To the Graduate Council:

I am submitting herewith a dissertation written by Brenda Sheffield Stephens entitled "Postpartum Body Weight and Body Composition of Adolescents in Eastern Tennessee: An Examination of the Patterns and An Analysis of the Influence of Some Physiological, Psychosocial, and Behavioral Factors". I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Human Ecology.

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Major Professor

We have read this dissertation
and recommend its acceptance:

Accepted for the Council:

Associate Vice Chancellor
and Dean of the Graduate School

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A Dissertation
Presented for the
Doctor of Philosophy
Degree
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ABSTRACT

Change in body mass index from conception to 12 months postpartum (BMIdiff) was studied in 75 white adolescents. Postpartum (PP) body fat was estimated with bioelectrical impedance analysis, and waist to hip ratio (WHR) was measured. The purpose of this study was to examine the relative influence of several variables (including age, gestational weight gain, PP energy and fat intake, dietary restraint, genetic influences, and lifestyle changes) on BMIdiff, and to examine possible relationships between these variables and body composition, including fat distribution. The adolescents were interviewed and actual measurements, including dietary intake, were performed at 12 months PP. Prepregnancy and PP dietary restraint, hunger, and disinhibition were evaluated retrospectively with Stunkard and Messick's Three-Factor Eating Questionnaire.

Mean BMIdiff was +2.11 ($\pm$3.56) kg/m^2, median was +1.43, and values ranged from -6.85 to +11.88. Close to 30% of the girls experienced decreases in BMI, and 31% remained within 1 unit of their BMI at conception.

Multiple linear regression modeling was used to estimate the relative influence of the studied variables on BMIdiff and/or weight change (Wtdiff). In most models, gestational weight gain was the strongest predictor, explaining as much as 46% of the variation in Wtdiff. Kcal/kg/day (dietary intake) was the strongest predictor in some models, including one model with an R^2 of 0.82, in which the partial R^2 for kcal/kg/day was 0.50. Gestational gain (+), socioeconomic status (-), gynecological age (-), and oral contraceptive use (-) were the other significant predictors.

Postpartum kcal/kg/day were negatively related to BMIdiff, as were kcal/day. In models which included interaction between gestational weight gain and weight at conception, the interaction variable was the strongest predictor, explaining as much as 53% of the variation in BMIdiff. PP smoking (-), PP dietary restraint (+), and WHR (+) were other significant predictors for the entire data set. For those with normal BMI at conception, PP smoking was not a significant predictor, but prepregnancy weight loss attempt (+) was significant. The following variables were not significant predictors of BMIdiff or Wtdiff in any of the models tested: PP kcal/day (dietary), % kcal from fat, PP activity levels, breastfeeding, major changes in school/work or marital/living arrangements.

Percent body fat (%BF) at 12 months PP was significantly correlated with BMIdiff ($r=0.67$, $P=0.0001$). Gestational weight gain explained 17% of the variation in %BF. Also, WHR was significantly correlated with PP BMI, %BF, and BMIdiff.

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CHAPTER 1

INTRODUCTION

Justification

The effect of pregnancy on postpartum body weight has been a topic of interest to health professionals for many years. There is a complex interaction of factors which determines an individual's body weight and body composition. Pregnancy, childbirth, and lactation further complicate this interaction by introducing physiological, psychological, and sociological changes which can all have an impact on body weight, either directly or indirectly. From the 1920's until about 1970, restriction of pregnancy weight gain was routinely recommended in an attempt to promote easier labor, to preserve the woman's figure, and to prevent complications, such as preeclampsia, which were thought to be caused by excessive gain (1). These long-standing recommendations for restricting pregnancy weight gain were officially reversed in 1970, with the publication of Maternal Nutrition and the Course of Pregnancy, by the National Academy of Sciences (2).

The Committee on Maternal Nutrition was organized by the Food and Nutrition Board of the National Research Council of the National Academy of Sciences (NAS) as part of the effort to find ways to address the relatively high rate of low birth weights and neonatal and infant deaths in the United States compared to other western

countries. The committee was charged with the task of "Reviewing current knowledge about problems, practices, and research that bear on the relation between nutrition and the course and outcome of pregnancy" and of "Making recommendations and pointing out implications for medicine and public health." (Preface) Among its recommendations the committee's report (2) included the following statement:

> An average pregnancy weight gain of 24 pounds (range of 20 to 25 pounds) is considered reasonable. This is a gain of about one pound per week during the second half of pregnancy and is commensurate with the most favorable outcome of pregnancy. Limiting the weight gain of normal women to 10 to 14 pounds is not justified; because of the possibility of adverse effects on birth weight and neurological development, weight-reduction programs and severe caloric restriction should not be undertaken. (pp. 132-133)

Regarding the idea that limitation of weight gain protects against toxemia, the committee stated, "Seldom has a medical idea with such a basis (hearsay evidence) been applied so widely and subjected to so little scientific study." (p. 176)

In late 1987, the Food and Nutrition Board of the NAS again established a committee to study maternal nutrition. One of the reasons for the establishment of the committee was that consensus had not yet been reached regarding recommendations for gestational weight gain. Thus, the objective of the Subcommittee on Nutritional Status and Weight Gain During Pregnancy was to evaluate the scientific evidence and formulate recommendations for desirable weight gains during pregnancy. The report of this committee (3), published in 1990, included the following statements:

> ...a large body of evidence indicates that gestational weight gain, particularly during the second and third trimesters, is an important determinant of fetal growth. Low gestational weight gain is associated with an increased risk of giving birth to a growth-retarded infant. This has important adverse consequences for subsequent somatic growth and,

> possibly, neurobehavioral development, and it increases the risk of infant mortality.
>
> The effect of gestational weight gain on fetal growth is modified by the mother's prepregnancy weight for height. Several epidemiologic studies, including the 1980 National Natality Survey, have convincingly demonstrated that the effect of a given weight gain (or rate of weight gain) is greatest in thin women and least in overweight and obese women.
>
> Most epidemiological evidence suggests that maternal age does not modify the effect of weight gain on fetal growth. Very young adolescents (less than 2 years postmenarche) may, however, give birth to smaller infants for a given weight gain than do older women.
>
> Very high gestational weight gain is associated with an increased rate of high birth weight which in turn is associated with some increase in the risk of fetopelvic disproportion, operative delivery, birth trauma, and asphyxia and mortality. (pp. 7-8)

The recommendations of the subcommittee were that underweight women (Body Mass Index < 19.8) gain 28 to 40 pounds, that normal weight women (BMI 19.8 to 26) gain 25 to 35 pounds, that overweight women (BMI 26 to 29) gain 15 to 25 pounds, and that obese women gain at least 15 pounds during pregnancy. These latest recommendations have triggered a great deal of concern about possible increases in postpartum weight retention (4,5).

Since the 1990 publication of the NAS guidelines for pregnancy weight gain, several studies have been conducted with the specific objective of comparing maternal and/or infant outcomes of gestational weight gain within the guidelines to maternal and/or infant outcomes of gestational weight gain above or below the guidelines. One such study was conducted with poor, black adolescents (6). The 141 adolescents were classified into three groups based on rate of pregnancy weight gain: slow gainers (<0.23 kg/wk), average gainers (0.23 to 0.4 kg/wk) and rapid gainers (>0.4 kg/wk). Results showed that obstetrical complications occured with equal frequency in the

three weight gain groups. Infants born to mothers in the slow gain group were significantly smaller and were more often born prematurely than infants of mothers in the other two groups. Abnormal fetal heart rate and need for resuscitation at birth was not significantly different among the three groups. Although this study seemed to clearly support the NAS recommendations, the authors expressed concern that the members of the rapid gain group were retaining significantly more weight than members of the other groups at six weeks postpartum.

Failure to return to prepregnancy weight is usually viewed as undesirable because it implies the retention of weight, which may increase health risks and decrease physical attractiveness. Actually, some women who retain weight after pregnancy probably benefit from this retention because they were initially underweight. This benefit may especially apply to adolescents who bear children, not only when they are initially underweight, but also when their growth is not complete prior to conception.

It seems important, then, not to treat all postpartum weight retention as undesirable. Instead, it is preferable to look at changes in weight status (such as Body Mass Index or weight for height percentile) following pregnancy, and to determine whether women actually experience an unhealthy change in weight status, either positive or negative. While weight status can be an important indicator of health risks, other nutrition-related factors could be equally, if not more important. For example, a teenage mother who has returned to her prepregnancy weight because of repeated

severe dieting may not be as healthy as a teenage mother who has not dieted and therefore weighs 5 pounds more than she did before pregnancy.

Although there has been an increasing interest in the study of postpartum weight development in the years following both the initial and the more recent NAS recommendations, only two studies have specifically examined long-term (past 11 weeks) postpartum weight development in adolescent mothers (7,8). These studies were very limited in terms of both sample size and scope. For example, neither study included data on postpartum caloric intake in the published manuscript. One study was limited to African American subjects. McNarney and Stevens-Simon (5) have suggested the following specific questions which need to be addressed: 1) Is there a relationship between high gestational weight gain and the subsequent risk of obesity among adolescents? 2) What is the distribution of the weight that is retained subsequent to pregnancy? 3) Are there ethnic and socioeconomic differences among adolescents at risk of retaining gestational weight gain after pregnancy compared with those who do not? This study addresses questions one and two, in addition to examining other potentially related factors which previously have not been included in a single study. Rationale for inclusion of these other factors will be addressed in the literature review.

Problem Statement

There is very little information available on long-term postpartum weight retention in white adolescents. This information is important in determining what amount of gestational weight gain might lead to subsequent obesity.

Overview of Study

The purpose of this study was to collect and analyze information that would contribute to a better understanding of postpartum weight change patterns in adolescents. Specifically, this study examined the effects of several variables on the weight status and body composition of white adolescents at 12 months postpartum. The primary dependent variable in this study was change in body mass index (BMI) from prepregnancy to 12 months postpartum (BMIdiff). Percent body fat, waist to hip ratio (WHR), and actual BMI at 12 months postpartum (PostBMI) were also examined as alternate dependent variables and/or correlates of BMIdiff. The following variables were examined as possible predictors of BMIdiff:

Gynecological age

Parental fatness

BMI and weight at conception

Gestational weight gain

Postpartum hormonal contraceptive use

Breastfeeding

Weight management history (before, during, and after pregnancy)

Scores on the Three Factor Eating Questionnaire (9) for both prepregnancy and the postpartum year, and changes in these scores.

Dietary intake at 12 months postpartum (kcal and percent kcal from fat)

Changes in dietary intake after pregnancy, compared to prepregnancy

Physical activity postpartum

Smoking and smoking cessation

Changes in work or school attendance from prepregnancy to postpartum

Changes in marital status or living arrangements from prepregnancy to 12 months postpartum

Socioeconomic status

The following additional variables were examined for control purposes:

Chronological age

Parity

Nausea and weight loss in pregnancy

Complications of pregnancy or delivery

Length of gestation

Rh factor of mother

Gender of infant

Postpartum health of the subject

This study was part of a larger project (TN860: Factors Influencing the Nutritional Health of Adolescents During and Post Pregnancy) funded by the University of Tennessee Agricultural Experiment Station. Other parts of the study examined the nutritional quality of subjects' diets (10), pregnancy-related dietary changes (including food cravings and aversions)(11,12), snacking patterns, peer and television influences on diet (13-15), pregnancy outcomes, infant feeding patterns, and infant growth (16-18).

Assumptions

It is assumed that all subjects were honest and as accurate as possible when providing the information requested for this study.

Limitations

The adolescent sample is not representative of all postpartum adolescents in the United States because it was limited to white postpartum adolescents in eastern Tennessee who could be identified and who agreed to participate in the study. The sample was limited to white girls to avoid effects of racial differences in weight development patterns during adolescence.

Limitations of the methods used in this study will be discussed in later sections.

Definition of Terms

Body mass index: weight in kilograms/(height in meters)^2

Gynecological age: chronological age minus age of menarche

Percent body fat: percent of body weight attributable to fat

Waist to hip ratio: circumference of waist/circumference of hips

Hypotheses

1. The following variables will be significant predictors of BMIdiff at 12 months postpartum in adolescent girls:
    a. Prepregnancy weight status
    b. Gestational weight gain
    c. Retrospective prepregnancy scores on the Three-Factor Eating Questionnaire
        i. cognitive restraint
        ii. disinhibition
        iii. perceived hunger
    d. Postpartum scores on the Three-Factor Eating Questionnaire
        i. cognitive restraint
        ii. disinhibition
        iii. perceived hunger

Subhypothesis:

Significant changes will occur from prepregnancy to postpartum in scores on all three scales of the Three-Factor Eating Questionnaire.

