THE INFLUENCE OF CHRONOLOGICAL AGE, GYNECOLOGICAL AGE, PREGRAVID BODY WEIGHT FOR HEIGHT, MATERNAL WEIGHT GAIN, AND PRENATAL CARE ON PREGNANCY OUTCOME IN ADOLESCENCE

by

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1. INTRODUCTION

In 1978, more than 1.1 million adolescent women in the United States, or 11 percent of all females aged 15 to 19 in the country, experienced a pregnancy. The pregnancies resulted in 543,000 births, 419,000 abortions, and an estimated 150,000 miscarriages and other fetal deaths (Dryfoos 1982).

Adolescent pregnancies are associated with potential risk. Not only do pregnant adolescents experience more social stress, but they also have more physiological problems such as toxemia, premature births, and iron-deficiency anemia. Maternal mortality and perinatal mortality have been found to be twice as common in teenagers, particularly younger ones, as in adults (Sacker and Neuhoff 1982).

Neonatal mortality rates are notably high for low birth weight infants, which are those weighing less than 2,500 grams at birth. Low birth weight infants delivered preterm before the 37th week of gestation are physiologically different from low birth weight infants born at term, or after the 37th week.

Preterm infants have not completed fetal growth because of their shorter gestation time. Since the fetus acquires two-thirds of its weight but only one-third of its length in the last 12 weeks of gestation, early delivery results in greater deficit in weight than in length and low body fat content. The weight of the preterm infant is usually consistent with gestational age.

Low birth weight infants born at term, in contrast to term infants of greater weight, have a deficit in fetal growth, which is an index of total somatic growth. Body organs are smaller, enzyme and hormone production may be limited, and bone age retarded. They are small for gestational age (Beal 1980).

Epidemiological studies show that mothers under 15 years of age are at about twice the average risk of having a preterm or low birth weight infant as older women, and the percentage of liveborns weighing less than 2,500 grams is much higher in nonwhite than in white women (Figure 1, Stickle and Ma 1975).

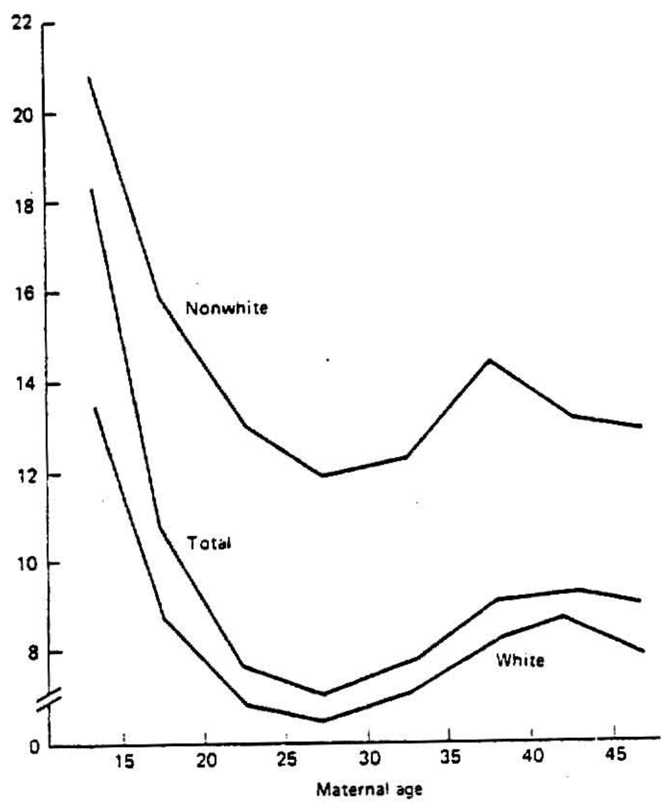

Figure 1: Percent of liveborns weighing 2.5 kilograms or less, by maternal age and race, United States 1968 (Stickle and Ma 1975)

In this report the physiological changes and nutritional needs ot the pregnant adolescent will be outlined. This will provide the basic knowledge for the following review of studies, which deal with the influences of chronological age, gynecological age, pregravid body weight for height, maternal weight gain, and prenatal care on the birth weight of infants of adolescent mothers. If risk factors associated with a low birth weight are identified, appropriate care could be given to pregnant adolescents and their infants.

2. PHYSIOLOGICAL CHANGES AND NUTRITIONAL NEEDS OT THE PREGNANT ADOLESCENT

Adolescence is a time of accelerated physical growth and development. The character and timing of physical growth and sexual maturation vary greatly among individuals. In general, the pubertal acceleration in growth occurs in girls prior to menarche at the age of 10 1/2 to 13 years, although linear growth is not completed until 4 years postmenarche. Since the average age of menarche in the United States is 12 1/2 to 13 years of age, females generally reach their final height between the age of 16 1/2 and 17 years (Worthington-Roberts 1981).

In early maturing girls (10 to 12 years) peak height velocity occurs at a younger age followed by menarche about 6 months later. In late maturing girls (13 to 15 1/2 years) the longer time interval of more than 1 1/2 years between peak height velocity and menarche suggests a general slowing of the entire pubescent sequence (Beal 1980, Figure 2). Figure 3 shows that peak weight velocity occurs slightly later than peak height velocity (Thomson 1976).

Nutrient needs during puberty and adolescence depend primarily on the rate of growth. Requirements increase from childhood levels at the onset of the growth spurt, reach their maximum at the time of peak growth and gradually approach adult levels with decreasing growth rate. During pregnancy the women requires not only nutrients and energy to maintain her own body but also those for growth of the placenta, supporting tissues, and fetus, as well as the tissues to prepare for lactation. Because body weight is increased there is also increased workload of movement, and consequently increased energy needs during gestation (Beal 1980).

The impact of growth rate on the nutritional requirements in pregnant adolescents is controversial. According to Thomson (1976) average growth rates

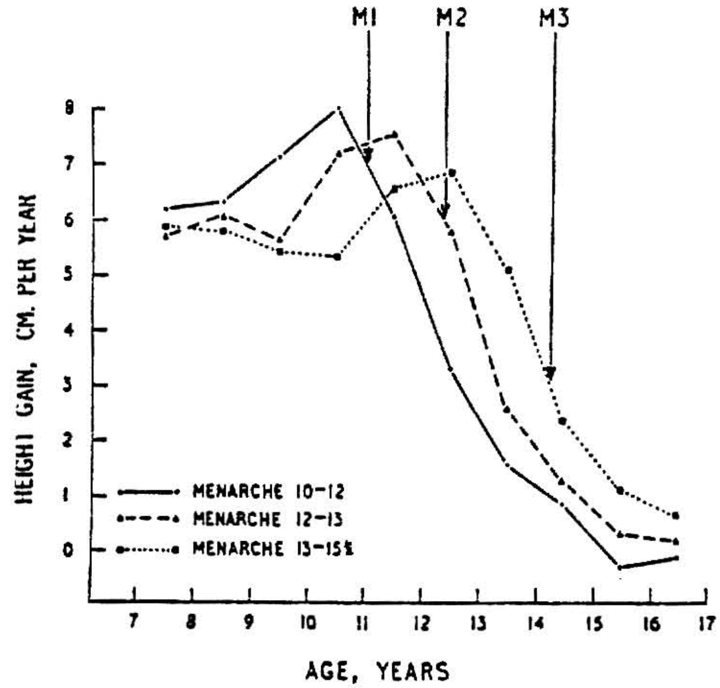

Figure 2: Relation of peak height velocity to age at menarche in early, average, and late maturing girls (Tanner 1962)

