every 8th day during the second half of pregnancy. The dietary information was used to estimate intake levels of individual nutrients and a nutrient adequacy ratio (NAR index), which is a measure of overall dietary quality. Obstetric data were obtained from medical records.

Multiple regression analysis was used to study the relationship of birth weight to 44 maternal and environmental factors to identify variables significantly and independently associated with birth weight. The analysis showed that infant birth weight was related positively to overall dietary quality, gestational age, and the square terms for the mother's age, delivery weight, and number of previous pregnancies. Birth weight was related negatively to iron and protein intake, age of mother, number of people in the household, number of cigarettes smoked daily, and weeks of gestation squared.

Women who smoked cigarettes (N=8) gained less weight during prenatal care ($p < 0.01$) and had infants with lower birth weights ($p < 0.01$) than non-smoking women (N=32). Some of the birth weight difference, however, may have been accounted for by age since the women who smoked were older ($p < 0.05$) than the non-smoking women, and age was correlated negatively with birth weight ($r = -0.324$, $p < 0.05$).

Springer et al. (15-17) conducted a retrospective study to survey the nutritional indexes of selected maternity patients and their infants (15, 16) participating in the Detroit Maternity and Infant Care Project (DMICP), and to assess relationships among developmental, medical and nutritional variables (17). The researchers reviewed the records of 198 pregnant women and their infants seen at the DMICP during 1971 and 1972.

The pregnant study population consisted mostly of black teenagers, the majority of whom had dropped out of school and were pregnant for the first time. Although all of the women were of low socioeconomic status, only slightly more than one-third participated in federal food programs. The mean age of the group was 20.5 yr, and about 60% were less than 20 yr old. Of the 204 infants born to the women in the study population, the majority had Apgar scores of 7 to 10 at birth. The mean scores of the infants were 8.0 and 9.4 at 1 and 5 min, respectively, and these mean scores were considered high (15).

Results of dietary data collected using a 24-hr recall and food frequency tool showed satisfactory intakes of meat, breads, and cereals, but low intakes of milk, fruit, and vegetables. These data reflected inadequacies of calcium, riboflavin, vitamin A, ascorbic acid, and other vitamins and minerals (16). Few significant correlations were found between mothers' dietary intake and the medical and developmental variables of the infants. A mother's protein intake, however, was related significantly to the infant's birth length. Correlational analysis also showed that the mother's pregravid weight was related positively ($p < 0.01$) to infant weight and length at birth. Maternal weight gain during pregnancy was an important index in determining anthropometric measurements of infants at birth. Maternal weight gain was related positively to infant birth weight ($p < 0.01$), length ($p < 0.01$), and head circumference at 4 wk ($p < 0.05$). In light of the importance of maternal weight gain, the researchers (17) recommended periodic monitoring of weight gain throughout pregnancy.

Bowering et al. (18) evaluated some biochemical indices of nutritional status and assessed the dietary adequacy and pregnancy outcome of 346 low-income pregnant women attending a clinic for high obstetric risk patients in East Harlem, New York. About one-half of the women were Puerto Rican and one-third were black American. The mean age was 27.6 yr, and one-fifth of the women were teenagers mostly in the age range of 17 to 19 yr. A majority of the teenagers were attending the high risk clinic because of anemia or obstetric history.

Biochemical analyses of the blood provided evidence of poor intakes of ascorbic acid and iron. Evaluation of the 24-hr diet recalls obtained at the first clinic visit before nutrition counseling indicated that the women's diets were least adequate for calcium, iron, and energy when compared to the 1974 RDA, while the greatest percentage of women had acceptable protein intakes (66% of the 1974 RDA). Women under age 20 yr generally had the best diets both quantitatively and qualitatively.

Data on pregnancy outcome were available on 311 women. The mean infant birth weight was 3124 g, and 13% of the live infants weighed less than 2500 g at birth. Puerto Rican women had more (9.9%) premature infants (birth weight < 2500 g and gestational age < 37 weeks), while black women had more (8.3%) nonlive births and more (7.1%) small-for-gestational-age (birth weight < 2500 g and gestational age $\geq$ 37 weeks) infants. Women who delivered either nonlive or small-for-gestational-age (SGA) infants consumed less of all nutrients and less nutrient-dense diets at the first clinic visit compared with women delivering live full-term or premature infants.

Pregravid Weight and Weight Gain

Rush et al. (19) collected data from more than 7000 medical records of low-income, black pregnant women who delivered at a public hospital in New York City between 1964 and 1967 to study factors affecting birth weight. Contingency table and multiple regression analyses indicated a sequence of relationships among variables that suggested a causal role for maternal nutrition as a determinant of birth weight.

The associations between birth weight and maternal height, age, and parity were negligible when maternal prepregnant weight was controlled. Birth weight generally increased with age across a gradient of 150 g between the lowest mean birth weight at age 16, to a maximal birth weight at age 26 and over. When birth weight was plotted by age among specified prepregnancy weight categories, however, birth weight differences between teenagers and women in their 20's disappeared. As prepregnant weight and maternal weight gain increased, there was an increase in birth weight, and each prior low birth weight delivery was associated with a decreased birth weight in the pregnancy under study. The researchers suggested that maternal weight and weight gain were intervening variables in the association of maternal age, height, and parity with birth weight, and that a woman's nutrition at conception and during pregnancy had a greater impact on birth weight than nutrition during childhood (using height as a crude index of childhood nutrition).

Using data from the Collaborative Perinatal Study (20), Niswander and Jackson (21) assessed the influence of the maternal characteristics of 5755 white and 6012 black women on the birth weight of their infants. Multiple regression analysis of 32 factors indicated that pregravid weight and maternal weight gain were of substantial importance, while the effect of maternal height on birth weight was small. Birth weight did not diminish with maternal weight gains of up to 30 lb, but increased an average of 9 g for each lb increase in maternal weight gain.

Simpson and coworkers (22) studied the influence of prepregnancy weight and pregnancy weight gain on the birth weight of infants born to 24,335 white and 2133 black women who delivered infants at the Brooke General Hospital in Texas. Regression analysis revealed an almost straight line correlation between maternal weight gain and birth weight. Birth weight increased with increasing maternal weight gain. As pregravid weight increased, there was also an associated increase in birth weight and a decline in the number of low birth weight babies (birth weight $\leq$ 2501 g). In white women, however, as pregravid weight rose above 160 lb there was no increase in birth weight. There was no association between pregravid weight and pregnancy weight gain except in women weighing more than 160 lb. Above 160 lb, there was a drop in pregnancy weight gain which was less marked in black women until 180 lb was reached.

Relationships of maternal weight gain, pregravid weight, and infant birth weight were examined by Gormican et al. (23) in 602 white, middle-class women obtaining prenatal care at a group practice clinic in Wisconsin. Analysis of the data showed that increases in maternal weight gain and pregravid weight were accompanied by increases in infant birth weight ($p < 0.01$). Birth weight was not significantly correlated with maternal age, parity, or height.

Infants born to women who smoked (N=62) weighed less ($p < 0.01$) than those born to nonsmoking women (N=239), although the maternal weight gains did not significantly differ between the 2 groups. The researchers suggested encouragement of adequate weight gains in women who smoke to help offset the contribution of smoking to lower infant birth weight.

Food Supplementation Studies

Numerous attempts have been made to modify the outcome of pregnancy with nutrition interventions. The results of these interventions in industrialized countries, however, are not clear-cut. Some studies (8-10, 24) have shown a positive effect of nutritional supplementation during pregnancy, while others (25-27) have been less conclusive.

Non-WIC

A nutrition intervention program for pregnant women in Montreal, Canada demonstrated the positive influence of food supplementation on pregnancy outcome. The Montreal Diet Dispensary has provided dietary counseling and food supplements to women during pregnancy since 1962. Rush (24) examined the impact of this nutrition service on the birth weight of infants. Women registering for prenatal care at a large

Montreal hospital clinic, which served a low-income population, were non-systematically referred to the Montreal Diet Dispensary. Pregnant women who were not referred to this service were used as retrospective controls. The comparison women were matched to 1213 white urban women using the diet dispensary based on a number of characteristics including year of delivery, religion, parity, pregravid weight, and trimester prenatal care began.