2. The following variables will be significant predictors of Body Mass Index (BMI) at 12 months postpartum:

   a. Prepregnancy BMI (+)

   b. Gynecological age (GA) at conception (-)

   c. Gestational weight gain (+)

   d. Postpartum dietary restraint score (-)

   e. Postpartum energy intake based on 4 days of intake records (+)

   f. Percent of energy intake from fat based on 4 days of intake records. (+)

   g. Postpartum activity level (-)

   h. Fatness of subject's mother (+)

Subhypothesis:

If the subject's mother is thin, the percent energy intake from fat will not be a significant predictor of percent body fat or postpartum BMI.

3. The following variables will be significant predictors of percent body fat at 12 months postpartum:

   a. Prepregnancy BMI (+)

   b. Gynecological age (GA) at conception (-)

c. Gestational weight gain (+)

d. Postpartum dietary restraint score (-)

e. Postpartum energy intake based on 4 days of intake records (+)

f. Percent of energy intake from fat based on 4 days of intake records. (+)

g. Postpartum activity level (-)

h. Fatness of subject's mother (+)

Subhypothesis:

BMIdiff will be positively correlated to percent body fat at 12 months postpartum.

4. Mean waist to hip ratio of girls whose postpartum BMI is above normal range will not be significantly different from mean waist to hip ratio of girls whose postpartum weights are within normal range.

5. Postpartum cognitive restraint scores will be negatively related to postpartum caloric intake.

6. Girls who are employed or attend school will have lower energy intakes and significantly different scores on the Three Factor Eating Questionnaire than girls who are not employed and do not attend school.

Abbreviations

The abbreviations used for terms in this dissertation are presented in Table 1-1.

Table 1-1. List of Abbreviations

Abbreviation	Term Definition
%BF	Percent body fat
BIA	Bioelectrical Impedance Analysis
BMI	Body Mass Index
BMIdiff	Postpartum BMI minus BMI at conception
GA	Gynecological age
Kcal	Kilocalories
Kg	Kilograms
PostBMI	BMI at 12 months postpartum
PostTFEQ	Postpartum score for Three-Factor Eating Questionnaire
PostWt	Body weight at 12 months postpartum
PP	Postpartum
PPWRF	Postpartum Weight and Related Factors ("Weight Questionnaire" used to collect data)
PreBMI	BMI at conception
PreTFEQ	Prepregnancy score for Three-Factor Eating Questionnaire
PreWt	Body weight at conception
SES	Socioeconomic status
TFEQ	Three-Factor Eating Questionnaire
WHR	Waist to hip ratio
Wtdiff	Postpartum weight minus preconception weight

CHAPTER 2

REVIEW OF LITERATURE

Overview of Postpartum Weight Studies

Postpartum weight retention has received more research attention in the past 10 years than it had in many prior years. This increased attention is partly due to the recommendations published by the National Academy of Sciences in 1990 (3). As late as 1987, Rookus et al.(19) noted that there had been a large number of longitudinal studies which examined weight gain during pregnancy (and its relation to the birthweight of the infant), yet comparatively few longitudinal studies had examined the relationship between pregnancy and the development of obesity in women. Sheldon (20) is frequently cited as the first researcher to call attention to the problem of "maternal obesity". Sheldon obtained weight histories, relevent obstetrical histories and related information from 40 women who had developed obesity in connection with the birth of one or more of their children. He compared these women to a control group of 40 women who had not gained weight subsequent to the birth of any of their children. Rookus et al. (19) summarized seven longitudinal studies that examined the effect of pregnancy on subsequent weight (21-27). The seven studies varied considerably in methodology and sample size, so findings could not actually be compared. Mean pregnancy-associated weight change determined by these studies

ranged from 0.5 to 2.4 kg. At least 17 additional postpartum studies have been published since 1980 (7,8,28-42). In addition, three reviews of postpartum weight change research have been published in the past three years (43-45). Table 2-1 summarizes the Rookus study and the 17 additional studies cited above, including dates of data collection, sample size and composition, postpartum measurement schedules, and findings about postpartum weight or fat change.

Of all the studies cited above, only two specifically addressed long-term postpartum weight development in adolescent mothers (7,8). Some of the other studies included adolescents, but did not separate them from older women for analysis of postpartum weight retention (32,36,39). Age was recognized in these studies as a confounding variable.

In general, the studies show that weight measured in all postpartum periods tends to be higher, on average, than pregravid weight for the same women. Simple observation of mean weights tends to obscure the variability of weight change among parous women. A large proportion of women in the studies actually weighed less at several months postpartum then they weighed before their pregnancies.

It is important to distinguish between postpartum weight loss and postpartum weight retention. Some studies have only measured weight loss (7,29), others have focused on the difference between prepregnancy weight and weight at some point in the postpartum year, also known as postpartum weight retention (28,31-36,39-41), and some studies have measured both (38). A greater postpartum weight loss does not

Table 2-1. Summary of Recent Long-Term Postpartum Studies

Authors & year published	Data Dates	n	Ages (years)	Sample Description	PreWt Method	PP Measurement Schedule	Conclusions re: Weight
Meserole et al. 1984 (7)	na	26	13.2 to 16.8	Western Washington state, USA	Self-report	< 1 month 1-3 months 4-6 months 7-12 months 13-18 months	% pregnancy gain lost 55.1 66.7 94.6 90.0 90.5
Rookus et al. 1987 (19)	1980 thru 1984	49	23-35	Single Dutch county	Measured	10 days 2 months 6 months 12 months	BMIdiff=.34 greater than controls
Greene et al. 1988 (31)	1959 thru 1965	7116	mean 23 SD 10.9	Entire USA (SES < mean)	Self-report	Inter-pregnancy interval (< 6 yrs.)	Wtdiff 1.5±5 kg
Sadurskis et al. 1988 (37)	na	23	mean 28.6 SD 2.8	Swedish lactating middle-income employed	Measured	5-10 days 2 months 6 months	Wtdiff 6.1±3.2 kg 2.9±2.7 kg 1.5±3.1 kg
Brewer et al. 1989 (29)	na	56	most 21-31 all < 18	Baton Rouge, Louisiana, USA White well-educated	Self-report	1-2 days 2 months 6 months	Mean Wt loss BF: 8.3 kg CF: 7.2 kg FF: 8.2 kg
Parham et al. 1990 (35)	na	158	mean 23	Illinois, USA urban low-income 50%W, 25%B little breastfeeding	Self-report (validated)	1-3 months 3-6 months 6-9 months	Wtdiff 4.2±3.4 kg 4.8±4.7 kg 3.8±5.4 kg

Table 2-1 (Continued)

Authors & year published	Data Dates	n	Ages (years)	Sample Description	PreWt Method	PP Measurement Schedule	Conclusions re: Weight
Ohlin & Rossner 1990 (34)	na	1423	17-49 mean 29.5	Stockholm clinics	Self-report	6-15 weeks 6 months 12 months	Wtdiff at 12 mos. = 1.5±3.6 kg (before adjustment)
Potter et al. 1991 (36)	1970 thru 1980	206	14-37 mean 21 ADC[a] 25 non	Illinois, USA 33% low income 51% primiparous	Self-report from medical record	6 weeks 12 months	Wtdiff at 12 mos. ADC[a] 3.8 kg non-ADC 2.4 kg
Schauberger et al. 1992 (38)	4/89 thru 3/90	795	mean 27.8	Wisconson, USA White middle-class married	Measured 1st prenatal visit	2 days 2 weeks 6 weeks 6 months	At 6 months Loss: 12.2±4.6 kg Retained: 1.4±4.8 kg
Kramer et al. 1993 (33)	na	24	mean 28.1	Northeastern USA White middle-class	Self-report	1-3 days Monthly to 6 months	Wtdiff BF: 1.2 kg CF: 2.8 kg FF: 5.6 kg
Keppel & Taffel 1993 (32)	88/ 89	2944	15+	Entire USA Representative	Self-report	No measures Interviewed at 10-18 months	Median Wtdiff: White 1.0 kg Black 3.2 kg
Segel & McAnarney 1994 (8)	Del 1/86 thru 1/89	30	<20 when con-ceived	Rochester, NY, USA Black low-income	Self-report	2.5 to 4.9 years (mean 3.3)	% BMIdiff by gestational gain rate: Low 3.4 Mod 13.2 High 19.9

Table 2-1 (Continued)

Authors & year published	Data Dates	n	Ages (years)	Sample Description	PreWt Method	PP Measurement Schedule	Conclusions re: Weight
Smith et al. 1994 (40)	1985 thru 1991	203 parous 925 nulli	18-30 at baseline	4 cities USA 20% black primiparas 38% black multiparas 24% white primiparas 18% white multiparas	Measured at baseline	5 years from baseline (PP period varied by individual)	Wtdiff: Black primi 3.3 kg White primi 2.3 kg
Sohlstrom & Forsum 1995 (41)	na	15	23-37 mean 29	Stockholm Breastfed minimum of 2 months	Measured	5-10 days 2 months 6 months 12 months	Wtdiff at 12 mos: 3.4±3.8 kg 2.86 kg=fat
Scholl et al. 1995 (39)	1985 thru 1990	274	12-29	Camden, NJ, USA mostly Black, Hispanic low-income normal BMI	Self-report	4-6 weeks 6 months	Wtdiff by gestational gain rate: Low 3.2 kg Mod 3.8 kg High 7.9 kg
Boardley et al. 1995 (28)	na	121W 224B	>18yr mean 25 B 26 W	Columbia, SC, USA WIC clinic half primiparous	Self-report	7-12 months	Mean postWt minus mean preWt: White 3.1 kg Black 6.0 kg

[a] ADC = Aid for Dependent Children

necessarily imply a lack of retention. In general, women who gain more weight in pregnancy tend to lose more weight postpartum (7,29,38), but they also may retain more of their pregnancy gain than women who gain less in pregnancy and lose less postpartum.

Variables Related to Residual Weight

Physical Maturity

Gynecological age (chronological age minus age at menarche) has been hypothesized to have an important impact on pregnancy in teenagers because less mature mothers are more likely to be still growing. Meserole et al. (7) studied pregnancy weight gain and postpartum weight loss patterns in 26 adolescents. Results showed that girls of low chronologic and gynecologic age gained less weight in pregnancy than girls of low chronologic age and higher gynecologic age. Also of importance was that 38% of the subjects weighed more at 6 to 12 months postpartum than they weighed before pregnancy, while height measurements remained unchanged. When prepregnancy and postpartum weight percentiles were compared, four of the subjects whose weight had increased had actually either remained at the same weight for height for age percentile, or had fallen to a lower percentile level.

A 1990 study by Scholl et al. (46) used knee height to measure continued maternal growth in 12- to 15-year old pregnant teens, and found that measurable growth did occur in more than 55% of the subjects studied. A later study by Scholl et

al. (47) demonstrated that still-growing adolescents retained significantly more weight at 4-6 weeks postpartum (6.9±0.5 kg) than non-growing adolescents (3.4±0.5 kg).

Frisch (48) developed estimations of typical weight gain in girls for each of the 5 years following menarche. Based on Frisch's data, girls gain about 10.12 pounds (4.6 kg) in the first year after menarche, 6.16 pounds (2.8 kg) in the second year, 2.42 pounds (1.1 kg) in the third year, and 1.76 pounds (0.8 kg) in the fourth and fifth years. Given these figures, it seems that gynecological age could definitely have an impact on weight change during the postpartum period, and possibly during pregnancy.

A more recent study, which examined one-year changes in weight and fatness in 668 high school girls, found that postmenarcheal girls gained about 14.3 pounds (6.5 kg) from about 1.5 years after menarche to age 18 years. Also, a majority of the subjects continued to show growth in height up to the age of 18 years. While the velocity of linear growth and change in weight decreased with increases in chronological age, the velocity of BMI change remained the same, with increments averaging 0.40 units per year at each age (49).

Age and Parity

Researchers who study the effect of pregnancy on weight usually acknowledge that weight tends to increase with age, regardless of whether or not a woman becomes pregnant. Some researchers simply adjust their findings to correct for the expected increase with age observed in other studies, while others actually select a control group for comparison.

Age has been shown to affect both the amount and the rate of weight lost after pregnancy. McKeown and Record (21) determined that the mean amount of weight lost postpartum increased with increasing parity and decreased with increasing age. McKeown and Record note that this trend resulted mainly from a change the proportion of women who lost weight, because there was not a consistent trend in the mean amount of weight lost. These researchers also noted that women tended to gain more weight during pregnancy and to lose more weight in the year after delivery as parity increased. McKeown and Record made the important observations that first births at high ages tend to be associated with "favorable social circumstances", and later births at low ages are characteristic of "unfavorable social circumstances". Using the relationship of the infant's growth to the mother's weight, McKeown and Record made a convincing case for the hypothesis that the relationships among maternal weight changes, age, and parity during the 3 to 12 month postpartum period was attributable to variation in nutrition (with greater weight loss being associated with less adequate nutrition).