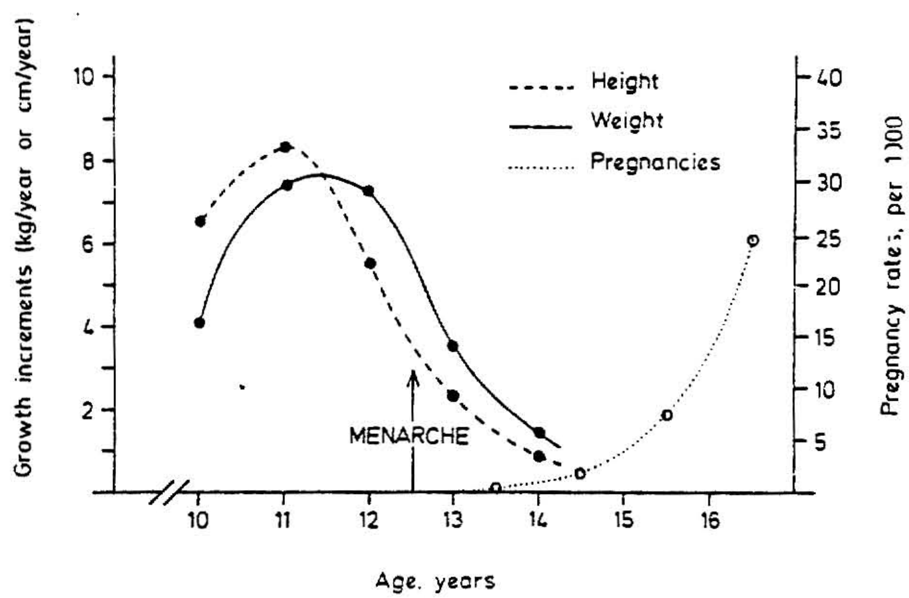

Figure 3: Growth rates around mean age of menarche and incidence of pregnancies by age (Thomson 1976)

in both height and weight are diminishing rapidly by age 12, and from a nutritional point of view are likely to be negligible after age 14. He concludes that pregnant adolescents 15 years of age and older do not have nutritional needs different from any other pregnant women.

Thomson's findings have not been substantiated by other investigators. Naeye (1981), Meserole et al. (1982) and Zlatnik and Burmeister (1977) found higher pregnancy weight gains in pregnant adolescents than in pregnant adults although the infants' birth weight was not higher in adolescent mothers than in adult mothers. This would suggest that the nutritional needs of pregnant adolescents exceed to some extent those of pregnant adult women since these girls are still growing. Only when the period of growth is completed (usually about 17 years of age), is the adolescent considered to be physiologically mature with similar nutritional demands for normal pregnancy as adult women (Worthington-Roberts 1981).

Inadequate information is available for defining requirements of the pregnant adolescent. The existing calculations are based largely on the interpretation and judgement of individuals or committees. The Recommended Dietary Allowances for pregnancy (Table 1) are obtained by adding the known or estimated increments during pregnancy to the age-specific nonpregnant recommendations. Consequently, the recommended energy intake for pregnant women younger than 15 years and protein intake for pregnant women younger than 19 years is greater than that for pregnant women 19 to 22 years of age. The recommended vitamin D-, calcium-, and phosphorus-intakes are higher for pregnant adolescents under 19 years of age than they are for pregnant women 19 to 22 years of age.

Because adolescent women vary greatly in their growth rates, age of menarche and response to pregnancy the nutritional recommendations can be

Table 1: Recommended Dietary Allowances during pregnancy (National Academy of Sciences 1980)

Age	11–14 years	15–18	19–22	Pregnant
Weight (kg) (lb)	46 101	55 120	55 120	
Height (cm) (in.)	157 62	163 64	163 64	
Nutrient Needs				
Energy (with range) (kcal)	2200 (1500–3000)	2100 (1200–3000)	2100 (1700–2500)	+300
Protein (g)	46	46	44	+30
Vitamin A[1] (mcg R.E.)	800	800	800	+200
Vitamin D[2] (mcg)	10	10	7.5	+5
Ascorbic Acid (mg)	50	60	60	+20
Folacin (mcg)	400	400	400	+400
Niacin (mg N.E.)[3]	15	14	14	+2
Riboflavin (mg)	1.3	1.3	1.3	+0.3
Thiamin (mg)	1.1	1.1	1.1	+0.4
Vitamin B_6 (mg)	1.8	2.0	2.0	+2.0
Vitamin B_{12} (mcg)	3.0	3.0	3.0	+1.0
Calcium (mg)	1200	1200	800	+400
Phosphorus (mg)	1200	1200	800	+400
Iron (mg)	18	18	18	—[4]

[1]1 R.E. = 1 mcg retinol or 6 mcg B carotene.
[2]As cholecalciferol. 10 mcg cholecalciferol = 400 IU vitamin D
[3]1 N.E. = 1 mg niacin or 60 mg dietary tryptophan.
[4]The increased requirement during pregnancy cannot be met by the iron content of habitual American diets or by the existing iron stores of many women. Therefore, the use of 30–60 mg of supplemental iron is recommended.

accepted only as tentative estimates until more accurate information is available. The actual nutrient needs of an individual pregnant adolescent are not known (Beal 1980). However, the Recommended Dietary Allowances are supported by the findings of Naeye (1981), Meserole et al. (1982), and Zlatnik and Burmeister (1977) for pregnant adolescents.

3. FACTORS AFFECTING THE BIRTH WEIGHT OF THE INFANT

3.1. Chronological age

In a 1979 statement on teenage pregnancy, the Committee on Adolescence of the American Academy of Pediatrics observed a greater incidence of low birth weight infants born to teenage women than those born to adult women. More recently a 1981 Amendment to Public Law 95-626 on Adolescent Family Life acknowledged a higher percentage of low birth weight infants among unmarried adolescents, particularly younger adolescents, than in adult women.

In a study on maternal health and neonatal development at Boston City Hospital, Zuckerman et al. (1983) compared 275 infants of primiparous adolescents (aged 13 to 18 years at delivery) with 423 infants of primiparous adults. The racial distribution of the mothers in both samples was:

	Adolescents	Adults
	%	%
Black	68	57
Hispanic	17	21
White	15	22

The percentage of adolescent black mothers was significantly higher than adult black mothers ($p < 0.003$). Univariate analyses were used to determine whether the study sample of adolescent and adult mothers differed in maternal characteristics, labor and delivery events, and neonatal outcome measures.

The comparison of the adolescent and adult mothers showed that the pregnant adolescents entered prenatal care later, were more likely to have a gonococcal infection during pregnancy, and had lower pregravid weight. The primiparous adolescents were less likely to engage in several behaviors that are thought to adversely affect fetal growth, such as cigarette smoking, alcohol consumption, and psychoactive drug use, than the adults.

The only statistically significant difference in the neonatal outcome measures between the two groups was that adolescent mothers delivered infants whose mean weight was 94 grams less ($p < 0.03$) than infants of adult mothers. Because the adolescent and adult mothers varied on many characteristics that might influence infant outcome, multivariate analyses were performed to determine the individual contribution of each variable and whether adolescent status was independently associated with adverse outcomes. These analyses demonstrated that adolescent status was not significantly related to the gestational age at birth or birth weight of the infants of these primiparous mothers. The regression analysis of birth weight is given in Table 2. The beta-coefficient describes the relative importance of each independent variable in explaining variation in the infant birthweight. Mothers who gained less weight during pregnancy, weighed less prior to pregnancy, were black, delivered male infants, and smoked marijuana during pregnancy were more likely to deliver infants of lower birth weights.

Table 2: Multiple regression analysis on birth weight* (Zuckerman et al. 1983)

Dependent Variable	Independent Variables†	Increase in R^2	β-Coefficient
Birth weight	Gestational age	.28	.49
	Weight change during pregnancy	.03	.18
	Weight prior to pregnancy	.03	.17
	Black/nonblack	.02	.10
	Sex of infant	.01	−.10
	Marijuana use	.01	−.08

* $N = 562$; $R = .63$; $R^2 = .40$.
† Variables significantly related to birth weight at $P < .05$.