The mean birth weight of infants born to women utilizing the diet dispensary was 40 g greater than those in the comparison group, and this difference was significant ($p < 0.05$). The effect on birth weight of participation in the diet dispensary service was conditional. The degree of rise in birth weight appeared to depend on the nutritional status of the woman. Compared to their matched controls, the mean birth weight of infants born to primigravidae and women weighing less than 140 lb at conception was 61 g and 63 g higher, respectively. These differences were statistically significant. There were no significant differences in the frequency of low birth weight infants born to women in the 2 populations.

In contrast with the preceding results, 3 food supplementation studies (25-27) in the United States have failed to show conclusive effects of the nutrition intervention on pregnancy outcome. In a study carried out by Osofsky (25) in Philadelphia, a group of 118 low-income women who began prenatal care in an urban hospital clinic before the 28th week of pregnancy were compared with 122 similar women who were provided a liquid protein-mineral supplement. The women in both groups were mainly black, and the 2 groups were studied sequentially. Assessments of dietary intake were made up to 4 times using the 24-hr recall technique.

Demographic information was obtained, and medical assessments were made throughout the pregnancy and during the post partum period. After birth, infants were measured and their gestational age carefully assessed.

The supplemented group, on the average, drank only half of the recommended amount of supplement. Still their mean daily intake was higher for protein, calcium, iron, and phosphorus than the unsupplemented group. Mothers in the supplemented group had a significantly lower incidence of findings suggestive of preeclampsia and had fewer complications during labor and delivery. Although gestational age at the time of delivery did not differ for the 2 groups, significant differences were found in infant birth weight, length, and head circumference, with the infants of supplemented mothers having lower values than those whose mothers were not supplemented. Infants of supplemented mothers also had lower ($p < 0.05$) 5 min Apgar scores than did infants of mothers who did not receive the supplement. However, the mean values of both groups were 9.4 and 9.7, respectively, which were considered to be high.

Adams et al. (26) studied the effects of nutritional supplementation on the pregnancy outcome of 102 women, who were judged to be at high risk of delivering low birth weight infants. The women in the study population received prenatal care at the Kaiser-Permanente Medical Center in San Francisco, California, and represented a wide range of ethnic and socioeconomic groups.

The women were assigned randomly to 1 of 3 dietary supplements: group 1--high-protein beverage, group 2--low-protein beverage, and group 3--vitamin-mineral preparation. The women receiving the beverages were instructed to drink 2, 8 oz cans per day. Each daily allowance of 2 cans of the high-protein beverage contained 40 g casein and soy isolate protein, 470 kcal, and vitamins and minerals, while the daily amount of the low-protein beverage contained 6 g protein, 320 kcal, and vitamins and minerals. The women in each group kept a 7-day dietary record before beginning the dietary supplement and a second one during the 34th wk of pregnancy. All subjects were enrolled by the 27th wk of pregnancy.

During the supplementation period, the mean intake of women in group 1 met 100% of the 1974 RDA for calories and protein, while groups 2 and 3 met 80% of the allowance for calories and 90% or more of the allowance for protein. Diet records indicated that the high-protein beverage was truly a supplement, whereas the low-protein beverage was used as a substitute for food.

Although the caloric and protein intakes in group 1 were much higher than the other 2 groups, the mean birth weight was similar in all 3 groups. As the protein intake of women in group 1 increased, there was an upward trend, although not significant, in birth weight. In addition, no association was found between birth weight and either the length of treatment or pregravid weight of the mother and weight gain. In comparing the Apgar scores for infants of mothers in the 3 groups, no significant associations were found. The researchers (26) concluded that since the women were well nourished and the sample size was small, changes in birth weight may have gone undetected.

Rush and coworkers (27) conducted a randomized controlled trial of prenatal supplementation in a poor black population in New York City. The study was designed to determine whether supplementation improved the pregnancy outcome of mothers at high risk of having low birth weight infants. The study population was selected from the clinic of a municipal hospital according to predetermined criteria. Of the 814 women, 263 were assigned to a supplement group (receiving 2, 8 oz cans per day of a beverage containing 4 g of animal protein, 470 kcal, and vitamins and minerals), 272 to a complement group (receiving 2, 8 oz cans per day of a beverage containing 6 g of animal protein, 322 kcal, and vitamins and minerals), and 279 to a control group receiving regular clinical care (including vitamin-mineral preparations).

The women consumed an average of 69% to 79% of the prescribed regimen for both supplements. The high-protein supplement contributed an estimated 326 kcal per day to the women's diets, while the complement supplied an estimated 233 kcal per day. No significant differences in birth weight were found among the 3 treatment groups. The mean birth weights were 2938 g for the supplement group, 3011 g for the complement group, and 2970 g for the control group. The supplement appeared to have some adverse perinatal effects. There was an excess of very early premature births and associated neonatal deaths, and there was significant growth retardation among infants born prematurely (<37 weeks gestation) to women in the supplement group. Smoking was related significantly to birth weight, and decreased maternal weight gain accounted for three-fourths of the deficit associated with smoking. Among women who smoked 15 or more cigarettes per day, supplementation with either the high-protein supplement or complement prevented depressed birth weight of these infants.

WIC

The initial nationwide medical evaluation of the WIC program was conducted by Edozien et al. (8) at the University of North Carolina under a contract with the United States Department of Agriculture to fulfill the congressional mandate that the benefits of the nutritional assistance be evaluated. The detailed medical evaluation was designed to determine the impact of the WIC program on the health and nutritional status of program participants.

Selected measures of nutritional status including nutrient intakes, and anthropometric and biochemical measures were obtained on the study population initially and after participation in the program for a specified interval. An estimate of the impact of the program was obtained by comparing the results of measurements taken on a group of participants after receiving food supplements for a specified time period with those of a similar group at the time of initial enrollment. Data were collected at 19 projects located in 14 states during the period from February 1974 through May 1975. The projects selected were not a probability sample representative of the WIC program because only a limited number of applications were available when the projects were selected.

Baseline data were collected on 9867 pregnant/lactating women, including 4125 women with completed pregnancies. The women were examined at the time of enrollment and re-examined every 3 months during pregnancy, at delivery, and after delivery. After the initial examination, the women returned for 5417 revisits at an estimated compliance rate of 40%. The mean age of women participating in this evaluation was 23.1 yr. The ethnic distribution was 24.5% white, 38.6% black, 33.8% Spanish American, and 2.5% other. Approximately one-third of the women smoked, and the mean gestational age at the time of enrollment was 23.5 wk. Indicators of nutritional status measured for women were anthropometric data, including weight gain during pregnancy; medical complications of pregnancy; vital statistics; biochemical; and nutrient intakes based on 24-hr diet recalls from 50% of the participants.

The WIC program produced measurable improvements in the nutritional status and health of the participants. The principle conclusions reported for women were as follows:

1) Pregnant women participating in the WIC program increased their consumption of protein, calcium, phosphorus, vitamin A, iron, thiamin, riboflavin, niacin, ascorbic acid, and folacin, but not of energy. Thus, it was apparent that the food package was not used as a true supplement, but as a substitution. However, the WIC foods did improve the usual diets of these women by providing them with more protein, minerals, and several vitamins.
2) Pregnant women who participated in the WIC program gained more weight during pregnancy than women in the initial population. In women who were pregnant for 24 to 31 wk, there was a maximum difference of 2 kg of weight gained.
3) After receiving WIC foods, there was an increase in the mean hemoglobin concentration and a reduction in the anemia rate for women who were pregnant for more than 28 wk.
4) An increase in the mean birth weight of infants was associated with WIC program participation. Supplementation for a period of less than 3 months had no effect on birth weight.