Brewer et al. (29) found that the rate of postpartum weight loss was slower for higher ages and parities. Olsen and Mundt (50) found that primiparous women lost more weight than multiparous women in the first 6 weeks postpartum. Potter et al. (36) reported similar findings.

Newcombe (27) concluded that age and parity each have effects on obesity in women, but that these effects are considerably confounded with each other.

Interestingly, Newcombe found that the effect of aging differed among social classes and that smoking habits made a difference in the effect of parity.

Greene et al. (31) concluded that age and parity had no effect on weight change during the interpregnancy interval, although a longer interpregnancy interval was associated with greater weight gain during the interval. In contrast, Smith et al. (40) found that black women who bore their first child during a 5-year study interval gained significantly more weight over that interval than women who bore no children or women who bore their second, third, or fourth child during the same interval. There was a similar pattern of weight change for white women, but the difference between white primiparas and white multiparas was not significant after adjustments for several confounding factors.

Parker and Abrams (51) used data from the 1988 National Maternal Infant Health Survey to examine postpartum weight retention of 20 pounds or more in black and white women who began pregnancy with normal BMI. These researchers found that high parity (and high parity for age) was associated with weight retention among black mothers but not among white mothers. Boardley et al. found that multiparity was associated with higher weight retention in both black and white mothers who were participants in the Special Supplemental Feeding Program for Women, Infants, and Children (WIC) in a Columbia, SC clinic (28).

Several studies (19,35,36,38) found no significant relationship between age or parity and postpartum weight retention. Ohlin and Rossner found that women who

bore their first child after age 35 tended to retain significantly more weight than other primiparous women, yet there was no independent effect of age or parity (34).

The diversity of findings on the effects of age and parity on postpartum weight retention is most likely explained both by the differences among the populations studied and differences in the study methods. For instance, the McKeown and Record study (21) was conducted in the 1950s, before the existence of the WIC program and in a time when weight gain recommendations were much lower than at present. Also, some studies examined weight gain or retention over long intervals of time, while others focused on the first six months postpartum. Finally, the more sophisticated analysis techniques used in some studies are probably more successful in isolating the effects of each variable.

Genetic influences

There is ample evidence that genetic predisposition is a very strong predictor of excessive weight accumulation. A study by Bouchard and colleagues (52) demonstrated the wide range of weight gains that can be associated with identical dietary excesses, and the fact that identical twins are much more likely to have similar weight gain responses to overfeeding than are unrelated subjects.

The study by Stunkard et al. (53) of fraternal and identical twins reared apart and together further confirmed the important role of genetics in determining BMI. The Stunkard et al. study also demonstrated the lack of influence of childhood environment on the BMI of adults. Earlier studies had already led to the conclusion

that 80% of the offspring of two obese parents become obese, compared to no more than 14% of the offspring of two normal weight parents (54).

One recent postpartum study of adolescents collected information on the weight and height of subjects' mothers. Mothers of obese adolescents (at 3 years postpartum) had higher BMIs (32.2 vs. 25.8) than mothers of non-obese adolescents (8).

Prepregnancy Weight

Sheldon (20) observed that women who did not retain weight from pregnancy tended to be below normal weight at marriage. McKeown and Record (55) concluded that the mean weight change between 124 days gestation and 12 months after delivery was largely determined by initial weight. McKeown and Record's data showed that women under 64 inches tall were much more likely to retain excess weight after pregnancy if they were more than 15% below or more than 5% above "expected weight" (based on linear regression) at 124 days gestation. Short women (less than 64") between these two parameters (less than 15% below or less than 5% above expected weight) were more likely to have lower weights after pregnancy than at 124 days gestation. Interestingly, McKeown and Record concluded that women who were at least 64 inches tall were just as likely to experience weight loss as to experience weight gain between 124 days gestation and 12 months postpartum, regardless of how their gestational weight related to "expected weight".

Greene et al. (31) reported that mean interpregnancy weight change was significantly lower in women whose prepregnancy weight (PreWt) was over 140% of

ideal body weight. The standard deviation of interpregnancy weight change was considerably higher for women whose PreWt was above 120% of ideal body weight, compared to women who were closer to ideal. The variability of weight change increased even more dramatically for women whose PreWt was above 140% of ideal.

Parham et al. (35) concluded that residual weight was significantly correlated with prepregnancy BMI at 1-3 months postpartum but not at 3-6 months postpartum. Parham et al. also found that 50% of the women who were overfat before pregnancy (BMI > 25) were in the lower maternal gain tertile.

Two recent studies (28,38) also found that prepregnancy weight is a significant predictor of postpartum weight retention. Parker and Abrams (51) found that average pregravid BMI was significantly higher (although not by a large amount) for women who retained more than 20 pounds than for women who retained less than 20 pounds. This was true for both black and white women. Keppel and Taffel (32) examined postpartum weight retention based on compliance with current gestational weight gain recommendations. Of the women who gained within the recommended ranges, 20.1 percent of the women with normal preBMI retained 9 pounds or more, compared to 36.3 percent of the women with high preBMI.

As the Parham study (35) demonstrated, the relationship of prepregnancy weight or BMI to postpartum weight retention may vary according to when postpartum weight is measured. Women with a predisposition to obesity could actually be exhibiting weight gain unrelated to pregnancy if postpartum weight is measured more than six months after delivery. Also, it is important to note that some studies did not

include women with the highest prepregnancy BMIs (32,51). Another important factor is that some studies have shown a tendency for heavier women to underestimate their prepregnancy weight (44).

Gestational Weight Gain

As might be expected, virtually every study of postpartum weight development shows a strong relationship between gestational weight gain and postpartum weight retention. Again, it is important to note that not all postpartum weight retention is undesirable.

Segel and McAnarney (8) measured the BMI of 30 young black women who had given birth approximately 3.3 years prior while participating in a study which measured rate of gestational weight gain during their first pregnancy. These women were all under the age of 20 when they entered the original study. Results showed that rapid gestational gain was associated with a 19.9% increase in BMI from prepregnancy to approximately 3.3 years postpartum, compared with a 13.2% increase for women with an average rate of gestational gain; these percentages were not significantly different.

Scholl and colleagues (39) studied the relationship between rate of gestational gain and postpartum weight retention in a group of 274 young, low-income, mostly minority women whose ages ranged from 12 to 29. Only women whose pregravid BMI was in the normal range (19.8 to 26.0) were included in the study. Results showed that 77 of the subjects had excessive rates of gestational gain, and a large

proportion of that group (77%) was under the age of 19. Mean change in weight from pregravid to 6 months postpartum was significantly higher for the group with excessive gains. Based on results of their own earlier study of pregnant adolescents (47), the researchers noted that greater pregnancy gains and early postpartum weight retention are characteristic of maternal growth during adolescent pregnancy.

Parham et al. (35) obtained weight and pregnancy-related information from clinic records of 158 low income women in two Midwestern cities. The women were divided into tertiles based on maternal weight gain, then pregravid weights were compared with postpartum weights at 1-3, 3-6, and 6-9 months postpartum. Parham et al. found that the residual weights at 1-3 and 3-6 months postpartum differed significantly among maternal weight gain groups, but they did not differ significantly at 6-9 months postpartum. The lack of significant difference at 6-9 months postpartum was partially due to the lower gain group having gained weight in the later postpartum months, and partially due to the small sample size. Only 26 women in the Parham et al. study had records which included a weight at 6 to 9 months postpartum, but for 92% of these women the Body Mass Index (BMI) category at 1 to 3 months postpartum was sustained throughout the study period. In the Parham study, a BMI below 20 was categorized as underweight, a BMI of 20 to 25 was considered acceptable, and a BMI above 25 was classified as overweight. Prepregnancy BMI category was compared to BMI category at 1-3 months postpartum for each individual, revealing that 83% of the women whose maternal weight gain was in the lower or middle tertiles remained in the same BMI category, while 10% had undesirable

category changes. Among the women in the high gain tertile, 39% had undesirable changes in BMI categories.

Using a very large sample (n = 7116) selected from the Collaborative Perinatal Study (conducted in the U.S. from 1959 to 1965), Greene et al. (31) found that women who gained 20 lbs (9.1 kg) or more in their first study pregnancy were 5.7 to 10.2 lbs (2.6 to 4.6 kg) heavier at the start of their second study pregnancy. Women who gained less than 20 lbs (9.1 kg) in pregnancy were not significantly heavier by the start of their second study pregnancy. Greene et al. found that pregnancy weight gain alone explained 21.1% of the variance in interpregnancy weight change.

Several other studies also reported that gestational weight gain was the strongest predictor of postpartum weight retention, by far, among all the variables examined. (28,34,35,38) The percentage of variance in weight retention explained by gestational weight gain varied from study to study, with the lowest being 12.7% (34) and the highest being 35% (38).

Some studies have examined gestational weight gain in each trimester as a separate predictive variable. Ohlin & Rossner (34) found that the relative predictive value of each trimester's gain depended on how prepregnancy weight was determined. When weight at 8 weeks gestation was used as "initial weight", third trimester gains were the most predictive, explaining 5% of the variation in weight retention, compared to 1% for the first trimester. When self-reported pre-pregnancy weight was used as the initial weight, first trimester gain explained 12% of the variation. This finding seems

important in assessing the possible problems involved in relying on self-reported pre-pregnancy weight to determine total gestational weight gain.

Some studies have compared women whose gestational weight gains were within the current guidelines to women whose gains were above or below recommended levels. Schauberger and colleagues (38) grouped all subjects according to whether they gained within the range recommended for normal weight women (11.4 to 15.9 kg) or gained above or below that range. Average retained weight for the women who gained under 11.3 kg was actually a loss of 1.2 kg. Average retained weight for "normal" gainers was 1.6 kg, and average retained weight for "high" (>16 kg) gainers was 5 kg. The authors stated that these differences were statistically significant, but which differences were significant was not clearly reported.

Keppel and Taffel (32) grouped their large representative sample by preBMI, gestational weight gain, and retained weight at some point between 10 and 18 months postpartum. This study relied entirely on self-reported weights. Groups were collapsed into those who gained within the recommended range for their preBMI and those who gained less or more than the amount recommended. Obese women were excluded because the recommended range of gain was not defined except by a minimum of 15 pounds. Of those who gained within the recommended range, 22.3% retained 9 pounds or more. Of those who gained more than recommended, 38.6% retained 9 pounds or more. Grouping by race showed that black women had a much greater tendency to retain weight than white women. Among the black women, 61.1%

of those who had high gains retained 9 pounds or more. Of the black women who gained less than the recommended amount, 29.3% retained 9 pounds or more.

Complications of Pregnancy or Delivery

Greene et al. (31) included complications of pregnancy as a covariable in multiple regression prediction of weight change between pregnancies. Complications included hyperemesis gravidarum, vaginal bleeding, hypertensive disease, placenta previa, and abruptio placentae. Presence of complications was found to be a significant predictor ($p < .001$), but the combination of complications and several other variables only accounted for 2.5% of the variation in interpregnancy weight change.

Some studies have found that women who have caesarean deliveries show greater weight loss in the first few weeks postpartum (36,38). Otherwise, there seem to be very few studies that specifically examined the relationship between complications of pregnancy and delivery with postpartum weight retention. Most studies of postpartum weight development exclude women who delivered earlier than 37 weeks gestation, and some exclude women with other complications as well.

Oral Contraceptive Use

Several studies have examined oral contraceptive use as a possible influence on posptpartum weight retention (19,34,38,50). None of these studies showed a significant difference in weight retention between women who used oral contraceptives and those who did not.

Infant Feeding Method

Findings on the effect of breastfeeding on postpartum weight loss or retention are varied. The majority of studies report no significant difference in weight retention between women who breastfeed and those who do not (20,28,29,31,34,38,39,50,51). Some studies have reported greater weight retention by women who breastfeed (19,27,36,56). Only a few studies have demonstrated that women who breastfeed retain less weight in the first postpartum year than women who exclusively feed formula to their infants (33,57). Some studies have shown that breastfeeding mothers lose more fat from their lower body than formula feeding mothers (33,41).