The replication of these analyses, which assessed whether younger adolescent mothers (age 16 or younger) experienced poorer fetal outcomes, yielded the same results as for the older adolescent group (18 years and younger). These younger adolescents did not experience a significantly higher rate of adverse outcome than older adolescents or adults did.

The Johns Hopkins Child Development Study, begun in 1959, has provided an opportunity to examine possible adverse effects of adolescent pregnancy (Hardy et al. 1978). Women were closely followed through pregnancy, labor, delivery, and the postpartum period. Their surviving children were evaluated by various pediatric, neurologic, and behavioral means through 8 years of age. A representative subsample of children has been studied at the 12-year level.

From January 1959 through summer 1965, 4557 women participated in the study. The women had lower-middle and lower socioeconomic backgrounds; 77 percent were black, and 23 percent were white. Data from a subset of 544 adolescents, 16 years of age and less at delivery, were examined separately.

Table 3 shows that the mean birth weight of infants of adolescents was 130 grams less, and the percentage of low birth weight infants (22 percent) was somewhat higher than the rate for the whole population (19 percent). The percentage distribution of low birth weights by maternal age and race (Figure 4) indicates that the mothers 16 years of age and younger had the highest proportion of low birth weight infants. In all age groups the percentage of low birth weight infants was much higher for black than white women, but the biggest difference between the two races was observed for mothers 16 years of age and younger.

Ancri et al. (1977) studied factors influencing the outcome of pregnancy in 98 women divided into 4 age groups: 26 women were 12 to 17 years of age, 22 were 18 to 19, 24 were 20 to 24, and 26 were 25 to 32. Subjects were

Table 3: Pregnancy outcome by maternal age in 4557 pregnancies (Hardy et al. 1978)

		Birth weight ≤ 2500 g		Mean	(SD)
Age in years	No.	No.	(%)		
≤ 16	544	119	(22)	2817.74	(704.5)
All ages	4557	860	(19)	2947.20	(728.598)

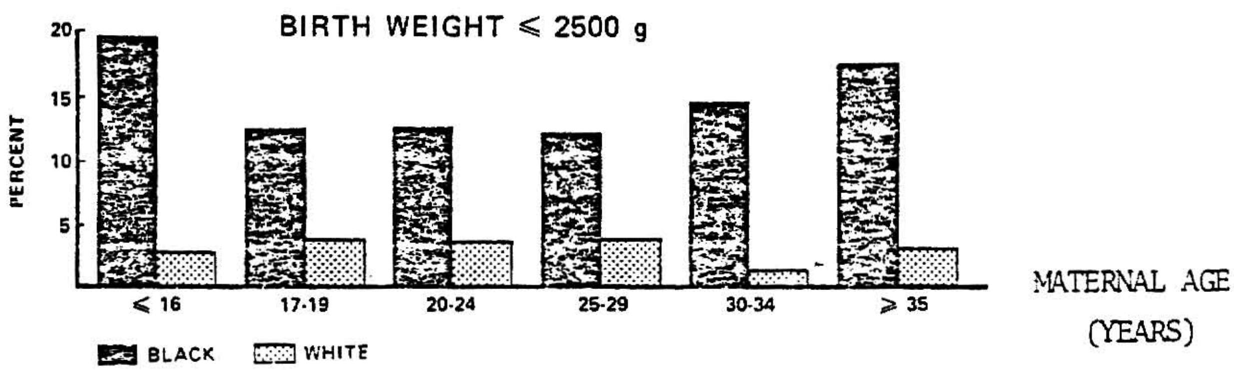

Figure 4: Distribution of low birth weight by maternal age and race (Hardy et al. 1978)

Caucasian, and obtained prenatal care from private physicians, a low-cost clinic, or within the home for unwed mothers in which they lived.

Most women were enrolled by the 20th week of gestation. On home visits at 4-week intervals the weight of subjects in indoor clothing without shoes was recorded using a portable spring balance. Because reliance on the memory of the participants of weight before conception might be of doubtful accuracy, weight gain before enrollment in the study and between the last contact and delivery was estimated according to the procedure of Thomson and Hytten (1966). A weight gain of 8.8 pounds was allocated for the first 20 weeks of pregnancy.

This was followed by an estimated gain of 1 pound/week during the second half of pregnancy which was used as a base line for calculating the weight gained for the few subjects enrolled after the 20th week when first data became available. The 1 pound/week was also used to estimate the weight gained in the period from the subject's last measurement to the actual time of delivery. The weights of the infants at birth were recorded by the hospital delivery room staff.

Analysis of variance showed a significant difference ($p < 0.001$) among the mean infant birth weights of the four age groups, with no significant interaction with gestational age. After the Scheffé procedure was applied to examine all possible linear combinations of group means, the only significant difference was between the mean infant birth weight of the 18 to 19-year-olds, the lightest, and that of the 25 to 32-year-olds, the heaviest.

Nine infants or almost 10 percent of the sample were born with a low birth weight of 2,500 grams or less. The mothers of the low birth weight infants were between 18 and 25 years old with an average of 20.7 years. No 12 to 17 year old had a low birth weight infant. The authors concluded that it is possible that the 12 to 17 year olds received more supervised prenatal care than did the 18 to 19 year olds, who had 5 low birth weight infants.

Other studies also revealed no differences between children of adolescent and older mothers when prematurity and low birth weight were compared. Rothenberg et al. (1981) investigated the relationship between maternal age and children's health and development at birth and at approximately 3 years of age. Subjects were 282 black and Hispanic women who delivered their first children in a New York City hospital in 1975. Hospital records showed that the mean birthweight of infants from mothers 19 years and younger (3185 grams), was not significantly different than that of infants from mothers 20 years and older (3176 grams).

King et al. (1972) studied social background, dietary intake, and clinical course and outcome of pregnancy in 18 pregnant teenagers in San Francisco during a 1-year period. The course and outcome of the pregnancies were evaluated from the medical charts. This was also done for a second group of 34 teenage girls to determine if the pregnancies of the girls in group I represented a sample typical of teenage pregnancies. The pregnant girls in both groups were 14 to 18 years old and were from various racial backgrounds.

The statistical analysis showed that birth weight was correlated with maternal weight gain during pregnancy ($p < 0.01$), but neither birth weight nor maternal weight gain were influenced by maternal age, height, or recorded dietary energy and nutrient intake.

Grazi et al. (1982) analyzed the records of all infants (N=925) born to teenage mothers at the Buffalo Children's Hospital, Buffalo, New York, during the years 1976 to 78 to determine whether there is an excess of chromosomal anomalies in the offspring of teenage mothers and also to provide information on the incidence of other problems such as low birth weight infants. The mothers were between 12 and 19 years old, 57 percent were white and 43 percent nonwhite. Statistics for all mothers at this institution (N=2,638) were used as control.

The occurence of low birth weight among infants born to all white and nonwhite teenagers (9.44 percent and 11.36 percent) was not significantly different from that among infants of racially matched mothers of all ages (8.24 percent and 12.67 percent). Furthermore, the incidence of low birth weight between the two teenage groups was similar. However, within each racial group frequency of low birth weight was consistently higher among younger teenagers. When studied as a single group, mothers under 18 years old did have a significantly higher frequency of low birth weight (12.63 percent) than the control group (9.25 percent, $p < 0.05$).