On the average, duration of gestation was 5 to 6 days longer for women who received food supplements for more than 6 months than for women who received supplements for less than 6 months. Since birth weight was related significantly to gestational age, WIC participation improved birth weight by extending the pregnancy. However, the relationship between duration of participation in WIC and birth weight was significant independent of the duration of pregnancy. Therefore, WIC had a direct effect on fetal growth.

Mauer (28) and others (4, 29) suggested that conclusions from the medical evaluation of the WIC program (8) be drawn with extreme caution because of the constraints of the study. There was insufficient time to implement adequate quality control measures including standardization and training. Other difficulties that arose during the study were the lack of a true control group, the inability to link patients so that initial and follow-up visit data could be analyzed, a large drop-out rate, and the absence of information on reasons for inclusion of an individual in the WIC program (4).

Wallach and coworkers (30) at the Yale University School of Medicine conducted a 3-part study to evaluate the impact of the WIC program on the recipients in the city of Waterbury, Connecticut. In part one of the study, the association between the nutritional status of the mother and infant mortality was used as a means of assessing the influence of the WIC program on mothers who participated in the program. The infant and perinatal mortality rates for the infants of WIC participants were compared to those for the remaining population of Waterbury. The rates for the years 1975, 1976, and 1977 were compared both individually and collectively.

Death certificates were examined for all fetal and infant deaths occurring in Waterbury from 1975-1977. For infants, cause of death, age at death, race, and sex were extracted from the death certificates. Whenever possible, death certificates were matched with appropriate birth certificates for complementary data such as weight at birth, mother's age at delivery, and legitimacy. The mother's participation in the WIC program was determined by matching her name with the WIC files. A mother was classified as a WIC participant if her name was present in the files and the enrollment date corresponded with the pregnancy under study. Because of time limitations and the small number of deaths, mortality rates were analyzed for all infants regardless of age or race classification.

For the combined 3 years of study, there was a statistically significant difference between infant mortality rates for WIC and non-WIC prenatal participants. The WIC mothers had an infant mortality rate of 8.4/1000 live births, while the rate for non-WIC mothers was 22.7/1000 live births. The perinatal mortality ratios between the 2 groups for the combined 3 years of study also differed significantly with WIC mothers having a perinatal mortality ratio of 10.5/1000 live births and a ratio of 24.5/1000 for non-WIC mothers. Causes of death among the 2 populations were identified, but the number of deaths in each category were too small to test for statistical significance.

The researchers (30) concluded that there was a need for further study to determine the causes of the differences between the infant and perinatal mortality rates for the 2 populations of Waterbury. Differences in mortality could not be attributed entirely to WIC. However, it could be stated that WIC prenatal participants experienced lower infant and perinatal mortality rates than those mothers who did not participate in WIC.

Kotelchuck et al. (9) investigated the effect of WIC program participation on the pregnancy outcome of WIC prenatal participants who gave birth in Massachusetts in 1978, compared to pregnancy outcome of similar women who were not WIC participants. The data for this study were obtained by linking 2 independently collected data sets: the State Birth and Death Registry and the WIC computerized system. Birth certificates provided data on maternal characteristics, prenatal care, and pregnancy outcome, while death certificates provided information on all infants dying between birth and 28 days. The WIC computerized system provided documentation of the names of all prenatal WIC participants along with data on the duration and extensiveness of their participation.

WIC prenatal participants were identified and birth data were obtained. Each WIC subject was then individually matched to a woman who gave birth in 1978, but did not participate in the WIC program. Matching was based on 6 maternal characteristics that included age, race, parity, years of education, marital status, and geographic location. The researchers were able to link and match 94% of the eligible WIC prenatal participants creating a study population of 4126 and a control group of equal number. The study design interpreted all statistical differences as a function of WIC participation and assumed that all other variables were similar across the 2 groups.

The Massachusetts WIC program reached a population known to be at high risk for poor outcomes of pregnancy. A higher percentage of the participants were teenagers, black, unmarried, or had never graduated from high school compared to statewide demographics for each of these classifications.

WIC participation was associated positively with improved pregnancy outcome. The incidence of low birth weight infants was less ($p < 0.005$) among WIC participants compared to the control group. Among WIC mothers, the incidence of low birth weight infants was 6.9% (N=283), while 8.7% (N=360) of the births to non-WIC women were low birth weight.

Neonatal mortality was significantly lower in the WIC population (N=12) compared to the control group (N=35). No significant differences were detected in the mean birth weight of infants in the 2 groups. Length of gestation was 1.5 days longer ($p < 0.001$) in the WIC population than among women in the control group. The percentage of infants who were premature, postmature, or small for gestational age did not differ significantly between the 2 groups.

When duration of participation in the WIC program was examined, as determined by the number of vouchers redeemed during the pregnancy, the association between WIC participation and improved birth outcomes was further clarified. The mean duration of participation in the WIC program was 4.6 months (33% of the women for 7 to 9 months, 45% for 4 to 6 months, and 22% for 1 to 3 months). Participation in WIC for 7 to 9 months during pregnancy was associated with the most positive birth outcomes: birth weight was increased by 111.2 g ($p < 0.001$), length of gestation by 5 days ($p < 0.001$), and percent of low birth weight infants ($p < 0.001$) and neonatal mortality ($p < 0.05$) decreased. For women who participated 4 to 6 months, outcomes of pregnancy were significantly better than their controls, but absolute improvement was not as great. No positive associations were noted for women who participated in WIC 1 to 3 months.

In 1978, the Massachusetts WIC program served 503 pregnant teenagers age 17 yr and younger. These young teenagers benefited extensively from WIC participation. Participation in WIC was associated with a 56.7 g increase in birth weight, a 3.5 day increase in gestation ($p < 0.03$), and a decrease in the percent of low birth weight infants compared to their matched control subjects. Of the young teenage WIC participants, 8.7%

had low birth weight infants, compared with 11.9% of the control subjects, and 10.0% of all young teenagers statewide.

The impact of pregnant women's participation in a WIC program in Massachusetts on the birth weight of infants was examined by Kennedy et al. (10) at the Harvard University School of Public Health. The researchers conducted a retrospective review of WIC and non-WIC medical and nutrition records at 9 sites in 4 different geographical areas in Massachusetts. Data collection covered the period from January 1973 to February 1978. Biological, sociodemographic, behavioral, and WIC data were collected for 1328 pregnant women, 910 WIC and 418 non-WIC women.

Two non-WIC comparison groups were chosen to overcome the potential self-selection bias of the WIC subjects. Comparison group 1 (C_1) consisted of pregnant women who had applied for WIC but were not certified because the program had no openings or who were certified post partum. Comparison group 2 (C_2) was composed of pregnant women utilizing non-WIC health facilities. The C_1 women were the preferred comparison group because they had applied for WIC and lived in the same area as the WIC participants. The comparability of the groups was evaluated by analyzing the baseline profiles of the WIC and non-WIC women using a t-test for the differences between means for biological and social variables. There were no significant differences between WIC and non-WIC participants in age, parity, prior low birth weight babies, number of previous premature births, number of prior miscarriages, weight, number of living children, family size or income.

There was a significant difference in the birth weights of infants born to WIC and non-WIC participants. The mean birth weights of infants born to WIC, non-WIC, and C_1 women were 7.19, 6.92 and 6.88 lb, respectively.

Multiple regression analysis was used to determine factors that contributed to the higher birth weights of infants born to WIC mothers. Five biological variables including total maternal weight gain, gestational age, pregravid weight, pregravid weight square, and prior low birth weight infants were associated significantly with birth weight and accounted for 37.17% of the total variance in birth weight. Maternal weight gain and gestational age had the greatest effect on birth weight.

Eight social variables including geographic location, agency location, income, marital status, racial/ethnic group, family size, number of living children, and number of children on WIC were added to the regression equation for birth weight. No significant associations were noted for any of the social variables or their interaction terms with birth weight.