Studies that have measured energy intake of breastfeeding and formula feeding mothers have found that breastfeeding mothers have considerably higher energy intakes than formula-feeding mothers (29,58). It is important to note, then, that breastfeeding mothers usually do not retain more weight than formula feeding mothers in spite of their higher energy intakes. Formula feeding mothers tend to reduce their calorie intakes to a level that will promote weight loss, while breastfeeding mothers avoid caloric restriction. One study that showed greater weight loss for breastfeeding mothers specifically excluded formula feeding mothers who were dieting (57).

Some studies have not distinguished between mothers who breastfeed for several months and those who only breastfeed for a few weeks, but many studies have accounted for this difference by assigning lactation scores or using the number of months of breastfeeding as the variable in statistical analysis. At least two studies have reported that the greatest difference in weight loss between breastfeeding and

formula feeding mothers is in the period from 3 to 6 months postpartum (29,57), and one study has reported no difference unless a mother breastfeeds for at least 4 months (32). Another study has suggested that the first postpartum month is the critical time (33).

Weight Management History

Ohlin and Rossner (34) specifically examined the relationship between residual weight and prepregnancy dieting practices. They found that residual weight tended to increase with the number of successful prepregnancy dieting experiences, but that the mean residual weight was only significantly higher for women who had dieted successfully at least six times before their pregnancy. Ohlin and Rossner also found that residual weight was more variable among prepregnancy dieters than among those who had not dieted prior to pregnancy. Unfortunately, it is difficult to separate previous dieting experience from a predisposition to obesity, because women who have a tendency to be overweight are those who are most likely to diet. No other studies of pospartum weight development have reported information about pre-pregnancy dieting history, although some have reported information about pre-pregnancy dietary intake. Actual dietary intake will be discussed in the next section.

There is some evidence that dieting itself tends to contribute to weight gain or to difficulty in losing weight by lowering resting metabolic rate (RMR). Elliot et al. (59) found that RMR decreased by an average of 22% in seven obese women during a protein-sparing modified fast. The reduction in RMR was maintained when measured

4 weeks after the fast had ended, and RMR was still significantly lower when measured 8 weeks after the fast had ended. The investigators point out that the reduction in RMR was not only due to a reduction in fat-free mass, but that RMR per kilogram of fat-free mass was also significantly reduced.

Steen et al. (60) found that male adolescent wrestlers who repeatedly lost and gained weight had RMRs which averaged 14% less than wrestlers who did not engage in repeated weight cycling. This study demonstrates the possible effects of repeated food restriction in non-obese subjects.

Numerous animal studies have shown increased metabolic efficiency after a single cycle of restriction and refeeding in both obese and normal weight animals (61). In addition to changes in RMR, some animal studies have shown that weight reduction is followed by increased activity of lipoprotein lipase (61,62).

Some human studies have examined the effects of weight reduction and refeeding on adipose tissue lipoprotein lipase activity (63-65). Kern et al. (63) and Schwartz and Brunzell (65) concluded that weight loss leads to increased activity of lipoprotein lipase after weight has stabilized. The study by Rebuffe-Scrive et al. (64) did not support these findings.

Because many studies have suggested that dietary restraint can predispose an individual to gain weight, the relationship between prepregnancy dietary restraint and later weight gain or weight retention should be of interest. There are numerous reports in the literature of the high prevalence of dieting among adolescent girls (66,67), so it

is important to consider the possible effect of this pattern on postpartum weight retention in adolescents.

Dietary Intake

While the measurement of dietary intake of pregnant and lactating women is quite common, the measurement of the dietary intake of non-lactating postpartum women has only received specific research attention within the last 10 years or so.

Three studies have compared the energy intake of lactating women to that of non-lactating postpartum women (29,33,58). Kramer et al. (33) simply reported that mean energy intake for breastfeeding and "combination feeding" subjects was 462 kcal more per day than the mean energy intake of formula-feeding mothers. This was a small study (n=24) of married, middle class, Caucasian women in the northern United States.

Brewer et al. (29) found that exclusively breastfeeding women consumed about 600 more calories, on average, than nonlactating postpartum women. Energy intakes were calculated from 3-day intake information, collected both at 3 and 6 months postpartum. One day's intake was determined by 24-hour recall, and the other 2 days were based on intake records completed by the women in the next 48 hours. Specific information about kcal/day consumed by the women in the Brewer et al. study is given in Table 2-2. Further information about the these subjects has been described in Table 2-1 (pp. 15-17).

Table 2-2. Prepregnancy and Postpartum Energy Intakes: Comparison of Studies

	Sadurskis et al.	Brewer et al.	Murphy & Abrams[a]
Before pregnancy	2000		1603
0-3 mos. Breastfeeding	2280	2055[b]	2023
3-6 mos. Breastfeeding			1807
0-3 mos. Formula only		1453[b]	1535
3-6 mos. Formula only			1594

[a] Data shown is specific to subset above poverty level.

[b] Average for first six months postpartum

Sources:

Brewer MM, Bates MR, Vannoy LP. Postpartum changes in maternal weight and body fat depots in lactatin vs nonlactating women. *Am J Clin Nutr.* 1989; 49:259-265.

Murphy SP, Abrams BF. Changes in energy intakes during pregnancy and lactation in a national sample of US women. *Am J Public Health.* 1993; 83:1161-1163.

Sadurskis A, Kabir N, Wager J, Forsum E. Energy metabolism, body composition, and milk production in healthy Swedish women during lactation. *Am J Clin Nutr.* 1988; 48:44-49.

Murphy and Abrams (58) used data from the Continuing Surveys of Food Intakes by Individuals (U.S. Department of Agriculture) in 1985 and 1986 to compare energy intakes before, during, and after pregnancy. This study compared whites and blacks, as well as those with incomes below poverty level and those with incomes above poverty level. Table 2-2 includes the energy intake information only for women above poverty level because it is the data most comparable with that from the other studies represented in the table. Since the energy intakes of those below poverty level are also of interest, more data from the Murphy and Abrams study are shown in Table 2-3. An interesting finding of this study was that the postpartum energy intakes of nonlactating white women tended to return to prepregnancy levels, whereas the postpartum energy intakes of non-lactating black women remained elevated compared to prepregnancy levels. A similar phenomenon was also evident with those above poverty level compared to those below poverty level. It is important to note that the mean prepregnant energy intakes of black women and poor women were significantly below those of white women and higher income women. It is possible that the energy intakes of the black and poor women were kept low prior to pregnancy due to lack of financial resources, and that supplemental food programs enabled the women to increase their intakes to more nutritionally adequate levels. Also, other researchers have suggested that black women are not necessarily at increased risk of gaining weight compared to white women, but rather are less likely to lose weight (28,68).

Sadurskis et al. (37), who studied lactating Swedish women, used a weighed inventory technique to collect four consecutive days of intake data (3 weekdays and

Table 2-3. Mean Postpartum Energy Intakes by Race, Income Level, and Infant Feeding Method

Reproductive Category	White	Black	Above Poverty	Below Poverty
Prepregnant	1569	1433	1603	1440[a]
Postpartum, non-lactating				
0-3 months	1534	1586	1535	1579
3-6 months	1600	1747	1594	1690
Postpartum, lactating				
0-3 months	1940	1562	2023	1693[a]
3-6 months	1750	1875	1807	1750

[a] significantly different from "Above Poverty"

Source: Murphy SP, Abrams BF. Changes in energy intakes during pregnancy and lactation in a national sample of US women. *Am J Public Health.* 1993;83:1161-1163.

one weekend day) before pregnancy and at 2 months postpartum. The Swedish women consumed an average of 280 more calories during lactation than before pregnancy. Average prepregnancy energy intake was 2000 ± 420 kcal/day, and average intake at 2 months postpartum was 2280 ± 590 kcal/day. Sadurskis et al. found that the prepregnancy intake measurements appeared to match estimates of physiological energy requirement in these women at that time. The findings of Sadurskis et al. are also shown in Table 2-2, for comparison purposes.

A recent study of clinic participants in the Special Supplemental Feeding Program for Women, Infants, and Children (WIC) examined the dietary intake, physical activity level, and weight retention of 365 women at seven to twelve months postpartum (28). A food frequency questionnaire was used to assess dietary intake for the postpartum period. Results showed that mean energy intake was 1552 kcal for white women and 2040 kcal for black women. The black women also had a higher percentage of energy from fat in their diets (40.7% compared to 37.5%). Mean body weight was 146.9 pounds for white women and 162.6 pounds for black women. The researchers used multiple linear regression modeling to test for significant predictors of postpartum weight retention. Calorie intake was only significant in models that did not include race as a variable, but no information was given about the relative significance of calorie intake in such models.

Two studies have examined dietary patterns in postpartum women, but not energy intakes specifically. Segel and McAnarney (8) found that young black mothers who were obese (BMI > 26) at 3.3 years postpartum were likely to eat more meals per

day (3.3 vs. 2.8) than their non-obese counterparts. Ohlin and Rossner (69), on the other hand, found that Swedish women who retained the most weight postpartum were more likely to have irregular eating habits, including skipping meals and snacking more often. Some studies have included inquiry as to whether the subjects were intentionally dieting. Of the women in the Swedish study (69), 13% reported dieting in the postpartum year. Among the WIC participants studied by Boardley et al. (28), approximately 30% of whites and blacks reported that they considered themselves to be dieting at the time of data collection (7 to 10 mos. postpartum).

In summary, very few studies have examined the energy intake of non-lactating postpartum women. Of those few studies, only one has examined the relationship between postpartum energy intake and postpartum weight retention (28). Boardley et al. found that energy intake was not a significant predictor of postpartum weight retention when race was in the model (28). Brewer et al. (29) examined the relationship between postpartum energy intake and postpartum weight loss. Thus far, no study has examined the relationship of postpartum energy intake to long-term postpartum weight retention in adolescents.

Physical Activity Patterns

Several studies of postpartum weight development have included data on physical activity patterns of the subjects (8,28,29,33,37,38,40,69). Some of these studies have simply compared physical activity among groups as a control measure, rather than actually examining it as a predictor variable for postpartum weight

retention (33,37,40). Sadurskis et al. (37) used 24-hour diaries to collect physical activity information both before pregnancy and at 2 months postpartum, and found that their subjects had equally sedentary lifestyles before and after pregnancy. This conclusion was based upon the classification of activities into nine different categories, assigning each a multiple of resting metabolic rate (RMR), and calculating a weighted average. Two studies (29,33) concluded that estimates of energy expenditure for maintenance and activity did not differ significantly among breastfeeding, formula-feeding, and combination-feeding groups.

Schauberger et al.(38), who classified exercise into subgroups that included aerobics, walking, running, swimming, and bicycling, found no difference in retained weight by self-report of these activities or by when these activities were resumed. Boardley et al. (28) found that postpartum physical activity was not a significant predictor of postpartum weight retention, but that physical activity in pregnancy was a predictive factor. For white subjects, higher prenatal activity predicted higher weight retention. For blacks, higher prenatal activity predicted lower weight retention. Activity scores were significantly lower for blacks both prenatally and postpartum, and blacks also retained significantly more weight than whites.

Segel and McAnarney (8) compared obese postpartum subjects with non-obese subjects, and found that a lower percentage of obese subjects (33% vs. 57%) reported exercising. Ohlin and Rossner (69) found that activity scores for leisure time from 7 to 12 months postpartum correlated with weight retention in their Swedish subjects. Also, a high percentage of weight retainers ($\geq$ 10kg) were inactive in their leisure time

througout the study, compared to other subjects (23% vs. 4%). Ohlin and Rossner also observed that a small group of their subjects retained high amounts of weight in spite of lowered caloric intake. They discovered that all of these women had physically active jobs prior to pregnancy.

Employment

While several studies of postpartum weight development have included employment information in data collection, very few have actually reported effects (or lack of them) of employment on postpartum weight retention. Schauberger et al. (38) found that the sooner a mother returned to work the less weight she retained. These findings were based on classifying women by whether they returned to work within 2 weeks, from 4 to 8 weeks, from 3 to 6 months, or not at all after delivery. Differences in weight retention were significant between groups. In Ohlin and Rossner's study of Swedish women, duration of maternity leave did not identify women with increased risk for weight retention (69).

Smoking

Garn and Shaw (24) used data from the Collaborative Perinatal Project (70) to examine the effects of maternal smoking on weight gain between pregnancies. They concluded that nonsmokers gain an average of 1-2 pounds more than smokers between pregnancies. Ohlin and Rossner (34) reported that women who stopped smoking in early pregnancy gained significantly more weight during pregnancy than other women.

They also found that women who did not start smoking again before one year postpartum had a significantly higher residual weight than those whose smoking status did not change.

Several more recent studies of postpartum weight development have collected data on smoking and acknowledged it as an important variable for control purposes, but have not actually reported the effects of smoking on postpartum weight retention (28,40,41). Schauberger et al. (38) reported that average retained weight was significantly lower for smokers than for non-smokers in their study, and that smoking was a significant predictor of postpartum weight retention.