Miller and Merritt (1979) analyzed data from 770 white teenagers at the University of Kansas Medical Center and compared the results with those of mothers 20 to 34 years old. Both, the study and comparison groups differentiated between mothers with no history of fetal-growth-retarding factors, mothers with behavioral conditions associated with low birth weight infants, and mothers with medical complications of pregnancy. Maternal behavioral conditions associated with low birth weight infants included:

Abnormally low pregravid weight for height

Low maternal weight gain in pregnancy

Lack of any prenatal care

Cigarette smoking during pregnancy

Use of addicting drugs or consumption of large amounts of ethanol during pregnancy

Medical complications of pregnancy included:

Acute or chronic hypertension

Pre-eclampsia

Severe vaginal bleeding (third trimester)

Chronic diseases involving heart, liver, lungs, kidney, gastro-intestinal tract, thyroid, or adrenal glands

Disseminated lupus erythermatosus

Sarcoidosis

Severe chronic infections

Anemia (10 grams hemoglobin/deziliter)

Leukemia

Malignant solid tumors; large ovarian cysts

Continuous medication with steroids or immunosuppressive, teratogenic, or growth-retarding drugs

Polyhydramnios

Oligohydramnios

The weights of infants born to these teenagers in Kansas City were comparable to the weight of babies born to white mothers in all age groups (Table 4). Mothers 15 to 16 years of age did not have more medical or behavioral complications of pregnancy than those in the 17 to 19 year old group. Except in women less than 15 years of age, the incidence of known growth-retarding factors in the adolescent mothers was not different from that for mothers in the 24 to 30 years age group.

Table 4: Low birth weight infants born to 770 teenage mothers at the University of Kansas Medical Center (Miller and Merritt 1979)

Mother's age at delivery (years)	**Mothers with no history of fetal-growth-retarding factors**			**Mothers with behavioral conditions associated with low-birth-weight infants**			**Mothers with medical complications of pregnancy**		
	Number of mothers:	Low-birth-weight infants born to them:		Number of mothers:	Low-birth-weight infants born to them:		Number of mothers:	Low-birth-weight infants born to them:	
		No.	%		No.	%		No.	%
17-19	171	4	2.3	214	21	9.8	70	9	12.8
15-16	51	3	5.9	76	6	7.8	30	8	26.4
14 or less	2	1	50.0	6	2	33.3	5	0	0
Total	224	8	3.6	296	29	9.8	105	17	16.2
Comparison with mothers 20-34	384	8	2.3	248	26	10.5	†	†	†

† Data not available

Most low birth weight infants born to adolescent mothers in the Kansas City study were born to adolescents with associated fetal-growth-retarding behavioral conditions. The incidence of low birth weight infants born to adolescent mothers without known growth-retarding medical or behavioral conditions did not differ significantly from that of those born to control mothers (3.6 percent versus 2.3 percent). The researchers concluded that when maternal- and fetal-growth-retarding factors are excluded, there are no significant differences in prematurity, or in low birth weight rates among infants born to adolescent mothers when compared to 20 to 34 year old mothers. The findings of Rothenberg et al. (1981), King et al. (1972), and Grazi et al. (1982) also support the hypothesis that for primiparous women factors other than young age (16 years or less) are associated with low birth weight.

3.2. Gynecological age

Several authors investigated the use of gynecological age to predict the risk of delivery of a low birth weight infant. Gynecological age is defined as chronological age minus age at menarche and thus measures the physiological maturity of the pregnant adolescent.

Zlatnik and Burmeister (1977) investigated the records of 1,005 predominantly white patients, 17 years of age and younger, who delivered at the University of Iowa Hospital during a three-year period (1972-74). The gynecological age of each patient was determined by substracting her age at menarche (as given in the antepartum record) from her chronological age at delivery. The patients in each chronological age group were subdivided into gynecological age groups and the rates of delivery of low birth weight infants were determined. The chi-square test was applied to compare the incidence of low birth weight infants for various chronological and gynecological ages.

The results showed that mothers with chronological ages from 13 to 15 years had significantly higher percentages of low birth weight infants than the older age group from 16 to 17 years (12 percent versus 7 percent; $p < 0.05$). There was also a significantly higher percentage of low birth weight infants in mothers with gynecological ages of 1 to 2 years than in mothers with higher gynecological ages (13 percent versus 7 percent; $p < 0.05$).

Generally, mothers with low chronological ages also have low gynecological ages. Therefore one should consider the possibility that the gynecological age is only covariantly associated with the chronological age. If this were the case low gynecological age would always lead to an increased risk of delivery of low birth weight infants.

In order to prove that chronological age and gynecological age independently affect the percentage of low birth weight infants Zlatnik and Burmeister compared the incidence of low birth weight infants in mothers 15 years old and younger with gynecological ages above 2 years to that in 16 to 17 year olds with gynecological ages below 2 years. If gynecological age had no effect independent of chronological age, the chronological younger group predictably would have a greater percentage of delivery of low birth weight infants which was not true. The difference of the incidence of low birth weight infants in both groups is not significant (9.1 percent versus 9.3 percent).

Figure 5 shows the effects of both chronological age and gynecological age on the rates of delivery of low birth weight infants in the 1,005 study patients. It can be seen that risk of delivery of a low birth weight infant is increased by both young chronological age and young gynecological age.

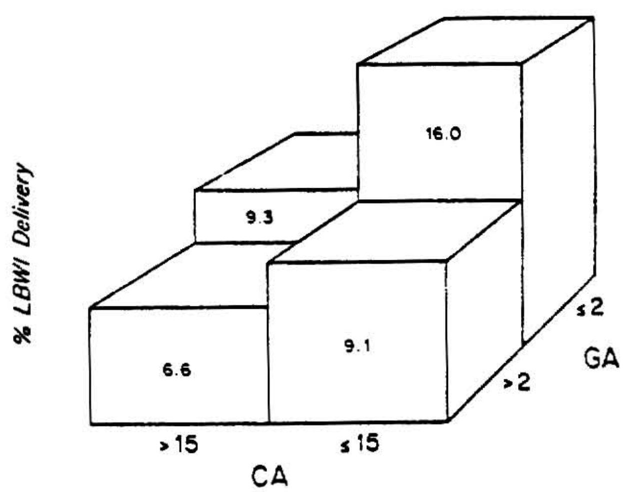

Figure 5: Graphic representation of the effects of both, chronological age (CA) and gynecological age (GA) on the rates of delivery of low birth weight infants (LBWI) in 1,005 study patients (Zlatnik and Burmeister 1977)

After analysis of this study population, Zlatnik and Burmeister examined the records of 129 patients 15 years old or less at delivery for the years 1970, 1971 and 1975 in order to increase the sample size to provide statistically significant results. The 129 patients were segregated by gynecological age, and the incidence of low birth weight infants were determined. Using the chi-square test, the data for all 15 year old patients from both study populations with gynecological age ≤ 2 years versus gynecological age >2 years were analyzed. There was a significant increased risk of delivery of low birth weight infants for 15 year old mothers with gynecological age ≤ 2 years versus that for mothers with the same chronological age but higher gynecological age (17 percent versus 9 percent; $p < 0.05$).

There were no discernible differences between the mothers delivered of heavier infants in terms of race, economic status, parity, or marital status. However, in this study the pregravid weight of the patients was not determined. It is possible that patients of low gynecological ages weighed less than those of higher gynecological ages. Therefore the changes in birth weight distribution observed may simply reflect an association between initial maternal weight and newborn weight.

If the gynecological age has significance of its own, nutritional influence may be involved. Because linear growth is not completed until 4 years after menarche a pregnant woman with a low gynecological age must satisfy the nutritional needs required for her own growth as well as those of her fetus. Menarche occurs closer to the growth spurt in girls with early menarche than it does in girls with late menarche (Figure 2). Zlatnik and Burmeister concluded that both chronological and gynecological age affect nutritional requirements in adolescents.

Meserole et al. (1982) developed curves for prenatal weight gain and postpartum weight loss in adolescents in a small sample. They showed that the weight gain of the adolescents exceeded the standard curves for prenatal weight gain in adult women (Figure 6). The weight gain in girls with a high gynecological age surpassed the adult standard curve right from the beginning. The total weight gain in this group was about 10 pounds higher than that for adults (Figure 7). Adolescents with low gynecological age fell below the adult standard curves in the first half of their pregnancy. At the 20th week they gained as much weight as adult pregnant women; and the total average weight gain was about 5 pounds higher than in adults. These findings of Meserole et al. substantiate Zlatnik and Burmeister's conclusions and show clearly that the weight gains are lower in pregnant adolescents with low gynecological age.