Behavioral characteristics including effects of prenatal care, nutritional counseling services, and smoking on birth weight were examined. There were no significant differences between WIC and non-WIC women in the amount of prenatal care received or in smoking status. The amount of prenatal care and number of nutrition counseling sessions were not associated with birth weight. Smoking did not directly influence birth weight when added to the regression equations. Total maternal weight gain, however, was adversely affected by smoking. As a result, smoking indirectly decreased birth weight.

In the last stage of the analysis the effect of WIC program participation on birth weight was analyzed by addition of 2 program variables, participation (yes/no) and number of vouchers, to the multiple regression equation. WIC food supplementation was associated positively with an increase in birth weight as was the number of vouchers received. As WIC participation increased from none to 7 or more months, there was a concurrent rise in birth weight. This rise in birth weight translated into a decrease in the incidence of low birth weight infants born to WIC mothers. The incidence of low birth weight in infants born to WIC, non-WIC, and C_1 comparison group women was 6.0, 8.8, and 10.1 percent, respectively, and the differences in incidence were statistically different.

Since gestational age exerted the greatest influence on birth weight, the data were analyzed in 2 additional ways to resolve the possible argument that women who received more WIC vouchers would normally have longer gestational periods. No significant differences were found when gestational age in WIC women was stratified by length of participation. Secondly, the positive and significant association of WIC participation with birth weight remained even when gestational age and maternal weight gain were omitted from the equation. Based on study results, the researchers (10) stressed the need for early identification and enrollment of high risk prenatal women in the WIC program to improve the outcome of pregnancy.

METHODOLOGY

The research proposal for the evaluation of the Effect of WIC Program Participation on Pregnancy Outcome of Kansas Teenagers and appropriate forms were submitted to and approved by the Kansas State University Subcommittee on Research Involving Human Subjects.

Data Sources

Data for the study were derived from 2 previously collected but unlinked data sets:

I. Professional Data Processing Associates (PDA), Inc.

   WIC Master File
   provided names and case numbers for all persons enrolled in the Kansas WIC Program

   WIC Voucher File
   source of data on actual dollars spent for WIC foods by each participating family including the time period in which the food dollars were spent

II. Kansas State Department of Health and Environment Vital Statistics

   Kansas Birth History Master File 1979-80
   source of data on all births in Kansas in 1979-80

The WIC Files maintained by PDA, Inc. provided documentation of the names of prenatal WIC participants along with the duration and extensiveness of their WIC participation. The Kansas Birth History Master File was the source of data on maternal characteristics, prenatal care, and pregnancy outcome for all women giving birth during the study period.

Permission was granted by Irvin Franzen, Director, Bureau of Health and Registration Statistics, to access data on the 1979-80 Kansas Birth History Master File of the State Department of Health and Environment

Vital Statistics, and by Sarah Harding, State WIC Coordinator, to access data on the WIC Master and Voucher Files.

Derivation of Sample

To derive the population of women who were enrolled in the Kansas WIC Program during pregnancy and gave birth in Kansas between July 1, 1979 and June 30, 1980, infant birth certificate numbers were hand-linked to corresponding WIC case numbers (fig 1). A birth certificate number is assigned to each infant at birth, and a WIC case number, assigned to a family at the time of enrollment, is unique to that family and identifies each participating member. The linking process was based on name, date of birth, address, and race.

The WIC Voucher File (fig 1) was accessed to determine the WIC family type (WIC number) for each woman in Data Set A (fig 1) during the woman's gestation period. The WIC number, printed on each voucher a family receives, indicates the number of women, infant's and/or children's partial food packages included on that voucher. For example the WIC number 102, where W=woman number, I=infant number, and C=child number, would indicate that 1 woman's partial food package, no infants, and 2 children's partial food packages were contained on that voucher.

Data Set A (fig 1) was classified into the following age categories: $\leq$ 19 yr, 20-34 yr, or $\geq$ 35 yr at the time of delivery, and was then cross-classified according to the W number, resulting in 2 subsets for each age category: W=1 or W$\neq$1. The WIC subset of interest for each age category had W=1, indicating that the woman participated in WIC during the pregnancy under study.

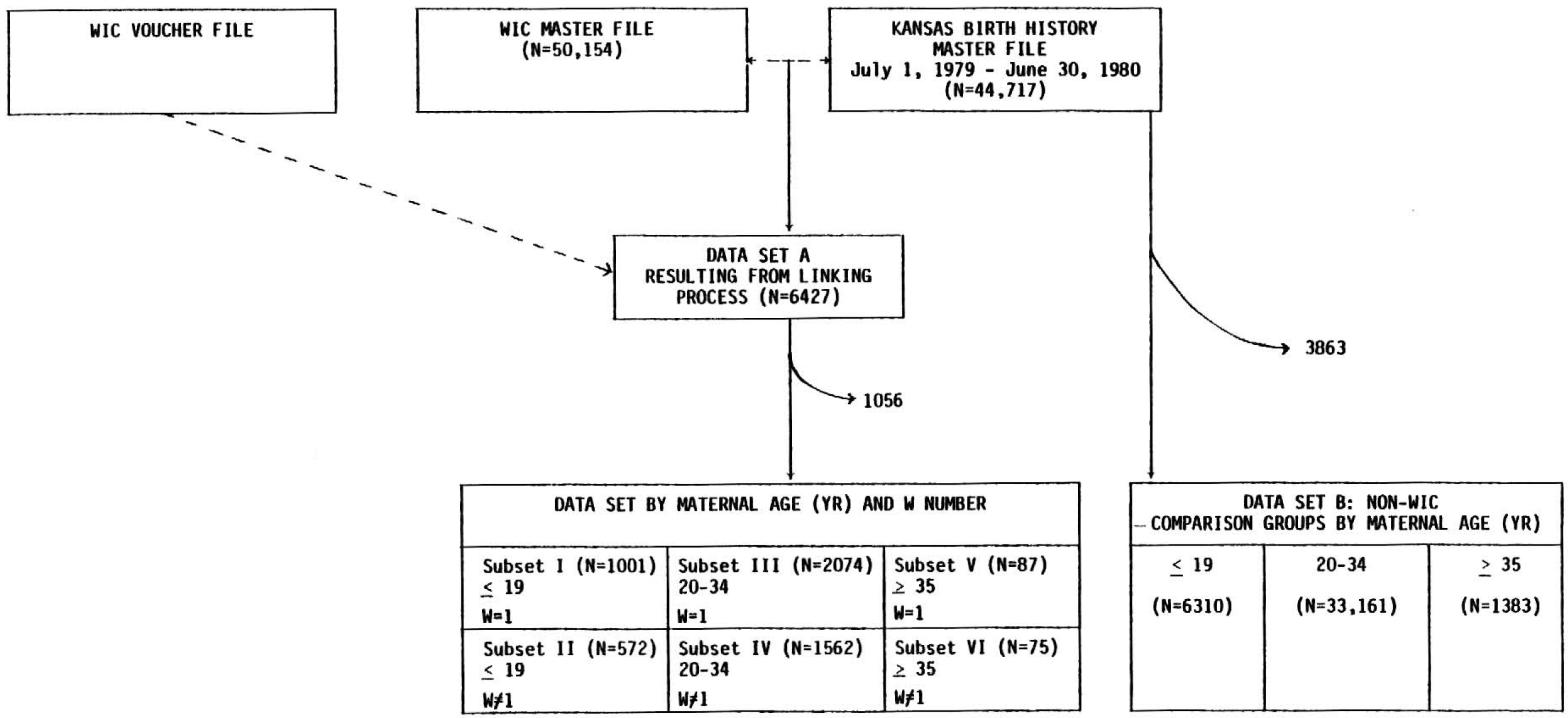

FIG. 1. Derivation of sample

The birth data remaining in the Kansas Birth History File after the linking process for women who gave birth during the study period were classified by age (fig 1, Data Set B). The women in each of these age categories served as non-WIC comparison groups as appropriate.