Marital Status

A few studies on postpartum women have examined the effect of marital status on weight retention. Schauberger et al. found that postpartum weight loss did not differ significantly by marital status (38). Parker and Abrams found that unmarried status was associated with weight retention among white mothers but not among black mothers (51).

Socioeconomic Status

Results have varied in studies that considered socioeconomic status (SES) as a possible predictor of postpartum weight retention. Greene et al. found that SES was not correlated with interpregnancy weight change (31). Schauberger et al. concluded that occupational category was not a significant predictor of postpartum weight

retention (38). Potter et al. stated that mean retained weight was 3.8 kg for women receiving income from Aid for Dependent Children (ADC), compared to 2.4 kg for non-ADC women (36). The statistical significance of this difference was not reported. Parker and Abrams (51) found that SES was significantly associated with retained weight for both white and black women. Ohlin and Rossner (69) reported that there were more "lower clerks" in the group of women with higher weight retention than in the group with lower weight retention.

Summary

Many variables have been shown to have an effect on postpartum weight retention, but the degree and direction of the effect often differs from study to study. The two variables which have consistently shown the same effect are gestational weight gain and smoking. Higher gestational weight gains are associated with greater average postpartum weight retention, although there is a great deal of individual variation among subjects. Smoking has been consistently associated with lower postpartum weight retention, and quitting smoking without resuming is associated with higher postpartum weight retention.

Physical maturity definitely affects increases in weight for nulliparous teenage girls, especially in the first few years after menarche. Weight has been shown to increase with age even in adult women, but the increase is greater in teenage girls due to continued maturation of the body. Linear growth has been shown to occur in younger teenage girls even during pregnancy, and linear growth has been shown to

occur in many nulliparous teenage girls as late as 18 years of age. These findings lead to the expectation that teenage girls will demonstrate greater postpartum weight retention than women who are already physically mature, and that younger teenagers will demonstrate greater postpartum weight retention than older teenagers, as long as dietary intake continues to support normal growth.

Age, parity, breastfeeding, physical activity, and employment, marital status, and socioeconomic status have been shown to have some effect on postpartum weight retention in some studies, but the direction and extent of the effect has varied from study to study, and sometimes among groups within a study. Many of these variables tend to be confounded with each other or with other variables, such as race.

Dietary intake has not been studied extensively as a predictor of postpartum weight retention, and the relationships that have been demonstrated have been relatively weak. The effect of oral contraceptive use on postpartum weight retention has been considered in several studies, and all of these studies have concluded that there was no effect.

Postpartum Body Fat Measurement

Several studies of postpartum weight development have included various measures of body fat. Scholl et al. (39) measured triceps, subscapular, and suprailеac skinfolds at 4 to 6 weeks postpartum and again at 6 months postpartum. They found

that subjects with excessive rates of gestational weight gain had a significantly higher sum of skinfolds than subjects with low to moderate rates of gestational gain.

Brewer et al. (29) measured triceps, subscapular, and suprailiac skinfolds immediately after delivery and at 3 and 6 months postpartum, and used these skinfold measurements to estimate total body fat. Results showed that the greatest fat loss was at the suprailiac site, where skinfolds decreased significantly for breastfeeders, combination feeders, and formula feeders over the 6-month period. Total body fat, as estimated from the skinfolds, also decreased significantly for all three groups, although the pattern of loss varied among groups.

Kramer et al. (33) measured skinfolds at five sites (triceps, biceps, subscapular, suprailiac, and midthigh) plus circumferences at three sites (waist, hip, thigh). Measurements were made shortly after delivery and then monthly up to 6 months postpartum. A comparison among breastfeeding, combination-feeding, and formula-feeding groups showed little difference in fat loss except that breastfeeding and combined-feeding groups had a significantly greater decrease in hip circumference in the first postpartum month. This difference was reflected in changes in the ratio of upper-body and lower-body composite measures.

Smith et al. (40) were able to obtain waist to hip ratios both before and after pregnancy for their subjects. The change measured in waist to hip ratio (WHR) was over a 5-year time frame, and the study compared women who gave birth to one infant during the 5-year period to women who remained nulliparous over the 5-year period. Results showed an eightfold greater increase in WHR for white primiparas, compared

to white nulliparas. White multiparas did not have a larger increase in WHR compared to white nulliparas. The increase in WHR among black primiparas was twice that of black nulliparas. Even when the model was adjusted for demographic characteristics, baseline WHR, behavioral factors, and weight change, WHR increases remained significantly greater among primiparas. The researchers noted that these changes in WHR might be at least partly due to changes in the elasticity of supportive tissues following pregnancy.

Sohlstrom and Forsum (41) utilized the technology of magnetic resonance imaging (MRI) to measure changes in adipose tissue volume and distribution associated with pregnancy in 15 Swedish women. Measurements were made prior to pregnancy, then at 5 to 10 days, 2 months, 6 months, and 12 months postpartum. Results showed that subcutaneous fat added to the thighs during pregnancy was lost within 12 months postpartum, but that nonsubcutaneous fat, especially in the lower trunk, tended to increase from 2 months to 12 months postpartum. Mean difference between prepregnancy weight and postpartum weight decreased through 6 months postpartum, then increased slightly at 12 months. Mean total adipose tissue volume decreased throughout the pospartum year, but was still 2.86 liters above the mean prepregnancy value when measured at 12 months postpartum. These researchers noted that there were very large differences between individual women with respect to changes in body fat and body fat distribution both during and after pregnancy.

Sadurskis et al. (37) estimated total body fat (TBF) and fat free body weight (FFBW) by measuring body weight, total body potassium, and total body water in 23

Swedish subjects. Measurements were made before pregnancy, soon after delivery, at 2 months postpartum, and at 6 months postpartum. All subjects were lactating. Results showed that a modest fat loss (1.7 kg) occured from 3 to 6 months postpartum, and that there was also a significant decrease in FFBW during the postpartum period. These researchers noted that the assumptions underlying many methods of calculating body fat may not necessarily hold true during reproduction.

In summary, pregnancy does appear to lead to some changes in body fat distribution, in addition to often adding to total body fat and weight.

Methodological Considerations

Determination of Prepregnancy Weight

One of the most difficult aspects of studying the long-term effect of pregnancy on weight is the determination of prepregnancy weight. A few researchers (19,37,41) have been able to conduct prospective studies where actual prepregnancy weights are recorded within a year or so of conception. One technique for estimating prepregnancy weight is to make adjustments to the weight measured at the first prenatal visit or at some specific point in pregnancy (21,27). Most studies (7,8,22,28-33,35,39) have simply relied upon self-reports of prepregnancy weight by the subjects being studied. Usually, the self-report is obtained at the first or second prenatal visit. Sheldon (20) relied upon subject recall for his study of the weight gain patterns of women throughout their reproductive history.

The accuracy of self-reported weights has been studied by several investigators, and results have varied. Stevens-Simon et al. (71) specifically studied the accuracy of self-reported prepregnancy weights (preWt) of pregnant adolescents and found self-reported weights to be highly correlated with actual preWt, although overweight girls had a tendency to underestimate their preWt. The subjects studied by Stevens-Simon were adolescents with an identifiable source of medical care.

Parham et al. (35) confirmed self-reported preWt in their study by comparing it either with the most recent weight measured in the clinic or with weight measured early in pregnancy. They found that there was very little difference in self-reported and measured weights. Stewart (72) found that women tend to underestimate their weights by about 1.4 kg, and that underestimation increases with actual weight.

Although self-reported preWt might not be totally accurate in some cases, there are problems with all methods of estimating preWt (19,71). Even when actual weights are measured before pregnancy, weight is subject to change between the time of measurement and conception.

Three Factor Eating Questionnaire

The Three-Factor Eating Questionnaire was developed by Stunkard and Messick (9) in an effort to improve upon some instruments that had previously been used in research. One of these instruments, the Restraint Scale developed by Herman and Polivy (73), has been used extensively in research to identify "restrained eaters". Several problems arose with the Restraint Scale, one being that it measured weight

fluctuation as well as dietary restraint, such that two of its weight fluctuation items accounted for more than 70% of the variance in total scores (74). Stunkard and Messick used some items from the Restraint Scale and some from Pudel's Latent Obesity Questionnaire (75) in addition to 17 newly written items to prepare a new instrument with 67 items. The instrument was then administered to some subjects who were selected specifically for their known degree of restraint or non-restraint in eating (both overweight and normal weight) as well as to three groups of subjects who were more representative of the population. By use of factor analysis techniques, Stunkard and Messick found that their newly developed questionnaire actually measured three factors: conscious control of eating, lability in behavior and weight, and perceived hunger. The scale was further refined and reduced to 58 items, and reliability measures were obtained. Coefficient alpha reliabilities were 0.92 for cognitive restraint, 0.91 for disinhibition, and 0.85 for perceived hunger. The scale was then reduced to 55 items and subjected to further analysis before being reduced to 51 items. The final reduction eliminated four weight fluctuation items from the disinhibition scale.

Ganley (76) conducted a factor analysis study of the 55 item version of the questionnaire (Eating Inventory) and obtained four factors rather than three. He found that the disinhibition scale actually measured two factors: weight lability and emotional eating. Since the 51-item questionnaire does not include 4 of the weight lability items on the 55- item questionnaire, the latest revision is much less likely to measure weight lability. Mean scores for each of the three scales have been obtained

from several study groups and were published in tabular form by Stunkard and Wadden (77).

Bioelectrical Impedance

Bioelectrical impedence analysis (BIA) is now a widely used method for estimating body composition. Although the most well-known use of BIA is estimation body fatness, the BIA instrument actually measures the electrical impedance of body tissues, thereby providing an estimate of total body water (TBW). Using the value for TBW, one can estimate fat-free mass (FFM). An estimate of body fat can then be made by subtracting FFM from body weight. The estimation of FFM from whole-body BIA has been based on the equation $V = p \times S^2/R$, where conductive volume (V) is assumed to represent TBW or FFM, p is the specific resistivity of the conductor, stature (S) is taken as an estimate of the length of the conductor, and whole-body resistance (R) is measured by the BIA instrument. The volume of TBW or FFM is therefore directly proportional to S^2/R. The problem with applying this equation to the human body is that the body violates the assumption that the conductor has a homogeneous composition, a fixed cross-sectional area, and a uniform distribution of current density. Even so, statistical associations have been established between S^2/R and TBW or FFM measured in samples of children and adults. Regression equations have been developed to predict FFM or TBW from S^2/R alone, S^2/R plus body weight (Wt), S plus R and Wt, and various other combinations of R with anthropometric, age, and gender variables. Some equations have been developed to predict body fat

directly from body weight and S^2/R. Houtkooper et al. (78) have recently summarized the regression models which have been developed in validation and cross-validation studies of the BIA method for estimation of TBW, FFM, or % body fat (BF) and have pointed out that the prediction errors for FFM with equations based on S^2/R alone are similar to those obtained with skinfold equations.

BIA was included in the third National Health and Nutrition Examination Survey (NHANES III, 1988-1994) for persons aged $\geq$ 12 years. One reason for the inclusion of BIA in NHANES III was dissatisfaction with the reliability of skinfold thicknesses, and the inability to otherwise obtain estimates of fat mass and lean body mass (79). At the time the decision was made to include BIA in NHANES III, there was evidence that the BIA method might provide meaningful estimates of body composition in surveys of healthy populations, but appropriate valid age-, ethnicity-, and sex-specific prediction equations were not available. Nevertheless, there was optimism that such equations would become available, and BIA had been determined to be safe and highly reliable. Additional advantages of BIA over other methods of estimating body composition were that it was not invasive, required only a few minutes of time, and was relatively inexpensive. These same advantages were important in choosing a method of estimating body fat in the present study, since the data collection circumstances in the present study were very similar to those for NHANES.

Kushner et al. (80) have recently summarized the clinical characteristics which influence bioelectrical impedance measurements. In healthy populations, these include

accurate measurement of height and weight, body position (both posture and abduction of limbs), consumption of food or beverage, and recent exercise. Although the effects of some of these variables may not always be large or even significant, it is important to standardize the conditions of data collection in order to obtain consistent, reliable results within and between studies.