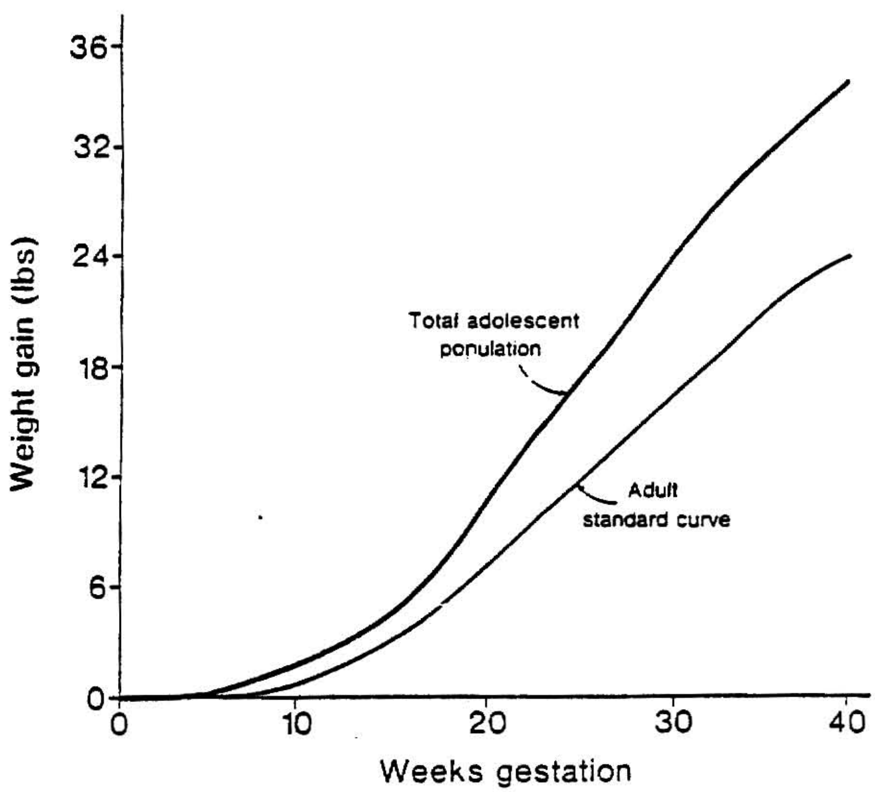

Figure 6: Prenatal weight gain: adolescents versus adults (Meserole et al. 1982)

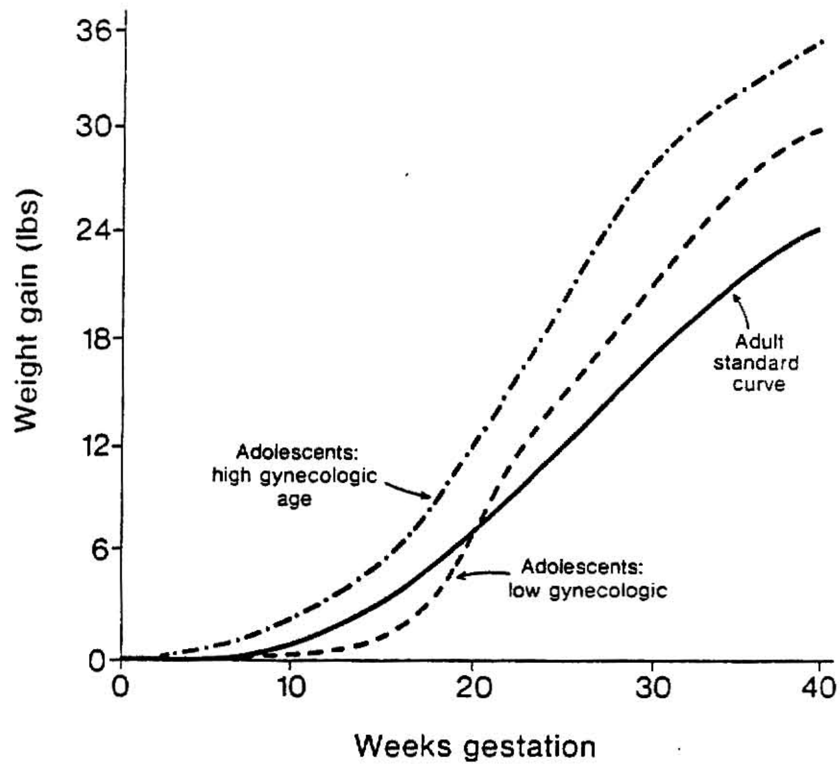

Figure 7: Weight gain in adolescents as a function of gynecological age (Meserole et al. 1982)

It might be expected that the lower weight gains in girls with low gynecological ages would result in a greater incidence of low birth weight deliveries in this group than in girls with high gynecological ages and higher weight gains. However, these data are not given in this study.

In the University of Kentucky Young Mother's Program Kotchen and Hollingsworth (in preparation) have evaluated the influence of low gynecological age ($<$ 2 years) and a young chronological age at conception ($\leq$ 16 years) on the outcome of pregnancy. Subjects were 406 primiparous teenagers with an age range of 12 to 18 years. Fifty-four percent were black, 46 percent were white and all were from a comparable low socioeconomic background. Gynecological age was calculated for 398 women in whom age at menarche was recorded.

The findings in 343 relatively mature (gynecological age $\geq$ 2 years) versus 55 relatively immature (gynecological age $<$ 2 years) pregnant adolescents are compared in Table 5. In the relatively immature group, age at menarche was significantly higher ($p < 0.0001$) and age at first intercourse significantly lower ($p < 0.0003$) than in the relatively mature group. No significant differences were found between the two gynecological age groups for pregravid weight, height at first clinic visit, or weight gain during pregnancy. In this population there were no differences in birth weight, length, head circumference, gestational age, or weight of the placenta for infants born to gynecologically less mature adolescents compared to those who were born to teenagers with a high gynecological age. In addition, there were no group differences found in number of health problems before pregnancy, amount of prenatal care, complications of pregnancy or delivery, condition of the infant at delivery, or the number or severity of neonatal problems.

The authors concluded that a low gynecological age ($<$ 2 years) could not be correlated with complications of pregnancy or neonatal outcome. However, it should be noted that in this study good prenatal care and a regional perinatal center were available to the mothers.

Table 5: Means of factors that influence or might influence pregnancy outcome by gynecological age of mother (Kotchen and Hollingsworth, in preparation)

	Gynecologic Age	
	≥ 2 Years (N = 343)	< 2 Years (N = 55)
Mothers		
Prepregnancy weight (lb)	125.6	119.9
Height (in)	63.6	63.4
Age at menarche (yr)	12.2	13.6*
Age at first intercourse (yr)	15.1	14.3**
Pregnancy weight gain (lb)	27.2	24.3
Infants		
Weight (gm)	3126.1	3052.4
Length (cm)	49.6	48.8
Placental weight (gm)	629.9	598.2
Gestational age (wk)	39.1	39.4
Head circumference (cm)	34.3	34.3
Infant's Father		
Age (yr)	19.3	19.0

*$p < 0.0001$.
**$p < 0.0003$.

3.3. Pregravid body weight for height and maternal weight gain

Pregravid body weight for height indirectly reflects nutritional stores of the mothers while weight gain during pregnancy reflects the calorie intake during this period. The relationships between pregnancy weight gain, pregravid body weight, and infant birth weight have been studied in adults (Gormican et al. 1980), but only a few studies are done with pregnant adolescents.