In this research project, teenagers 19 yr and younger who participated in WIC during pregnancy (fig 1, Subset I) and non-WIC teenagers (fig 1, $\leq$ 19 yr in Data Set B) were studied.

Proportional Voucher Dollar Sum for Prenatal WIC Participants

For the prenatal WIC participants, the proportional dollar value of the family food package that should be allocated to the pregnant WIC participant was estimated as follows. The dollar sum of the cashed vouchers issued during the 9 month period prior to the infant birth date was computed for each pregnant woman who was the sole participant in the family (WIC number = 100). The mean actual dollars spent by these women during pregnancy was then computed (ACT 100 = $128.14). The mean actual dollars spent during the 9 month period prior to the infant birth date by each possible combination of WIC family types for Subsets I, III, and V (fig 1) also was computed. Ratios for ACT 100 to each of the following were then calculated: ACT 110, ACT 120, ACT 130, ACT 101, ACT 111, ACT 121, ACT 102, and ACT 112. The appropriate ratio was multiplied by the value of the family's cashed vouchers during the woman's gestational period to reflect dollars spent on WIC supplemental foods for the woman during pregnancy.

Data Analysis

Frequency distributions and percentages were compiled for each variable studied (list of variables, Appendix A) for both the WIC teenagers and the non-WIC comparison group. In addition means, standard deviations, and coefficients of variation were computed for maternal biological variables of the teenagers in both groups.

Analysis of covariance was used to identify factors significantly associated with birth weight in the WIC population. Variables included in the analysis were selected on the basis of availability, and were those thought to be significantly associated with birth weight (10, 14, 17, 19, 21-23). Data were analyzed for live singleton births only, deleting women with reported pregravid weights > 300 lb. An equation was specified for the outcome variable birth weight: Birth Weight = f (race, pregravid weight, maternal weight gain, proportional voucher dollar sum). Complete data for the variables studied were available for 515 WIC teenagers. The effect of the same variables, except proportional voucher dollar sum, on the birth weight of infants born to non-WIC teenagers were studied. Complete data for the study variables were available for 4297 non-WIC teenagers. The partial regression coefficients of these selected maternal variables were compared between the WIC and non-WIC teenagers to determine if they differed.

RESULTS AND DISCUSSION

Description of WIC Teenagers and Non-WIC Comparison Group

Maternal Biological Variables

The mean age of teenage WIC participants was 17.6 yr (Table 1) and about 42% (Table 2) of these teenagers were 17 yr or less at the time of delivery, while the mean age of non-WIC teenagers was 17.9 (Table 1) and a smaller percentage (32.5) were 17 yr or less at delivery. The mean pregravid weight and height of women in both groups was approximately 127 lb and 64 in, respectively (Table 1). About 70% of the women in each group weighed between 100-139 lb and approximately 95% were 60-69 in tall. Women in both groups gained an average of 29 lb during pregnancy, and the highest percentage of teenagers in each group had a cumulative weight gain of 21-30 lb. Over 13% of the teenagers in each group gained 41 lb or more during pregnancy (Table 2). In California, King et al. (11) found that the mean cumulative weight gains of 2 groups of pregnant teenagers were 27 and 30 lb.

Maternal Social Variables

In the WIC group, 58.3% of the teenagers were white, Mexican, or Puerto Rican, while these races comprised 83.4% of the non-WIC comparison group (Table 3). A greater percentage of the WIC teenagers were black (39.6%) in contrast to the comparison group (15.2%). In a nationwide evaluation of the WIC program, Edozien et al. (8) found that the ethnic distribution of prenatal WIC participants was 38.6% black, 24.5% white, 33.8% Spanish American, and 2.5% other. Kotelchuck et al. (9) reported a greater percentage of black prenatal WIC participants (23.8%) giving

TABLE 1
Means, standard deviations, and coefficients of variation of maternal biological variables of Kansas teenagers

Variables	N[1]	$\overline{X}$	SD	CV
				%
WIC				
Age (yr)	989	17.57	1.33	7.6
Pregravid weight (lb)	678	127.42	23.90	18.8
Height (in)	626	64.16	2.60	4.0
Weight gain (lb)	671	29.31	11.83	40.4
Weeks gestation	965	39.42	4.93	12.5
Non-WIC				
Age (yr)	6242	17.86	1.20	6.7
Pregravid weight (lb)	4446	127.73	24.76	19.4
Height (in)	4197	64.25	2.76	4.3
Weight gain (lb)	4459	29.10	11.50	39.5
Weeks gestation	6023	39.49	4.01	10.2

[1]N varies because of missing data.

TABLE 2
Maternal biological variables of Kansas teenagers

Variables	WIC N[1]	WIC Percentage	Non-WIC N[1]	Non-WIC Percentage
Age (yr)				
12			2	0.0
13	2	0.2	11	0.2
14	17	1.7	55	0.9
15	58	5.9	204	3.3
16	144	14.6	628	10.1
17	196	19.8	1127	18.0
18	264	26.7	1784	28.6
19	308	31.1	2431	38.9
Pregravid weight (lb)				
≤ 99	38	5.6	234	5.3
100-119	234	34.5	1412	31.8
120-139	244	36.0	1749	39.3
140-159	98	14.5	661	14.9
160-179	35	5.1	242	5.4
≥ 180	29	4.3	148	3.3
Height (in)				
≤ 59	17	2.7	89	2.1
60-64	352	56.2	2276	54.2
65-69	244	39.0	1749	41.7
≥ 70	13	2.1	83	2.0
Weight gain (lb)				
0-10	27	4.0	148	3.3
11-20	141	21.0	929	20.9
21-30	243	36.3	1667	37.3
31-40	158	23.5	1089	24.5
≥ 41	102	15.2	626	14.0
Weeks gestation				
< 37	46	16.0	771	12.8
37-42	684	70.8	4537	75.3
> 42	127	13.2	715	11.9

[1]N varies because of missing data.

TABLE 3
Maternal social variables of Kansas teenagers

Variables	WIC		Non-WIC	
	N[1]	Percentage	N[1]	Percentage
Race				
White, Mexican, Puerto Rican, and all other Caucasians	576	58.3	5209	83.4
Black	392	39.6	946	15.2
Indian	16	1.6	58	0.9
Asian or Pacific Islander, excluding Hawaiian and Filipino	5	0.5	24	0.4
Cajun or Creole			4	0.1
Filipino			1	0.0
Marital status				
Married	383	38.7	3788	60.7
Unmarried	606	61.3	2451	39.3
Unclassifiable			3	0.0
Education (yr)				
1-8	58	5.9	325	5.2
9-12	909	92.4	5668	91.2
13-15	17	1.7	222	3.6

[1]N varies because of missing data.

birth in Massachusetts during a one-year study period compared to the percentage of black women giving birth statewide (6.2%).

There was marked difference in marital status between WIC and non-WIC teenagers. In the WIC group approximately 61% were unmarried and 39% were married, while the percentages in the comparison group were reversed (Table 3). Kotelchuck et al. (9) reported similar results in that a higher percentage of the WIC participants were unmarried compared to statewide demographics for women giving birth during the study period. In the present study, more than 90% of the teenagers in both groups had completed 9 to 12 yr of education. A small percentage of each group completed less than 9 yr of education (Table 3).