The use of BIA for body composition measurement was the subject of a National Institutes of Health Technology Assessment Conference in December of 1994. The conference statement (81) included the following conclusions regarding the use of BIA in the estimation of body adiposity:

> BIA appears to be a more accurate measure of FFM and percentage of body fat than body weight, height, or body mass index, and at little extra cost or difficulty but with somewhat greater complexity. BIA may provide a more accurate measure of adiposity than do skin-fold measurements and may be more easily standardized, although measurements of skin folds and girths may provide additional useful information on body fat patterning.
>
> BIA does not appear to be useful to assess the composition of changes of weight consequent to dieting in the obese, presumably due to disproportionate loss of water over FFM. (p. 529S)

These conclusions provide support for the choice of BIA as the method for measuring body composition in the present study, with the understanding that BIA may not be as accurate in assessing body composition in individuals who have recently lost a substantial amount of weight in a short span of time.

Waist-to-Hip Ratio

The relationship of body fat distribution to health consequences was noted by Vague in 1956, when he observed that women with a male pattern of upper-body

obesity have a greater prevalence of diabetes and atherosclerosis than women with gynoid obesity, even if degree of obesity is comparable (82). Body fat distribution has received increased recognition in recent years as more and more studies demonstrate a relationship between fat patterning and chronic disease and/or its risk factors. Some of these studies, their implications, and methods of measuring body fat distribution have recently been summarized by Freedman (83). The ratio of waist circumference to hip circumference is one indicator that has been used to distinguish abdominal obesity from a gynoid pattern of obesity. Waist to hip ratio (WHR) has been related to diabetes, cardiovascular disease, and adverse lipid and insulin levels (84). Although various skinfold thickness ratios have also been used to measure body fat distribution, circumference measurements have less measurement error (85), and are as strongly related to metabolic complications (86).

The significance of body fat distribution indices in adolescents has been investigated. Sangi and Mueller (87) analyzed data from the U.S. Health Examination Survey (1966-1970) to examine the relationship between fat distribution indices and three cardiovascular risk factors: total cholesterol and systolic and diastolic blood pressure. The study demonstrated that body fat distribution was only significantly related to those specific cardiovascular risk factors in sexually mature adolescents. In less mature adolescents, general body fatness and size appeared to be the major correlates with the risk factors in black and white subjects of both sexes.

Freedman et al. (84) analyzed data from 361 children ages 6 to 18, who were selected because of extreme levels of very-low-density- and low-density-lipoprotein

cholesterol (VLDL and LDL). The investigators found that children with high concentrations of both cholesterol fractions had more truncal fat but less peripheral fat than children with low lipoprotein cholesterol concentrations, after adjustment for generalized obesity. Decreased concentrations of high-density-lipoprotein (HDL) cholesterol and apolipoprotein A-1 were also associated with a truncal fat pattern. Skinfold thicknesses and waist circumference were used as indices of fat distribution.

Wabitch et al. investigated the relationships between body fat distribution and steroid hormone concentrations in obese adolescent girls (88). The girls were classified as abdominally obese if WHR was greater than 0.86 (upper tertile). Girls in the upper tertile of WHR had significantly higher serum concentrations of testosterone and a significantly higher free androgen index than girls in the lower tertile. Multivariate regression analysis showed a significant effect of WHR on sex hormone binding globulin, cortisol, the free androgen index, and the free cortisol index after adjustment for BMI and age. It has been established that hyperandrogenic obese women frequently present the unfavorable metabolic syndrome which may include hyperinsulinemia, type 2 diabetes mellitus, lipid abnormalities, and hypertension (88,89).

In summary, measurement of WHR was included in the present study to add a measure of body fat distribution which might contribute more information about the health risks associated with postpartum weight retention. The measurement might also contribute further information about the relationship between WHR and changes in body mass index.

CHAPTER 3

METHODOLOGY

Overview

This research was one part of a larger project (AES-TN860) funded by the Agricultural Experiment Station, University of Tennessee Institute of Agriculture. The objective of AES-TN860 was to identify factors affecting the nutritional intake and status of pregnant and postpartum adolescents. This study focused on factors affecting the energy intake, weight, and body composition of postpartum adolescents.

Human Subjects Approval

The Committee on Research Participation (CRP) of the University of Tennessee, Knoxville granted permission to conduct this study. The confidentiality of information collected for this research was protected by assigning a code number to each subject and by using only this code number for identification on all forms on which confidential information was recorded. Only two forms (the "Statement of Informed Consent" and the "Information Form", Appendices A and B) identified both the name and the code number of the subject. Each of these two forms was filed in a

separate location from the remaining data collection forms, and access to the two identifying forms was limited to researchers approved by the CRP.

Subject Recruitment and Retention

Longitudinal Sample

The majority of the subjects in this study were recruited during the third trimester of pregnancy by other researchers involved with the AES-TN860 project. Selection criteria specified that subjects must be pregnant, white adolescents who were between the ages of 11 and 17 years (inclusive) at conception, and who lived within a 120 mile radius of Knoxville, Tennessee. Subjects were recruited from a variety of settings, including physicians' offices, health departments, schools, and special programs and residential homes for pregnant teens. Referral forms (Appendix C) and/or publicity posters with detachable postcards (Appendix D) were provided to agencies willing to assist with recruitment.

Subjects recruited during pregnancy were interviewed during their third trimester by two or three graduate students involved with the TN860 project. For some portions of the project, two personal interviews were required during pregnancy. Interviews began in May, 1989. Pregnancy interviews were completed by the end of 1990, and postpartum interviews of TN860 subjects were completed by mid 1992. Study participants were paid $5.00 per interview and were given small gifts as well.

Several methods were used to maintain contact with the subjects during the first postpartum year. Information obtained at the first interview included more than one address and phone number, so that someone knowing the new address of the subject could be reached if the subject had moved. Participants were contacted by phone approximately two weeks after their expected dates of delivery, and information about the birth was collected. After this contact was made, small baby gifts were mailed. At three months postpartum, a short survey form was mailed to participants.

At about six months postpartum, participants were interviewed (by a fourth graduate student) about their infant feeding practices and their babies' health and development. Addresses and demographic data were updated at this interview, participants were paid $5.00, and their babies each received a gift.

Each subject who had completed the pregnancy interviews was contacted by mail at around 10 months postpartum. Within two to four weeks after the 10-month letter had been mailed, the subject was contacted by phone to set up an appointment for her final interview. Each final interview was scheduled within 11 to 13 months postpartum, plus or minus 2 weeks. After the final interview, subjects were paid $5.00 and given a small gift for their babies. An additional $5.00 and a small gift for the subject were mailed when the subject's food records and other questionnaires were returned by mail.

At each contact time, there were some subjects who could not be reached through the phone numbers or addresses known to the researchers. When this was the case, researchers contacted the person or agency which had referred the subject during

pregnancy, or the school the subject had attended. If these efforts were not successful, or if the subject had moved out of the state, the subject was lost to follow-up. Some subjects moved out of state during their first postpartum year, but had returned to the state by the end of the year and were able to participate in the final interview.

Data collected during the pregnancy interviews included demographic information, two 24-hour dietary recalls, information related to food cravings and aversions, sensory assessment, and information regarding the influence of television and peers on food-related behavior. Subjects also were required to keep a two-day food record, and they were given instructions about the amount of detail needed on the records.

Supplemental Postpartum Sample

Due to the large number of subjects in the original sample who were either lost to follow-up or again pregnant at 12 months postpartum, additional subjects were recruited in order to enlarge the sample size. These subjects were seen only at 12 months postpartum, and they were recruited by one of three methods. The first method consisted of contacting adolescent mothers who had participated in another University of Tennessee study of pregnant and postpartum adolescents and who had indicated willingness to be contacted about this study. The second method consisted of contacting public health nutritionists in a 14 county area of eastern Tennessee, explaining the study to them and asking them to display recruiting posters and/or distribute recruiting letters (Appendix E) to adolescent mothers who met the study

criteria. The third method consisted of contacting high schools in a few counties in middle Tennessee and inquiring about special programs for adolescent mothers.

Instrumentation

This study utilized data collected for the overall TN860 project (demographic and dietary), data collected for the infant health and feeding portion of the TN860 study (breastfeeding information and medical records data), and data collected specifically for the research reported here. The primary instrument used for the data reported in this dissertation was a questionnaire entitled "Postpartum Weight and Related Factors" (PPWRF). (See Appendix F.) As a supplement to the PPWRF, the researcher purchased a set of copyrighted body image silhouettes from Profile Associates of Chapel Hill, North Carolina. (See example in Appendix G.) A second instrument used for this research was the "Three-Factor Eating Questionnaire" developed by Stunkard and Messick (9), which is currently called the "Eating Inventory" (EI). Forms were also developed for recording anthropometric and medical records data. (See Appendixes H and I.)

In addition to data collection questionnaires, several instruments were used for actual physical measurements. The only physical measurement instrument that will be discussed in this section is the bioelectrical impedance instrument used to estimate percent body fat. The scale, tape measure, and height measuring devices used for anthropometric measures will be described briefly in the data collection section.

Postpartum Weight Questionnaire (PPWRF)

The PPWRF was designed by the researcher to gather data about weight changes during and after pregnancy as well as all factors (other than diet) that were hypothesized to affect postpartum body weight and/or body composition. The questionnaire was composed of the following parts: A) Reproductive Status and History, B) Weight Control Before Pregnancy, C) Weight Changes During and After Pregnancy, D) Postpartum Health, E) Work and/or School, F) Physical Activity, G) Smoking History, and H) Parent Weights.

The PPWRF was pilot tested with mothers who brought their babies in for immunizations or WIC recertification at the local health department in the researcher's city of residence. After pilot testing, the questionnaire was modified to be somewhat less structured in that subjects were asked an open-ended question to describe how their weight had changed after delivery. Changes to allow more freedom in responding were made in the section for recording information about weight control measures used before pregnancy.

Due to the amount of time required to complete the pilot-test version of the questionnaire, several modifications were made to shorten the questionnaire. Questions about the weight and weight control measures of parents were deleted and the silhouette choice was added instead. Questions about fatness of other relatives also were deleted. In addition, questions about breastfeeding, infant's birthweight, and subject's current height and weight were deleted because they duplicated information collected elsewhere in the TN 860 study. Questions about weight changes, infant

birthweights, and infant feeding following previous pregnancies also were deleted, because most subjects were primiparous. Questions about age at menarche, oral contraceptive use, postpartum illnesses, work, school, physical activity, and smoking were added due to possible effects of these factors on postpartum weight changes.

Body Image Silhouettes

Data collected on fatness of the subjects' parents were based on sets of eight numbered line drawings of graduated sized silhouettes of men and women (Profile Associates, Chapel Hill, NC). These drawings were used to help assure consistency in estimation of parent fatness and also to quantify parent fatness in a way that did not depend on the subject's knowledge of her parents' weights or heights.

Three Factor Eating Questionnaire

The Three Factor Eating Questionnaire (TFEQ) was modified slightly for use in this study. One item (#25) was omitted because it was intended to assess weight fluctuations or changes due to changes in diet. As it appears in the standard TFEQ, item 25 is worded as follows: "My weight has hardly changed at all in the last 10 years." Since weight change is a normal part of pregnancy, it was expected that all subjects would respond negatively to this item, but that their negative response would not necessarily be indicative of the "disinhibition" which the item was intended to measure. Since item 25 was omitted, there were only 50 items on the version of the

TFEQ used for this study, and items numbered 25 or above did not have the same item number as they have in the standard TFEQ.

The TFEQ was further modified in order to also obtain a retrospective pre-pregnancy TFEQ score (preTFEQ). All items were re-worded to the past tense to assist the subject in thinking retrospectively about her eating habits and feelings about eating before her pregnancy. Wording of the items was left in the present tense for the measurement of postpartum TFEQ scores. (See Appendixes J and K.)

Body Composition

Bioelectrical impedance analysis (BIA) was chosen as the method for measuring body composition in this study for several reasons. First, this method measures fat in the entire body rather than only at selected sites, as is the case with skinfold measures. Also, the BIA method is very quick and easy to use, and it does not pose the problem of lack of consistency when measurements are taken by different researchers. Finally, the method does not require that the subject remove her clothes, other than one sock and shoe.

The RJL Systems Body Composition Analyzer model BIA-101A was used to measure percent body fat of subjects in this study. The BIA-101A is a small, portable instrument that can be powered by a rechargable battery or plugged directly into an electrical socket. The instrument measures resistance of the body to the flow of an electric current, as well as reactance, which is the opposition to the flow of electric current caused by capacitance. Theoretically, reactance is an indication of the quantity

of body cell mass. Reactance is not affected by the quantity of body fat, because fat tissue cells are not surrounded by cell membranes. Resistance is affected by the quantity of body fat, because fat is a poor conductor of electrical current while lean tissue is highly conductive.

The BIA-101A consists of a rectangular-shaped box to which two cables, one red and one black, are attached by a single round 5 pin connector. Two electrode clips (one red and one black) are attached to each cable. The clips are attached to the subject in a manner to be described in the data collection section. After the cables are attached to the subject, the instrument is turned on and readings are immediately displayed digitally.