The Collaborative Perinatal Project of the National Institute of Neurological and Communicative Disorders and Stroke recorded information on gestation, labor, delivery, and the neonatal period in patients at 12 medical school-affiliated hospitals in different regions of the United States between 1959 and 1966. From this information Naeye (1981) analyzed the data from 13,830 black neonates to compare fetal growth in offspring of mothers of various ages. Mothers were placed in the following age categories for analysis: 10 to 14 years (N=161), 15 to 16 years (N=566), 17 to 19 years, and 20 to 32 years. Separate analyses were undertaken for 17-to 19-year old mothers, but the results were so similar to those of 20-to 32-year old mothers that the two age groups were combined in the presentation of the results (N=7295).

The data were stratified by pregravid body weight for height and pregnancy weight gain. Both were included as independent variables in analyses in this study. Each mother's pregravid weight for height was calculated as a percent of mean desirable values as published by the Metropolitan Life Insurance Company. Prepregnancy weights were recorded from interview information given by mothers at their first or second prenatal visit for medical care. Net pregnancy weight gain was calculated as maternal weight gain at the end of pregnancy minus the weight of the neonate and placenta. It included nutrients incorporated into maternal tissues during pregnancy, extracellular water including amniotic fluid, and other tissue nutrients. Height was not measured at the end of pregnancy. Because mothers' weights and heights after the postpartum period were not measured it was not possible to calculate the teenage mothers' growth during the prenatal and postpartum period.

Data were also stratified by maternal chronological age, gynecological age and cigarette smoking during pregnancy. Subjects of the 3 chronological age groups were initially categorized as underweight, normal sized, or overweight by comparing pregravid body weight for height of each subject with the mean desirable value published by the Metropolitan Life Insurance Company. Each of these 9 groups was further subdivided according to the net weight gain during pregnancy. Net weight gains of less than 4 kilograms were considered to be low, 4 to 8 kilograms were moderate, and those more than 8 kilograms were categorized as high. Using chi-square analysis and a three-way F test with one-way analysis of variance the following results were obtained. First, the group of younger mothers 10 to 14 years of age and normal sized or underweight before pregnancy had a higher incidence of growth-retarded neonates than older mothers ($p < 0.05$). Secondly, the birth weight between age groups did not differ significantly in mothers who were overweight before pregnancy (Table 6).

The same procedure was followed when the data were stratified by gynecological age and similar findings were observed (Table 7). A significantly lower birth weight was found in infants of normal-sized mothers with net weight gains of more than 8 kilograms and gynecological ages of 2 years and below when compared to normal-sized mothers with the same net weight gains but gynecological ages above 2 years ($p < 0.01$). This finding was even more significant when the mothers gained only 4 to 8 kilograms ($p < 0.005$). Again, the differences were not significant in overweight mothers. The lack of significant findings

Table 6: Birth weights of black infants by mothers' chronological age, pregravid body weight and maternal net pregnancy weight gain (Naeye 1981)

Mothers' Net Pregnancy Weight Gains†	Ages of Primigravidas (yr)			Birth Weights (gm)
	10–14	15–16	17–32	10–14
A. Less than 83%				
<4 kg	2,664 ± 260 (4)	2,876 ± 371 (5)	2,899 ± 279 (10)‡	...
4–8 kg	2,873 ± 313 (7)	3,040 ± 220 (5)	3,029 ± 284 (27)§	...
>8 kg	3,024 ± 297 (4)	3,189 ± 426 (7)	3,151 ± 409 (47)	...
B. 83%–120%				
<4 kg	2,836 ± 391 (14)	2,955 ± 454 (50)	3,037 ± 443 (221)§	...
4–8 kg	2,854 ± 351 (34)	3,052 ± 420 (115)	3,099 ± 440 (460) ‖	...
>8 kg	3,056 ± 383 (55)	3,143 ± 447 (160)	3,212 ± 426 (540)§	...
C. More than 120%				
<4 kg	3,083 ± 369 (12)	3,057 ± 390 (38)	3,054 ± 385 (164)	2,353 ± 240 (2)
4–8 kg	3,160 ± 516 (13)	3,127 ± 384 (36)	3,176 ± 437 (186)	...
>8 kg	3,237 ± 294 (16)	3,207 ± 397 (54)	3,241 ± 363 (232)	...

* Measurements are mean values ± 1 SD of full-term infants of nonsmoking mothers. Number of cases is shown in parentheses.
† Categories refer to mothers' pregravid body weights in percent of Metropolitan Life Insurance Co desirable values.
‡ $P < .1$.
§ $P < .05$.
‖ $P < .02$.
¶ $P < .01$.

Table 7: Birth weights of black infants by mothers' gynecological age, pregravid body weight and maternal net pregnancy weight gain (Naeye 1981)

Mothers' Net Pregnancy Weight Gains†	Birth Weight (gm) by Gynecologic Ages of Mothers (yr)				
	<1	1–2	2.01–3	3.01–5	>5
A. Less than 83%					
<4 kg	..	...	2,864 ± 381 (2)‡	..	2,914 ± 199 (4)
4–8 kg	..	3,034 ± 440 (3)	3,034 ± 280 (2)	2,930 ± 379 (6)	2,932 ± 285 (21)
>8 kg	2,353 ± 369 (3)	3,037 ± 392 (7)	3,078 ± 357 (6)	3,104 ± 414 (17)	3,153 ± 442 (31)§
B. 83%–120%					
<4 kg	2,982 ± 401 (6)	3,043 ± 516 (21)	2,994 ± 410 (29)	2,950 ± 407 (86)	3,056 ± 477 (142)
4–8 kg	2,709 ± 612 (12)	3,077 ± 430 (41)	2,968 ± 396 (61)	3,076 ± 375 (158)	3,103 ± 411 (333)‖
>8 kg	3,021 ± 431 (24)	3,102 ± 451 (58)	3,168 ± 444 (72)	3,132 ± 403 (204)	3,227 ± 423 (395)§
C. More than 120%					
<4 kg	3,060 ± 714 (7)	3,045 ± 480 (15)	3,132 ± 357 (31)	3,034 ± 343 (53)	3,06[illegible] ± 420 ([illegible])
4–8 kg	3,023 ± 428 (6)	3,033 ± 567 (10)	2,979 ± 381 (14)	3,188 ± 378 (51)	3,179 ± 449 ([illegible])
>8 kg	3,232 ± 260 (3)	3,178 ± 435 (17)	3,300 ± 350 (23)	3,235 ± 373 (70)	3,232 ± 365 (183)

* Measurements are mean values ± 1 SD of full-term infants of nonsmoking primigravidous mothers. Number of cases is shown in parentheses. P values refer to significance of changes in values with gynecologic age from 0 to >5 years.
† Categories refer to mothers' pregravid body weights in percent of Metropolitan Life Insurance Co desirable values.
§ $P < .01$.
‖ $P < .005$.

in the analysis of underweight mothers may be due to the small sample sizes in these groups.

Naeye's study shows that fetuses grow more slowly in most 10 to 16 year old mothers than in older women. This may indicate that the growth needs of the younger women are competing with the growth needs of their fetuses for available nutrients. Since the growth retardation was not found in obese mothers it can be concluded that large maternal pregravid nutritional stores appear to spare the young mother's fetuses from the effects of this competition. This raises the possibility that the optimal pregnancy weight gains for fetal and neonatal survival may be higher in younger teenagers than in older mothers.

King et al. (1972) found that the birth weight was positively associated with the weight gain of 18 adolescent mothers ($p < 0.01$) but both were not influenced by maternal age. The smaller the girl prior to pregnancy the more weight she gained ($p < 0.01$).

Ancri et al. (1977) did not consider the pregravid body weight for height in their study. Their correlations between the mother's weight gain and the age of the mother produced significant negative associations ($r=-0.307$, $p < 0.01$). Older mothers (25 to 32 years of age) had a smaller weight gain while younger mothers (12 to 17 years of age) had a larger weight gain. No significant correlations were found between mother's weight gain and birth weight. One reason for this might be that, based upon pregravid body weight, all subjects entered pregnancy in reasonably good nutritional status.