Maternal Behavioral Variables

Smoking habits and utilization of prenatal care services were studied for both WIC and non-WIC teenagers. In the WIC group, 4.4% of the teenagers reported smoking during pregnancy, while 3.7% of the non-WIC teenagers were smokers (Table 4). About three-fifths of the women in both groups began prenatal care in the first trimester, and slightly less than one-third of the women in each group began prenatal care in the second trimester. Less than 1% of both the WIC and non-WIC teenagers received no prenatal care during pregnancy. In each group, about one-third of the teenagers made 8 or fewer visits for prenatal care, while two-thirds made 9 or more visits (Table 4). In Massachusetts, Kennedy et al. (10) found that a higher percentage of the women studied made fewer visits for prenatal care during pregnancy. More than 40% of their

TABLE 4
Maternal behavioral variables of Kansas teenagers

Variables	WIC		Non-WIC	
	N[1]	Percentage	N[1]	Percentage
Smoking habits				
Smoker	35	4.4	193	3.7
Non-smoker	765	95.6	5005	96.3
Prenatal care				
Number of visits				
< 9	317	32.4	1904	32.0
≥ 9	661	67.6	4265	68.0
Month care began				
No care	6	0.6	55	0.9
1-3	598	61.2	3769	61.6
4-6	321	32.8	1906	31.2
7-9	53	5.4	386	6.3

[1]N varies because of missing data.

WIC prenatal participants and women in the non-WIC comparison groups made 8 or fewer prenatal care visits.

Pregnancy Outcome

In the WIC group, 1.2% (N=12) of the teenage pregnancies resulted in stillbirths, whereas 1.1% of the non-WIC teenagers had stillborns (Table 5). There were 989 and 6242 livebirths to women in the WIC and non-WIC groups, respectively. Of these, the percentage of males and females in both groups were similar with a slightly greater percentage of males in both groups. The percentage of twins was twice as great in the non-WIC group (1.3%) compared with the WIC group (0.6%). Congenital malformations were reported in 1.6% of the infants born to WIC teenagers and 1.2% of those born to non-WIC teenagers.

TABLE 5
Pregnancy outcome of Kansas teenagers

	WIC		Non-WIC	
	N[1]	Percentage	N[1]	Percentage
Total births	1001	100.0	6310	100.0
Livebirths	989	98.8	6242	98.9
Sex of infant				
Male	525	53.1	3224	51.6
Female	464	46.9	3018	48.4
Congenital malformations				
None	973	98.4	6170	98.8
Malformation reported	16	1.6	72	1.2
Birth weight (g)				
< 2500	92	9.3	537	8.6
≥ 2500	897	90.7	5705	91.4
Sets of twins	3	0.6	41	1.3
Stillbirths	12	1.2	68	1.1

[1]N varies because of missing data.

The mean birth weights of infants born to WIC and non-WIC teenagers were 7.04 and 7.16 lb, respectively. WIC teenagers had a greater percentage (9.3%) of liveborn infants weighing less than 2500 g than did non-WIC teenagers (8.6%) (Table 5). In the WIC group, 16.0% of the liveborn infants were delivered prior to 37 wk gestation compared with 12.8% in the non-WIC group (Table 2). In contrast to these findings, Seiler and Fox (12) reported no incidence of low birth weight infants born to 30 Nebraska girls age 16 yr and younger. In Vermont, Ancri et al. (13) found that 10% of the infants born to 98 women who were primarily Caucasian weighed 2500 g or less at birth and all were delivered between 31 and 38 wk gestation. A slightly higher percentage (13%) of the 346 low-income pregnant women in East Harlem, New York (18) gave birth to infants weighing less than 2500 g. Kotelchuck et al. (9) and Kennedy et al. (10) reported a significantly lower incidence of low birth weight infants born to prenatal WIC participants than to non-WIC women. In the study conducted by Kotelchuck et al. (9), the incidence of low birth weight infants was 6.9%, while 8.7% of the births to non-WIC women were low birth weight. Similarly, Kennedy et al. (10) reported a 6.0, 8.8, and 10.1 percent incidence of low birth weight infants born to WIC, non-WIC, and C_1 comparison group women (pregnant women who had applied for WIC but were not certified because the program had no openings or who were certified post partum).

Apgar Scores. The Apgar scoring system is a useful aid in evaluating the condition of an infant at birth. The infant is rated at 1 and 5 min for heart rate, respiratory effort, muscle tone, reflex irritability, and color. Each of these conditions is rated from 0 to 2 and then totaled. Apgar scores of 7 to 10 generally indicate that an infant is in excellent condition.

The percentage of infants with 1 and 5 min Apgar scores in each of the scoring categories were similar between the WIC and non-WIC groups. At 1 min more than 85% of the infants born to mothers in each group scored from 7 to 10, and at 5 min, more than 95% attained scores between 7 and 10 (Table 6). Similarly, Springer et al. (15) found that the majority of the 204 infants born to women participating in the Detroit Maternity and Infant Care Project had Apgar scores of 7 to 10 at birth. The mean scores of the infants were 8.0 and 9.4 at 1 and 5 min, respectively. In a food supplementation study conducted in Philadelphia (25), infants of supplemented mothers had significantly lower 5 min Apgar scores than did infants of non-supplemented mothers. The mean values of infants in both groups, however, were judged to be high.

TABLE 6
Apgar scores of infants born to Kansas teenagers

Score	WIC		Non-WIC	
	N[1]	Percentage	N[1]	Percentage
One minute				
0-3	28	3.2	171	3.1
4-6	74	8.5	532	9.5
7-10	770	88.3	4903	87.4
Five minute				
0-3	8	0.9	49	0.9
4-6	22	2.5	131	2.3
7-10	839	96.6	5405	96.8

[1]N varies because of missing data.

WIC Participation

The mean proportional dollars spent by WIC teenagers during pregnancy for supplemental foods was $120.71 (Table 7). About three-fifths of the WIC teenagers purchased $50.00 - $100.00 worth (proportional voucher dollar sum) of supplemental foods during the gestation period, while approximately one-fifth purchased $175.00 or more.

TABLE 7
Mean, standard deviation, and coefficient of variation of the proportional voucher dollar sum for Kansas WIC teenagers during pregnancy

	N	$\overline{X}$	SD	CV
				%
Proportional voucher dollar sum	764	120.71	91.86	76.1

	N	Percentage
Proportional voucher dollar sum		
$\leq$ 24.00	50	6.5
25.00 - 49.00	104	13.7
50.00 - 74.00	111	14.5
75.00 - 99.00	111	14.5
100.00 - 124.00	85	11.1
125.00 - 149.00	73	9.6
150.00 - 174.00	80	10.5
175.00 - 199.00	42	5.5
$\geq$ 200.00	108	14.1

Factors Affecting Birth Weight

Race

The analysis of covariance for effects of selected variables on infant birth weight showed significant differences in the birth weight of infants among women of different races for both WIC (N=515) and non-WIC teenagers (N=4297) (Table 8). The least squares means and standard errors for race are listed in Table 9. Kennedy et al. (10) studied factors affecting the birth weight of infants born to Massachusetts prenatal WIC participants using multiple regression analysis. They reported that sociodemographic factors including racial/ethnic group did not influence prenatal outcome when biological variables were held constant. The significant differences in mean birth weights among the races studied were attributed to differences in the total weight gains of the mother and in gestational age at birth in the various racial/ethnic groups.

TABLE 8
General linear model analysis of covariance for effects of selected variables on infant birth weight for Kansas WIC and non-WIC teenagers

Source of variation	WIC			Non-WIC		
	df	Mean squares	F	df	Mean squares	F
Maternal race	3	4.29	3.87**	4	23.57	19.94***
Pregravid weight (lb)	1	7.89	7.12**	1	67.44	57.04***
Pregravid weight square	1	3.76	3.40	1	33.39	28.24***
Maternal weight gain (lb)	1	6.08	5.49*	1	179.42	151.76***
Maternal weight gain square	1	0.05	0.04	1	56.27	47.60***
Proportional voucher dollar sum	1	0.93	0.84			
Error	506	1.11		4288	1.18	
R^2	0.2063			0.1673		

* $p \leq 0.05$ ** $p \leq 0.01$ *** $p \leq 0.001$

TABLE 9
Least squares means and standard errors for race of Kansas WIC and non-WIC teenagers from analysis of effects of selected variables[1]

Race	Least squares means and standard errors	
	WIC	Non-WIC
White, Mexican, Puerto Rican, and all other Caucasians	7.3088 ± 0.0611	7.3056 ± 0.0180
Black	6.9906 ± 0.0736	6.8788 ± 0.0453
Indian	7.4784 ± 0.3982	7.5643 ± 0.1922
Asian or Pacific Islander, excluding Hawaiian and Filipino	6.9002 ± 0.7548	7.4038 ± 0.2914
Cajun or Creole		7.4625 ± 0.7692

[1]Data presented only for significant findings.