RJL Systems supplies a software program and manual (90) to accompany the BIA-101A instrument. The program calculates percent body fat by using an equation that incorporates weight and height measurements as well as resistance and reactance readings. The program actually includes a whole set of equations, one of which is automatically selected for use on the basis of the subject's age and gender (90).

Data Collection

Interview Format

The majority of the postpartum interviews were conducted in a motor home equipped as a mobile laboratory. Because the subjects were located in 40 different counties in Eastern Tennessee, the mobile laboratory provided a consistent

environment for the interviews, while making it possible to travel to a location convenient for the subject. The motor home was rented for periods of a few months at a time so that it would be available at the times when most of the subjects would be scheduled for interviews. Subjects who were interviewed when a motor home was not available were usually interviewed in their own homes, but sometimes in other places (such as a residential school or a community center) which were relatively convenient to the subject as well as private enough for confidential interviews.

The order of data collection was carefully considered for the postpartum interview. Because most of the subjects had their babies with them at the time of the interview, it was important to collect the data as efficiently as possible. Also, because the interview included questions about feelings about weight as well as questions about food preferences, an effort was made to minimize the influence of data collection on the answers to questions posed in other parts of the interview.

The one-year postpartum interview, which included segments not included in this dissertation (in parentheses below), was conducted in the following order:

1. Review and signature of consent form
2. Updating of addresses and demographic data
3. 24-hour dietary recall
4. Bioelectrical impedance
(5. Infant feeding and development questions)
6. PostTFEQ
7. Weight questionnaire (PPWRF)

(8. Sensory assessment)

(9. Snack choices)

(10. Cravings and aversions)

(11. Perceived changes in consumption from various food groups

groups from pregnancy to postpartum)

12. Anthropometric measurements of the subject

Bioelectrical impedance was performed early in the interview because a 4-hour fast was required prior to measurement. The anthropometric measurements were done last so that knowledge of the measurements would not affect answers in other parts of the interview. With the exception of about five subjects, this researcher personally collected all data that were specific to this portion of the study (numbers 4,6,7 & 12 above). The questionnaire was designed so that it could be administered by other researchers when absolutely necessary without affecting the results. In the absence of the researcher, another graduate student collected the data specific to this study. This student had observed the researcher several times and had been trained prior to collecting these data.

Data which were not specific to this study were usually collected by a graduate student other than the researcher, with the exception of the subjects recruited to supplement the original sample. Prior to recruiting the supplemental subjects, however, the researcher had observed the collection of the general data on numerous occasions and had received specific training to maintain consistency in the interview protocol.

Demographic Data

The demographic data form (see Appendix M) was used to record the subject's age, date of birth, grade in school or last grade completed, current living arrangements, mother's education, father's education, and spouse's education, if applicable. The mother's, father's, and spouse's occupation also were recorded on this form, as well as the expected or actual date of delivery, the name of the subject's doctor during pregnancy, and the name of the hospital or clinic where the subject delivered her infant. This form was utilized for both the pregnancy and postpartum interviews, because some of the information was subject to change.

The education and occupation information collected was used to calculate the Hollingshead Four Factor Index of socioeconomic status. This index is actually based on the education and occupation of all wage earners in a household. For example, several subjects lived with her husband and his parents. If the subject's spouse and her father-in-law both earned the money that was used to pay the household expenses, the Hollingshead Index was based on the education and occupation of the subject's spouse and his father. In such a case, the information needed on the demographics form would be the education and occupation of the girl's father-in-law rather than her father. Thus, the format of the demographics form often had to be adjusted to reflect the actual source of financial support for the subject. If these adjustments were overlooked, the information collected might not have been sufficient to calculate the Hollingshead Index correctly.

Breastfeeding Data

Information on whether the subject chose to breastfeed or bottlefeed was collected at the six months postpartum interview by a graduate student other than this researcher. This student summarized the information and shared it with this researcher for use in this study. Information on duration of breastfeeding also was collected and shared.

Dietary Data

The dietary data used for this study were collected at the 12-month postpartum interview and by means of food records and follow-up phone calls after the interview. The 24-hour recall obtained at the interview was recorded on the form in Appendix N. Measuring utensils, drinking glasses, and plastic food models were used to help the subjects estimate portion sizes. If the subject had consumed food at a fast-food restaurant, she was asked to indicate what size drink or fries (small, medium, or large) she had ordered and whether or not she had consumed the whole order. If she had consumed a pre-packaged item, she also was questioned about the size of the package.

Subjects were provided with forms (same as for recall) and an instruction sheet and asked to keep food records for two days following the interview. A postage-paid envelope was provided for returning the records to the researchers. When the food records were received by mail, project researchers (all experienced Registered Dietitians) examined the records for detail, and called the subject to clarify any questionable items. This phone call was also used to obtain another 24-hour recall

from the subject. Special effort was made to obtain a recall or record for one weekend day out of four days total. In almost all cases, it was possible to include one weekend day.

Bioelectrical Impedance Measurement

Prior to their appointment, most subjects received written instructions regarding preparation for measurement of percent body fat. (See Appendix O.) These instructions asked the subject to refrain from eating or drinking for at least four hours prior to the appointment and to wear clothing that would facilitate the impedance measurement.

Just prior to impedance measurement, subjects were asked to remove their right shoe and sock as well as all their jewelry and metal hair ornaments or eyeglasses. Subjects were asked to sit on the bed at the rear of the motor home while electrodes were attached to their right hand and right foot. The electrodes supplied by RJL Systems were disposable foil tabs that were pre-gelled. Each electrode was cut in half, based on instructions provided with the impedance instrument. One half-electrode was placed such that its straight edge was across the top of the wrist, transecting the ulnar head. Another half-electrode was placed just above the middle knuckle of the right hand (at the distal metacarpals), with its straight edge facing the wrist. One of the foot electrodes was placed across the top of the right ankle, such that its straight edge transected the lateral malleoli. The other foot electrode was placed on top of the right foot just above the second toe (at the distal metatarsals).

The subject was then asked to lie down on the bed, and the cable clips were attached to the electrodes. Clips on the black lead were attached to the foot, with the black clip attached to the toe electrode and the red clip attached to the ankle electrode. Clips on the red lead were attached to the hand, with the black clip attached to the knuckle electrode and the red clip attached to the wrist electrode.

Next, the subject's position was adjusted so that her legs were not touching each other and her hands were not touching her body. She was asked to remain as still as possible while readings were taken. The instrument was then turned on, and readings were recorded. The instrument has a switch that changes the reading from resistance to reactance. In order to get three paired readings for each subject, the switch was toggled back and forth from resistance to reactance, and readings were recorded each time on the anthropometric measurements form (Appendix H).

After the readings were recorded, the instrument was turned off and the clips were disconnected from the electrodes. Subjects were asked to remove their own electrodes from their hands and feet, since removal tended to pull slightly on the skin and hair. Electrodes were then placed in a waste receptacle.

Three-Factor Eating Questionnaire

Subjects were asked to respond to the TFEQ postpartum version by thinking about what answer would best fit their feelings and behavior in the time since their baby had been born. The researcher explained that there were no right or wrong answers, but that the subject was to choose the answer that fit her best. Subjects were

encouraged to ask the researcher to explain any questions that did not seem clear. If a subject seemed to find the questionnaire unusually difficult to complete, the questions were read aloud to her and her response was marked for her. (Only two subjects completed the questionnaire in this way.)

After the postTFEQ had been completed, some of the subjects were then given the preTFEQ to be completed at home and mailed in along with food records. After 15 subjects had completed the questionnaire in this manner, the researcher's committee suggested that perhaps the results would be more valid if the preTFEQ was not completed until at least two weeks after the interview. For the remaining subjects, then, the preTFEQ was mailed to the subject at least 2 weeks after the interview, together with a letter reminding the subject that the questionnaire pertained to her food-related behavior before her pregnancy. At the interview, the subject was informed that the preTFEQ would be mailed, and that the results of her body fat analysis would be reported to her when the completed preTFEQ was returned to the researcher in the postage paid envelope provided.

Weight Questionnaire (PPWRF)

Each item on the PPWRF was read aloud by the researcher and the subject's response was recorded. If the subject responded positively or uncertainly to the second question ("Are you pregnant now?"), she was not eligible to be included in the sample of postpartum subjects used for data analysis, she was not weighed or measured, and she was not asked to complete any more dietary records.

The last two questions on the PPWRF pertained to parent fatness. At this point, the subject was asked to look at the set of female silhouettes obtained from Profile Associates and choose the one which looked most like her own mother. She was then asked to look at the male sillhouettes and choose the one which looked most like her biological father.

Anthropometric Measurements

Body Weight. The scale used to measure body weight was a platform type with a beam and movable weights (Continental Scale Corporation, Chicago, Illinois, Model 400-DHI). If the scale was not balanced at zero, the movable tare was adjusted with a screwdriver in order to balance the scale at zero. Before a subject was weighed, an object of known weight was weighed in order to check the accuracy of the scales.

The subject was asked to remove her shoes and then to position herself with her feet in the center of the scale platform. Her weight was then determined to the nearest quarter pound by movement of the weights until the beam was balanced. The subject was then asked to step off the scale and step back on again. If the beam balanced at the same weight again, this weight was used as the second weight measurement. If the beam was not balanced at the same weight the second time, the weight was adjusted and recorded as different from the first weight. If the first and second weights were different, the average of the two weights was calculated.

Height. In the mobile laboratory, a non-stretchable fiberglass measuring tape was affixed to the wall where the subjects' heights were measured. The subject, with bare or sock-clad feet, was asked to stand with her back to the wall such that the tape was positioned in the center of her back and head. She was asked to stand normally and look straight ahead while a specially constructed right-angle headboard was placed on the top of her head and against the wall. The headboard was held firmly in place as the subject moved away from the wall, then the tape was read at the point where the bottom of the horizontal portion of the headboard met the wall, and height was recorded to the nearest tenth of a centimeter.

When a subject was interviewed in a place other than the mobile laboratory, her height was measured with an anthropometer. In order to help ensure that the anthropometer was perpendicular to the floor, the instrument was placed next to a wall or door frame. The subject, without shoes, was positioned with her back to the wall and the anthropometer centered to her back and head. The horizontal arm of the instrument was then lowered to the top of the subject's head, and her height was read on the vertical portion of the instrument. This procedure was repeated twice. If the two measurements were different by more than one centimeter, a third measurement was taken and the average of the closest two measurements was used. If the initial two measurements were relatively close, the average of these two measurements was calculated.

Waist and Hip Circumferences. Both circumferences were measured with a non-stretchable fiberglass tape, and were recorded to the nearest eighth of an inch. The waist measurement was made at the smallest circumference of the torso (the natural waist), and the hips were measured at the level of maximum extension of the buttocks. The subject was asked to raise her shirt above her waist for the waist measurement, but she was not asked to remove any clothing for the waist or hip measurement. If the subject's abdominal wall sagged near the level of hip measurement, the tape was positioned underneath the sagging abdomen in order to obtain a true hip circumference.

Circumference measurements were usually made by the researcher and one other graduate student. If the researcher was not present at the interview, two other graduate students performed the measurements, one being the student who usually made measurements with the researcher. Subjects in the supplemental sample were measured twice by the researcher. In all cases, the average of the two measurements was calculated, then used to calculate the WHR ratio.

Medical Record Data

The informed consent form signed by the subjects included a statement which granted permission for the researchers to obtain infomation from the subject's medical records. After all subjects in the longitudinal sample had been interviewed at 12 months postpartum, the researcher and one other graduate student compiled a list of subjects grouped by hospitals at which the subjects had delivered. Next, the medical

records director of each hospital was contacted by phone to request permission to review the medical records of subjects who had delivered there, and to make an appointment to review the records. Some hospitals requested detailed information about the study and required a review by committee in order to grant permission for records access. Other hospitals required that the subject's consent be obtained within 90 days of the record review, and that the hospital's own consent form be used. The majority of the hospitals were willing to accept the consent form signed at the interview as sufficient documentation to grant access to medical records. A copy of the consent form for each subject who delivered at a particular hospital was mailed to the medical records director together with a letter reviewing the phone conversation and confirming the review appointment. The subject's birthdate and delivery date were noted on the consent form to facilitate record retrieval. Just prior to the review appointment, medical records personnel were phoned to confirm that the records had been pulled for review.