3.4. Prenatal Care

Nearly one fourth of mothers age 15 and under have no prenatal care at all or delay medical consultation until near the end of their pregnancy. Late referral is normal for this group; seven out of ten teenagers receive no prenatal care in the first trimester (Robertson 1981).

Ideally, pregnant women should be seen by their physician early in gestation, examined monthly until the seventh month, and then bimonthly until the 36th week, and weekly from the 36th week until delivery (Safro 1980).

Currently, there are more than 200 school systems in the United States participating in service programs for pregnant school-age girls (Berg et al. 1979). Many of these programs have been able to demonstrate that students in these programs receive earlier and more adequate prenatal care and have lower complications and fewer low birth weight infants.

Berg et al. (1979) analyzed the data of two groups of pregnant adolescents (13 to 18 years of age) participating in the Maternal and Infant Care Project (St. Paul, Minnesota) in order to measure the adequacy of prenatal care, pregnancy complications, incidence of prematurity, and low birth weight infants. The study group consisted of 36 adolescents who were enrolled in a public school where the services of a nurse practioner, social worker, and clinic attendant were available daily. Other members of the interdisciplinary team of professionals, including an obstetrician, a nutritionist and a dental hygienist, were available weekly. The comparison group consisted of 36 adolescents (matched for race) who received their care at a weekly non-school adolescent prenatal clinic. Information was obtained from obstetrical summary coding sheets.

In order to assess the adequacy of care in both groups the number of prenatal visits and the time prenatal care was initiated was compared. In the school study group 58.3 percent began prenatal care by the third month of pregnancy as compared with 36.1 percent of the comparison, non-school group. Only one student in the study group made a first visit as late as the 7th month; 10 patients (27 percent) in the comparison group began care in the 7th month or later (Figure 8).

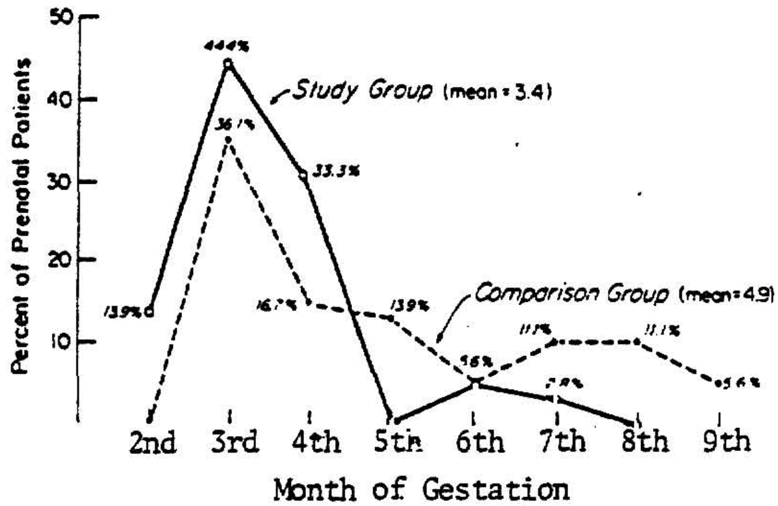

Figure 8: Month of gestation at first prenatal visit in two groups of pregnant adolescents receiving prenatal care in a special school for teen-age mothers (study group) or at a non-school adolescent prenatal clinic (comparison group) (Berg et al. 1979)

Total prenatal visits for the study and comparison groups are illustrated in Figure 9. In the Maternal and Infant Care school study program the average number of visits was 12.2 as compared to 9.0 visits for the comparison group. The incidence of low birth weight infants was 5.5 percent in the study group and 13.9 percent in the comparison group. This difference is not statistically significant. However, it demonstrates a lower incidence of low birth weight infants in pregnant adolescents with increased use of prenatal care provided within a public school setting by an interdisciplinary team.

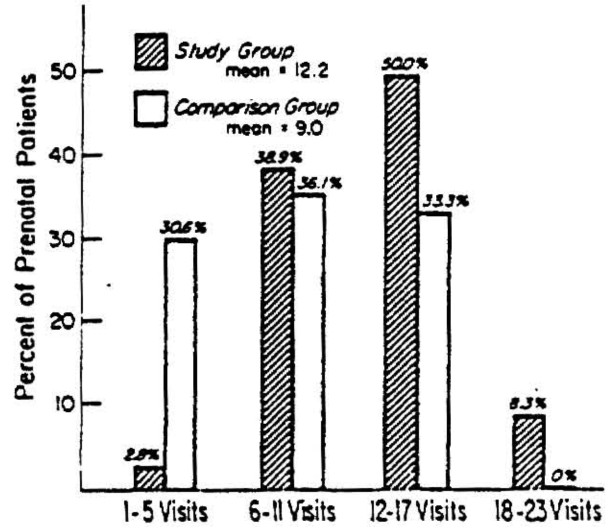

Figure 9: Total number and mean of prenatal visits in two groups of pregnant adolescents receiving prenatal care in a special school for teen-age mothers (study group) or at a non-school adolescent prenatal clinic (comparison group) (Berg et al, 1979)

Stine and Kelley (1970) compared 224 births to mothers who had attended a special school for teen-age mothers in Baltimore with 224 other Baltimore City births matched for age and race of mother and sex and birth order of infant. The school for teen-age mothers required each to register with a social agency and to either attend a clinic or consult a physician for prenatal care. The school provided a school lunch, supplemental milk, counseling, and nutrition and health education. The matched 224 births represented 69 births to mothers 14 years of age, 129 to mothers 15 years of age and 26 to mothers 16 years old.

The two groups were compared in terms of birth weight, length of gestation, trimester of first prenatal care and infant mortality.

The percentage of low birth weight infants in the study group was significantly lower than in the control group (11.6 percent versus 23.7 percent, $p < 0.01$). The distribution of low birth weight infants according to the age of the mother in both groups (Table 8) shows that the proportion of low birth weight infants is much lower in 14 and 15 years old mothers of the study group than that in the 14 and 15 years old mothers of the control group. The difference is statistically significant for the 14 year old groups.

Table 8: Live births to 14-year-old and 15-year-old mothers according to birth weight, age of mother, and study group membership (Stine and Kelley 1970)

Birth Weight in Grams	Study Group		Control Group		Total
	Age of Mother				
	14	15	14	15	
1,000 or less	-	-	-	3	3
1,001 - 1,500	-	2	1	1	4
1,501 - 2,000	1	4	4	4	13
2,001 - 2,500	6	11	14	19	50
2,501 - 3,000	25	48	16	40	129
3,001 - 3,500	31	47	26	47	151
3,501 - 4,000	5	17	7	13	42
4,001 - 4,500	1	-	1	2	4
4,501 and over	-	-	-	-	-
Total	69	129	69	129	396
2,500 grams or less	7	17	19	27	70
%	10.1	13.2	27.5	20.9	17.6

A comparison of the length of gestation in both groups shows that in the school group 21.4 percent of the mothers had gestation periods of less than 37 weeks as compared to 34.4 percent in the control group ($p < 0.01$). The proportion with the most favorable pregnancy outcome (birth weight > 2,500 grams and gestation of at least 37 weeks) was approximately 71 percent for the study group compared to 54 percent for the control group. Infants with low birth weights, but born after 37 weeks of gestation might be those whose growth has been retarded by inadequate nutrition or inadequate function of the placenta. The percent of the low birth weight for gestation infants was 5.4 percent in the study group and 10.7 percent for the control group.

Table 9 shows that more than 44 percent of the mothers who attended the school began prenatal care during the first trimester of pregnancy while less than 29 percent of the control group began similar care. No prenatal care was reported for two of the study group mothers and 12 of the control group mothers. There were no differences in birth weights when infants are grouped by trimester of first prenatal care. This means that the differences in percent of low birth weight infants cannot be explained by an initiation of prenatal care.