Biological Factors

Maternal weight gain and pregravid weight were associated significantly and independently with birth weight (Table 8). For each additional 1 lb increase in maternal weight gain, the birth weight of infants born to WIC teenagers increased by 0.0352 lb (Table 10). For pregravid weight there was a tendency, although not significant ($p = 0.06$), for the rate of increase in birth weight to decrease as the pregravid weight of the WIC teenager increased (Table 8).

In the non-WIC comparison group, all maternal biological variables tested had a significant impact on birth weight (Table 8). Unlike the WIC teenagers, both maternal weight gain and the square term were associated ($p \leq 0.001$) with birth weight. The fact that both terms were significant indicated a curvilinear relationship to birth weight.

TABLE 10
Partial regression coefficients and standard errors from analysis of effects of selected variables on infant birth weight for Kansas WIC and non-WIC teenagers

Variables	WIC		Non-WIC	
	$\hat{B}_i$	Std error	$\hat{B}_i$	Std error
Pregravid weight (lb)	0.0317	0.0119	0.0371	0.0049
Pregravid weight square	-7.2965-05	0.0396-05	-9.0185-05	0.0170-05
Maternal weight gain (lb)	0.0352	0.0150	0.0655	0.0053
Maternal weight gain square	-4.4580-05	0.0022-05	-0.0005	0.7720-04
Proportional voucher dollar sum	-0.0005	0.0006		

Additionally, both pregravid weight and the square term showed associations ($p \leq 0.001$) with birth weight, also indicating a nonlinear relationship to birth weight. Pregravid weight exerted the greatest effect on birth weight in lighter-weight women.

Maternal weight gain, pregravid weight, the square terms of each, the proportional voucher dollar sum, and race accounted for 20.63% of the total variance in birth weight of infants born to WIC teenagers (Table 8). For non-WIC teenagers, those same variables excluding the proportional voucher dollar sum accounted for 16.73% of the variance.

Data from numerous studies (10, 11, 15, 19, 21-23) have shown significant associations between pregravid weight, maternal weight gain, and birth weight. In a study of 2 groups of pregnant San Francisco teenagers, King et al. (11) found that infant birth weight was associated positively with maternal weight gain of the mothers in both groups.

Springer et al. (15), Rush et al. (19), and Gormican et al. (23) reported that increases in maternal weight gain and pregravid weight were accompanied by increases in infant birth weight. Similarly, data from a study conducted by Simpson and coworkers (22) revealed a linear relationship between maternal weight gain and infant birth weight for all women studied, and the same relationship for pregravid weight and birth weight in black women. For white women, however, as pregravid weight rose above 160 lb there was no increase in birth weight.

Kennedy et al. (10) reported that maternal weight gain and gestational age exerted the greatest influence on birth weight. For each additional lb of maternal weight gain, birth weight increased by 0.02061 lb, while an added wk of gestation increased birth weight by 0.3699 lb. Both pregravid weight and the square term were associated significantly with birth weight indicating a curvilinear relationship to birth weight. Using multiple regression analysis, Niswander and Jackson (21) found that pregravid weight and maternal weight gain had a substantial effect on birth weight, and birth weight did not diminish with maternal weight gains of up to 30 lb.

WIC Participation

WIC supplemental feeding, as measured by the proportional value of the cashed vouchers for the pregnant teenager during the gestation period, showed no association with birth weight (Table 8). In contrast, data from other WIC studies (8-10), measuring the effect of WIC participation by length of maternal participation (8) or number of vouchers received (10) or redeemed (9) by the family during the woman's pregnancy have indicated a positive effect of WIC on pregnancy outcome.

In a nationwide evaluation of WIC program benefits, Edozien et al. (8) reported that an increase in the mean birth weight of infants was associated with WIC program participation. Supplementation for a period of less than 3 months, however, had no effect on birth weight.

Kotelchuck et al. (9), investigating the effect of WIC participation on the pregnancy outcome of 4126 Massachusetts' prenatal WIC participants found that WIC participation was positively associated with a lower incidence of low birth weight infants and neonatal mortality compared to those of matched control women. There were no significant differences, however, in the mean birth weights of infants in the 2 groups. When duration of participation was examined according to the number of vouchers redeemed, WIC participation for 7-9 months was associated with increased birth weight ($p < 0.001$), and decreased incidence of low birth weight ($p < 0.001$) and neonatal mortality ($p < 0.05$). No positive associations were noted for women who participated in WIC 1 to 3 months.

In another study of Massachusetts prenatal WIC participants, Kennedy et al. (10) found a significant difference in the mean birth weights of infants born to WIC and non-WIC participants. Using multiple regression analysis to determine factors that contributed to the higher birth weights of infants born to WIC mothers, the researchers reported that WIC participation (yes/no) and the number of vouchers received were associated positively with birth weight. As participation increased from none to 7 or more months, there was a concurrent rise in birth weight which translated into a decrease in the incidence of low birth weight infants born to WIC mothers.

Results of non-WIC nutrition interventions have generally been less conclusive. Rush (24) found that the mean birth weight of infants born to women who participated in the Montreal Diet Dispensary Service was 40 g greater ($p < 0.05$) than those of infants born to matched control women. In contrast, 3 food supplementation studies (25-27) conducted in the United States failed to show positive effects of the intervention on pregnancy outcome. Adams et al. (26) and Rush et al. (27) found no significant differences in the birth weights of infants born to supplemented and non-supplemented women. Osofsky (25) reported significant differences in infant birth weight, length, and head circumference with the infants of supplemented mothers having lower values than those whose mothers were not supplemented.

Comparison of the Partial Regression Coefficients of Selected Maternal Variables Between WIC and Non-WIC Teenagers

The partial regression coefficients for pregravid weight, maternal weight gain, and the square terms of each (Table 10) did not differ ($p < 0.05$) between the WIC and non-WIC teenagers. Although the pregravid weight and maternal weight gain were associated significantly with birth weight for both groups, the magnitude of the effect of these variables on birth weight did not differ between the groups. The square terms for pregravid weight and maternal weight gain were significantly associated with the birth weight of infants born to non-WIC but not WIC teenagers. The impact of these variables between the groups was not different.

Subset II Teenagers

Subset II was comprised of teenagers, 19 yr and younger, with $W \neq 1$, indicating that these teenagers did not participate in WIC during the pregnancy under study or that it was not possible to verify their WIC participation. Means, standard deviations, and coefficients of variation for maternal biological variables of those teenagers are listed in Table 11 (Appendix B). Frequency distributions and percentages for maternal biological, social, and behavioral variables, pregnancy outcome, and Apgar scores are recorded in Tables 12-16 (Appendix B). The analysis of covariance for the effects of selected variables on infant birth weight for the Subset II teenagers (N=164) and the least squares means and standard errors for race are listed in Tables 17 and 18 (Appendix B). The partial regression coefficients and standard errors from the analysis are recorded in Table 19 (Appendix B).

SUMMARY

The effect of WIC supplemental feeding and selected maternal variables on the birth weight of infants born to teenage prenatal WIC participants, 19 yr and younger, who gave birth in Kansas between July 1, 1979 and June 30, 1980 were investigated. The influence of the same maternal variables on the birth weight of infants born to Kansas teenagers who gave birth during the same time period but did not participate in the WIC program were examined, and the impact of each variable on birth weight was compared between the 2 groups.

Data for the study were extracted from 2 previously collected but unlinked data sets. The WIC files provided documentation of the names of prenatal WIC participants along with the extensiveness of their WIC participation. The Kansas Birth History Master File was the source of data on maternal variables and pregnancy outcome for all women giving birth during the study period. Birth certificate numbers were hand-linked to corresponding WIC case numbers to derive the teenage WIC group. Data on teenagers remaining in the Birth History Master File served as the non-WIC comparison group. Pregnancy outcome data were available for 1001 WIC and 6310 non-WIC teenagers.

The mean age of teenage WIC participants was 17.6 yr and about 42% of these teenagers were 17 yr or less at the time of delivery, while the mean age of non-WIC teenagers was 17.9 yr, and a smaller percentage were 17 yr or less at delivery. More than two-thirds of the teenagers in each group weighed between 100-139 lb prior to pregnancy, and almost all teenagers in both groups were 60-69 in tall. A greater percentage of the WIC teenagers were black (39.6%) in contrast to the comparison group (15.2%).

In the WIC group approximately 61% were unmarried and 39% were married, while the percentages in the comparison group were reversed. About three-fifths of the women in both groups began prenatal care in the first trimester, and less than 1.0% in each group received no prenatal care.

WIC teenagers had a greater percentage (9.3%) of liveborn infants weighing less than 2500 g than did non-WIC teenagers (8.6%). Most of the 1 and 5 min Apgar scores of infants born to WIC and non-WIC teenagers were high; approximately 85% and 95% of infants born to mothers in each group scored from 7 to 10 at 1 and 5 min, respectively.

The analysis of covariance for the effects of selected variables on infant birth weight indicated that there were significant differences in the birth weight of infants among women of different races in both the WIC (N=515) and non-WIC comparison group (N=4297). For WIC teenagers, maternal weight gain and pregravid weight were associated significantly with infant birth weight. WIC supplemental feeding, as measured by the sum of the proportional value of the cashed vouchers for the pregnant teenager during the gestation period, had no effect on birth weight. In the non-WIC comparison group maternal weight gain, pregravid weight, and the square terms of each were associated significantly with infant birth weight, indicating a nonlinear relationship between each of these variables and birth weight. The magnitude of the effect of maternal weight gain, pregravid weight, and the square terms of each did not differ between the WIC and non-WIC teenagers.

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APPENDIXES

APPENDIX A

Data Extracted from the Kansas Birth History

Master File 1979-80

Data Extracted from the Kansas Birth History Master File 1979-80

Maternal Biological Variables

age
height
weeks gestation
weight gain
pregravid weight

Maternal Social Variables

race
marital status
education

Maternal Behavioral Variables

smoking habits
prenatal care
- number of visits
- month care began

Pregnancy Outcome

livebirths
- sex of infant
- congenital malformations
- birth weight
- twins
- Apgar scores

stillbirths

APPENDIX B

Tables for Subset II Teenagers

TABLE 11
Means, standard deviations, and coefficients of variation of maternal biological variables of Kansas teenagers in Subset II

Variables	N[1]	$\overline{X}$	SD	CV
				%
Age (yr)	567	17.71	1.30	7.4
Pregravid weight (lb)	364	126.56	22.65	17.9
Height (in)	330	64.02	2.48	3.9
Weight gain (lb)	364	28.42	11.71	41.2
Weeks gestation	536	39.04	3.75	9.6

[1]N varies because of missing data.

TABLE 12
Maternal biological variables of Kansas teenagers in Subset II

Variables	N[1]	Percentage
Age (yr)		
13	1	0.2
14	9	1.6
15	30	5.3
16	65	11.4
17	106	18.7
18	152	26.8
19	204	36.0
Pregravid weight (lb)		
≤ 99	24	6.6
100-119	109	29.9
120-139	151	41.5
140-159	56	15.4
160-179	11	3.0
≥ 180	13	3.6
Height (in)		
≤ 59	5	1.5
60-64	199	60.3
65-69	124	37.6
≥ 70	2	0.6
Weight gain (lb)		
0-10	10	2.7
11-20	99	27.2
21-30	120	33.0
31-40	84	23.1
≥ 41	51	14.0
Weeks gestation		
< 37	81	15.1
37-42	405	75.6
> 42	50	9.3

[1]N varies because of missing data.

TABLE 13
Maternal social variables of Kansas teenagers in Subset II

Variables	N[1]	Percentage
Race		
White, Mexican, Puerto Rican, and all other Caucasians	371	65.4
Black	183	32.3
Indian	9	1.6
Asian or Pacific Islander, excluding Hawaiian and Filipino	3	0.5
Cajun or Creole	1	0.2
Marital status		
Married	249	43.9
Unmarried	318	56.1
Education (yr)		
1-8	43	7.6
9-12	378	89.2
13-15	18	3.2

[1]N varies because of missing data.

TABLE 14
Maternal behavioral variables of Kansas teenagers in Subset II

Variables	N[1]	Percentage
Smoking habits		
Smoker	16	3.5
Non-smoker	440	96.5
Prenatal care		
Number of visits		
< 9	183	32.8
≥ 9	375	67.2
Month care began		
no care	5	0.9
1-3	326	58.7
4-6	191	34.4
7-9	33	6.0

[1]N varies because of missing data.

TABLE 15
Pregnancy outcome of Kansas teenagers in Subset II

	N[1]	Percentage
Total births	572	100.0
Livebirths	567	99.1
Sex of infant		
Male	279	49.2
Female	288	50.8
Congenital malformations		
None	560	98.8
Malformation reported	7	1.2
Birth weight (g)		
< 2500	72	12.7
≥ 2500	495	87.3
Sets of twins	5	1.8
Stillbirths	5	0.9

[1]N varies because of missing data.

TABLE 16
Apgar scores of infants born to Kansas teenagers in Subset II

Score	N[1]	Percentage
One minute		
0-3	8	1.6
4-6	55	11.3
7-10	425	87.1
Five minute		
0-3	2	0.4
4-6	12	2.5
7-10	472	97.1

[1]N varies because of missing data.

TABLE 17
General linear model analysis of covariance for effects of selected variables on infant birth weight for Kansas teenagers in Subset II

Source of variation	df	Mean squares	F
Maternal race	4	3.42	4.29**
Pregravid weight (lb)	1	4.24	5.32*
Pregravid weight square	1	3.07	3.85*
Maternal weight gain (lb)	1	0.83	1.04
Maternal weight gain square	1	0.03	0.04
Voucher dollar sum	1	0.00	0.00
Error	154	0.80	
R^2			0.2267

* $p \leq 0.05$ ** $p \leq 0.01$

TABLE 18
Least squares means and standard errors for race of Kansas teenagers in Subset II from analysis of effects of selected variables[1]

Race	Least squares means and standard errors
White, Mexican, Puerto Rican, and all other Caucasians	7.3183 ± 0.0876
Black	6.7595 ± 0.1318
Indian	7.8517 ± 0.5224
Asian or Pacific Islander, excluding Hawaiian and Filipino	6.8618 ± 0.9092
Cajun or Creole	8.6622 ± 0.9220

[1]Data presented only for significant findings.

TABLE 19
Partial regression coefficients and standard errors from analysis of the effects of selected variables on infant birth weight for Kansas teenagers in Subset II

Variables	$\hat{B}_i$	Std error
Pregravid weight (lb)	0.0908	0.0394
Pregravid weight square	-0.0003	0.0002
Weight gain (lb)	0.0235	0.0230
Weight gain square	-6.5333-05	0.0003
Voucher dollar sum	-1.9752-05	0.0005

EFFECT OF WIC PROGRAM PARTICIPATION ON PREGNANCY OUTCOME OF KANSAS TEENAGERS

by

KIMBERLY ANN LIOTTA

B.S., Kansas State University, 1978

AN ABSTRACT OF A MASTER'S THESIS

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