Table 9: Number and percent distribution of live births according to trimester of first prenatal care (Stine and Kelley 1970)

Trimester	Study Group		Control Group	
	Number	Percent*	Number	Percent*
1	100	44.6	63	28.1
2	104	46.4	118	52.7
3	16	7.1	29	12.9
None	2	0.9	12	5.4
Unknown	2	0.9	2	0.9
Total	224	100.0	224	100.0

*Individual percentages may not add exactly 100.0 because of rounding.

Seiler and Fox (1973) studied the outcome of 30 pregnant adolescents who were 16 years of age or under at the onset of pregnancy. All patients were receiving nutritional, social service, and nursing care guidance through the Maternal and Infant Care Project, a program sponsored by the U.S. Department of Health, Education, and Welfare for low-income pregnant mothers.

None of the infants was premature. The average weight gain was 26 pounds with a range of 15 to 43 pounds. Sixteen girls gained more than 25 pounds. The authors suggest that the weight gain, considered high by comparison with recognized standards, may have been beneficial and perhaps accounted for the absence of low birth weight infants in this study.

Ancri et al. (1977) found no low birth weight infant in twenty-six 12 to 17 year old mothers and suggested that the reason for this could be a well supervised prenatal care.

Roeder et al. (1976) studied 28 black 15 to 17 year old primiparous adolescents at high risk for delivery of premature and low birth weight infants. Outcome of pregnancy was markedly improved for adolescents enrolled in the program compared to a control non-program group matched for age, race, and parity. The average birth weight was significantly higher for program infants than for non-program infants (3213 g $\pm$ 90 versus 2910 g $\pm$ 99). When the distribution of infants was examined according to gestational age the study group had fewer premature infants than the controls. The difference in mean gestational age (40.5 $\pm$ 0.3 versus 38.2 $\pm$ 0.5 weeks) was significant.

4. SUMMARY AND CONCLUSION

Several authors have reported that infants of adolescent mothers are more likely to be born prematurely and have a lower birth weight than infants of older mothers. Unfortunately, few of these reports which associate an increased incidence of unfavorable pregnancy outcome with young age of the mother have considered other growth-retarding factors. In many studies factors such as race, pregravid body weight for height, maternal weight gain, prenatal care patterns, cigarette smoking, psychiatric disorders, and medical problems, all known to influence fetal growth, have not been systematically compared with those in appropriate populations of older women.

Authors who did exclude those factors found no significant differences in prematurity or in low birth weight rates among infants born to adolescents or adults. This would support the hypothesis that factors other than young age are associated with low birth weight.

One of these factors might be a low gynecological age since pregnant adolescents with a gynecological age below 2 years have particularly high energy and nutrient requirements for their own growth as well as those for the fetus. However, if good prenatal care and sufficient nutrient and energy intakes are provided, a low gynecological age may not have an adverse effect on pregnancy outcome. Additional energy and nutrient requirements are reflected by the greater weight gain of adolescents during pregnancy over those of pregnant adults. Adolescent mothers with low weight gains, often associated with low gynecological age, should be considered as high risk patients.

Weight gain during pregnancy should not be evaluated separately from the maternal pregravid body weight. A comparison of 10 to 16-years old teenage mothers with their pregravid body weights (Table 6) showed, that a high net pregnancy weight gain (≥ 4 to 8 kilograms) in underweight or normal-sized girls resulted in birth weights similar to obese mothers having a small net pregnancy weight gain (< 4 kilograms). Thus, underweight and normal sized young mothers should receive special regard.

Young chronological age, young gynecological age, low pregravid body weight, small pregnancy weight gain and poor prenatal care have all been shown to play an important role in pregnancy outcome. Therefore they should be recorded as early as possible to identify the risk of delivery of a low birth weight infant. However, they do not necessarily always result in low birth weight deliveries.

Recent studies indicate that good prenatal care and attention to the psychosocial and economic problems of pregnancy reduce the perinatal death and complication rate for pregnant teenagers. Multidisciplinary efforts to deliver comprehensive prenatal care for adolescent mothers have significant benefits for the outcome of pregnancy. However, when comparing the effects of school-affiliated and non-school prenatal care one should realize that the young mother who elects to attend the school may be more mature, both socially and physically. She may be more capable of meeting her own needs and her family may be more accepting of the pregnancy and more supportive of her. The school program may influence a more favorable pregnancy outcome by providing improved nutrition through the school lunch program and nutrition education. It may also give additional emotional support and reinforce use of medical and social services. Cigarette smoking, at least during classroom time, is discouraged. Tensions and anxiety might be reduced by group discussions and counseling. It encourages regular hours for activity, eating, and sleeping through its own structural schedule. All these factors may contribute to the more favorable outcome of pregnant adolescents receiving prenatal care in a school program.

Further evaluation is needed to determine what constitutes an optimal weight gain in adolescents for a satisfactory pregnancy outcome. Therefore, the gynecological age should be considered because this has been shown to significantly influence weight gain. The weight gain curves for pregnant adults that are currently used for teenagers probably underestimate the growth requirements for pregnant adolescents.

In order to develop standard curves for prenatal weight gain in adolescents one might weigh them monthly on home visits using a portable spring balance. If the pregnant adolescent is enrolled in a school or non-school prenatal care program, she may be weighed there, and in case of absence, weighed during the home visits. The procedure of Thomson and Hytten (1966) can be used for estimating the maternal pregravid body weight, the weight gain before enrollment in the study and between the last contact and delivery. In this procedure a weight gain of 8.8 pounds is allocated for the first 20 weeks of pregnancy. This is followed by an estimated gain of 1 pound/week during the second half of pregnancy up to the week when first data become available. The 1 pound/week is also used to estimate the weight gained in the period from the subjects last measurement to the actual time of delivery.

Use of growth curves specific for pregnant adolescents, increased prenatal care, and awareness of danger of low birth weight deliveries by both physicans and pregnant adolescents will hopefully contribute to early identification of risk, improvement of maternal health and successful pregnancy outcome in adolescents.

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THE INFLUENCE OF CHRONOLOGICAL AGE, GYNECOLOGICAL AGE, PREGRAVID BODY WEIGHT FOR HEIGHT, MATERNAL WEIGHT GAIN, AND PRENATAL CARE ON PREGNANCY OUTCOME IN ADOLESCENCE

by

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Adolescent pregnancies are associated with potential risk. In addition to psycho-social problems, they face physiological problems as well, including toxemia, prematurity, and iron-deficiency anemia. Epidemiological studies show that mothers under 15 years of age are about twice as likely as older women of having a preterm or low birth weight infant less than 2,500 grams birth weight.

In this report the physiological changes and nutritional needs of the pregnant adolescent are outlined. This provides the basic knowledge for a review of studies which examine the influences of chronological age, gynecological age, pregravid body weight for height, maternal weight gain, and prenatal care on the birth weight of infants of adolescent mothers.

The literature review reveals that in many studies factors such as race, pregravid body weight for height, maternal weight gain, prenatal care patterns, cigarette smoking, psychiatric disorders, and medical problems, all known to influence fetal growth, have not been systematically studied when comparing pregnant adolescent and older women. Low chronological and gynecological age, low pregravid body weight for height, low maternal weight gain, and poor prenatal care have all been shown to play an important role in pregnancy outcome. Therefore, they should be identified as early as possible to assess the risk of delivery of a low birth weight infant. However, if good prenatal care is provided and sufficient nutrient and energy intake assured, these factors may have less influence on the incidence of low birth weight infants.

Although further evaluation is needed to determine the optimal weight gain for pregnant adolescents gynecological age should be an important consideration. Presently the weight gain recommended for pregnant adolescents is the same as that for pregnant adults. Because adolescents are still growing their nutritional needs may be underestimated. In this report a procedure for the development of standard weight gain curves is described.