The form used to record medical record data was designed by another graduate student after meeting with the researcher and two faculty members to discuss what information should be obtained from the records. The following information was recorded on the form (Appendix I): prepregnancy weight; admission weight at delivery; infant's gestational age and/or mother's weeks gestation; delivery date; infant birth weight, length, and gender; APGAR scores at one and five minutes; fetal complications; and complications of pregnancy. The following complications of pregnancy or delivery were listed on the form to remind the researcher to check for

each one: gestational diabetes, C-section, abruptio placenta, toxemia, hypertension (admission blood pressure was recorded), extended labor (hours of labor were recorded), anemia (initial and final hemoglobin and/or hematocrit were recorded), edema, and Rh blood factor.

Data Reduction

Demographic Data

Socioeconomic status. The Hollingshead Four Factor Index of social status (91) was calculated based on the education level and occupation of all members of the household (as well as parents living outside the household) who provided economic support for the subject. For each income provider, an education score (1 to 7 points) and an occupation score (1 to 9 points) were determined based on the scales shown in Appendix P. For each individual, the education score was multiplied by three and the occupation score was multiplied by five. The weighted scores were then summed to obtain a Hollingshead Index for each individual. The individual scores of each income provider were then summed and divided by the number of providers in order to obtain the "household score" used as an indicator of the subject's socioeconomic status. Thus, the potential range of scores was 8 (low SES) to 66 (high SES).

Change in marital status/living arrangement. Since it was hypothesized that changes in marital status or living arrangements could be related to weight changes,

the demographic information collected during pregnancy was compared to the demographic data collected at 12 months postpartum. A single dichotomous variable was used to indicate either change (=1) or no change (=0) in either marital status or living arrangements. If a subject had been living in a residential home for pregnant teens during pregnancy, but returned to her prior living arrangements afterwards, this was not regarded as a true change in living arrangements.

Change in school or work status. Since it was hypothesized that changes in school or work status could be related to changes in weight, it was necessary to determine whether a major change in school or work status had occured for the subject between conception and 12 months postpartum. A dichotomous variable (change=1, no change=0) was used to indicate whether or not such changes occured in either work or school status. If, for example, a subject quit school during her pregnancy and did not return to school at any time after delivery, this would be considered a major change in school/work status. On the other hand, if a subject graduated from school during her pregnancy and then got a job or went to a training program, such as cosmetology school, this would not constitute a major change in school or work status. The objective of using this variable was to account for any major change in the subject's lifestyle, especially change from being away from home for several hours to being at home most of the time.

Age and Parity

Age at delivery. The subject's age at delivery was determined to the nearest tenth of a year by first subtracting the year of birth from the year of delivery, then either adding or subtracting tenths of a year, depending on whether delivery occured before or after the subject's birthday. Tenths of the year were determined by converting months to tenths by dividing the number of months difference between birthdate and delivery date by 12.

Age at menarche. Each subject was asked at what age she had her very first menstrual period. She was then asked if she could remember during what season or what month of the year her period started. Some subjects were only able to roughly estimate their age at the time of menarche (by saying they were either 12 or 13, or in 7th or 8th grade). Other subjects were able to give the exact date when their period started, because it was near a memorable event such as their birthday, Christmas, or another holiday. Most subjects were able to at least specify the season of the year when menarche occured.

Age at menarche was determined by subtracting the year of the subject's birth from the year of menarche, then adjusting by tenths of a year according to whether menarche occured before or after the subject's birthday in that year. If a subject stated that menarche occured when she was in 7th or 8th grade, her age was estimated to be 12.5, since 7th graders are typically 12 years old. If a subject could remember her age at menarche but not the season, five tenths were added to the age she specified. For

purposes of estimating tenths of a year, summer menarche was assumed to be in July, fall menarche in October, winter menarche in January, and spring menarche in April (unless the month was specified by the subject).

Gynecological age. The subject's gynecological age at delivery was calcaluted by subtracting age at menarche from age at delivery (each age having been determined to the nearest tenth of a year, as described above).

Parity. For the purposes of this study, parity was coded as either one or zero. If the pregnancy being studied was the subject's first pregnancy, parity was coded as "zero." If the subject had given birth to any children prior to the pregnancy being studied, her parity was coded as "one."

Dietary Analysis

Food records and recalls were analyzed for nutrient content using the Nutritionist III Data Analysis package (version 5.0, 1988, N-Squared Computing, Salem, OR). Postpartum diets of subjects in the longitudinal sample were coded and analyzed by two other graduate students, both Registered Dietitians. Foods were coded and entered into the program to obtain the subject's 4-day average intake for all nutrients. The output included a printout of all foods consumed as well as the portion sizes consumed. The printed food list was compared with the original food intake records to check for possible coding or input errors. To minimize error, the graduate

students divided the coding, input, and checking tasks such that one student coded the foods and another student checked the output. The checker thus became aware of the codes being used by the coder, and the students were able to alternate tasks while maintaining consistency. When foods consumed were not in the Nutritionist III data base, substitutions were made based on comparable nutrient content. A master list of substitutions was maintained for reference.

To assure consistency of nutrient data analysis for the supplemental sample, the researcher participated in some of the coding and checking done for the longitudinal sample to familiarize herself with codes and substitutions being used. Since the other students were no longer available when data for the supplememtal sample were analyzed, the researcher performed all coding, input, and checking tasks for the supplemental sample.

Dieting History and Intake Changes

The PPWRF questionnaire included the following questions about dieting history:

B1. Before you ever became pregnant (for the first time, if you have been pregnant more than once) did you ever make any special effort to control your weight or to change your weight? (yes or no)

B2. If yes, how old were you when you first made an effort to control your weight or change it?

B3. If yes, what have you done?

C4. a. Did you make any effort to control your weight during your pregnancy? (yes or no)

C4. b. Please tell me what you did to control your weight (during pregnancy) and why you did it.

C6. Please tell me how your weight has changed from the time your baby was born until now, and tell me if you did anything special to cause your weight to change, or if something happened to cause your weight to change.

The combined answers to questions B1 and B3 were used to determine whether or not the subject had attempted weight loss dieting, specifically, prior to pregnancy. Answers to question B3 also allowed a determination of the maximum amount of weight a subject had lost by dieting at any one time. The combined answers to questions C4a and C4b were used to determine whether or not a subject had made an effort to limit her weight gain during pregnancy. Answers to question C6 were used to determine whether or not a subject had dieted in order to reach her minimum postpartum weight, and also how many months it took for her to reach her minimum postpartum weight.

Three-Factor Eating Questionnaire

The TFEQ scores for both pregnancy and postpartum were determined by assigning a score of either 1 or 0 for the response to each question. The key for assignment of response scores, as published by Stunkard and Messick (9), has been placed in Appendix K. Scores for each subscale of the TFEQ (restraint, perceived

hunger, and disinhibition) were calculated by summing the scores for all questions assigned to each subscale. Differences between postpartum scores and retrospective prepregnancy scores were calculated by subtracting prepregnancy scores from postpartum scores. Because the retrospective prepregnancy questionnaire was delayed more for some subjects than for others, statistical tests were run to check for any significant differences in score changes between the two groups of subjects.

Physical Activity Score

In order to determine a numerical score for physical activity for each subject, the researcher devised a scoring system based on hours per week of sitting versus standing activities. Mothers of 12-month-old infants had difficulty estimating the number of hours they were actually standing because they were constantly getting up and walking around even when they were mainly watching television. Although there appeared to be some variation in parenting styles and living situations that might affect energy expended in child care, it was not possible to differentiate these styles accurately enough to assign different scores on that basis. Instead, each subject was assigned a baseline score of 40, to represent the average amount of physical activity expended in caring for an infant in the first year of life.

The baseline score was then adjusted according to the number of hours spent sitting or standing at work or in school. Many of the subjects attended school for as many as 35 hours per week, but school was only in session for 9 months of the year. Months of school attendance were divided by 12, then multiplied by hours of school

per week, in order to estimate the average hours per week in school for the entire postpartum year.

Many of the subjects had jobs which required that they stand and often also walk, carry items, etc. Most of the subjects worked for at least a portion of the postpartum year, and many had several jobs, each of which lasted only a few months. Hours worked per week also varied from job to job and subject to subject. A score was calculated for each job held by the subject. Months employed on that job were divided by 12, then multiplied by the hours worked per week. In general, jobs were either sedentary or non-sedentary for the entire amount of time worked. If a job consisted of both sedentary and non-sedentary activities, hours for each type of activity were determined, and each type of activity was scored separately.

Subjects were also asked whether they got any regular exercise such as physical education classes, walking, swimming, etc. Average hours per week of these types of activities were determined in the same way as average hours of school and job activities.

The physical activity score was calculated by adding average "standing" and "exercising" hours per week to the baseline score of 40, then subtracting average "sitting" hours per week from the total. The baseline score was sufficiently high to keep all final scores above zero.

Smoking Status and Changes in Smoking Status

The PPWRF included several questions about the subject's current and former smoking habits. Answers to these questions were used to assign values to the following variables:

1) Was a smoker at conception? (no=0, yes=1)

2) Smoked at all during pregnancy? (no=0, yes=1)

3) Smoked most of the first postpartum year? (no=0, yes=1)

4) Quit smoking for most of pregnancy? (no=0, yes=1)

5) Quit smoking permanently? (no=0, yes=1)

Weight Changes

Pregnancy weight gain. The subject's gestational weight gain was determined by subtracting self-reported prepregnancy weight from the delivery admission weight on the medical record. Self-reported prepregnancy weight was used because prepregnancy weights were not reported in many of the medical records reviewed. Self-reported weights were compared to weight at first prenatal visit as a way of checking whether the self-reported weight was considerably different from what would be expected. For all but two of the subjects, self-reported prepregnancy weights compared reasonably with weight at the first prenatal visit and/or with self-reported prepregnancy weight recorded in the medical record.

Change in BMI from conception to 12 months postpartum (BMIdiff). Body mass index (BMI) was calculated for both prepregnancy and 12 months postpartum by using height as measured at 12 months postpartum (BMI = weight in kilograms/(height in meters)^2). BMI change was calculated by subtracting pre-pregnancy BMI from BMI at 12 months postpartum.

Body Fat Determination

Percent body fat was calculated using the software provided with the bioelectrical impedance instrument. Age, gender, height, weight, resistance and reactance values were entered for each subject. Equations used for most subjects were those developed by RJL, but the RJL software utilizes equations developed by Houtkooper et al. (92) for subjects under 18 years of age (90).

Medical Record Data

Medical record data were obtained for 58 of the 75 subjects. Only selected information from medical records was used in this study. Maternal weights have already been described. Gestational age and infant birthweight were also included in statistical analyses. Although data were collected for several types of pregnancy complications, the complications selected as most relevant to this study were caesarean section, edema caused by pregnancy-induced hypertension, and Rh blood factor. Although gestational diabetes may also have some relevance, only one of the subjects had gestational diabetes.

Data Analysis

All data were analyzed with the SAS Statistical package (SAS Institute Inc., Cary, NC). Analyses included calculation of simple statistics and correlations as well as testing of hypotheses through multiple linear regression, analysis of variance, and t-tests. Frequency distributions were graphed for selected variables.

Simple Statistics and Frequencies

Mean, standard deviation, and median were calculated for each variable studied using the Proc Corr procedure. Frequency distributions were graphed with Proc Gchart.

Correlation Analysis

Spearman correlation coefficients and error probabilities were calculated for every possible pair of variables using Proc Corr. Although hypotheses had already been formulated regarding the relationships between some of the variables, correlation values were used to identify additional variables which might have a significant influence on postpartum weight retention or on other variables.

Hypothesis Testing

Predictors of BMIdiff. It was hypothesized that prepregnancy weight status, pregnancy weight gain, and scores on the pre- and postTFEQ would be significant

predictors of the difference in BMI (BMIdiff) between conception and 12 months postpartum. This hypothesis was tested by using a stepwise multiple regression procedure, with BMIdiff as the dependent variable. Both retrospective pre-pregnancy scores and 12-month postpartum scores on the TFEQ were entered into the equation, resulting in six variables (one for each scale of the TFEQ) for TFEQ scores alone. Pre-pregnancy weight and pregnancy weight gain were the only other variables tested in this particular procedure. Because the number of retrospective TFEQ scores available (n=36) was considerably less than the number of subjects (n=75), another stepwise procedure was performed using only postpartum scores on the TFEQ. This change both reduced the number of variables being tested and more than doubled the size of the sample, thus increasing the reliability of the test.

Changes in TFEQ Scores. It was also hypothesized that retrospective preTFEQ scores would be significantly different from postTFEQ scores. Testing of this hypothesis was complicated by the fact that some subjects completed the preTFEQ shortly after the postTFEQ, while others completed the preTFEQ at least 2 weeks after the postTFEQ. This hypothesis was tested by using a student's T-test to compare the preTFEQ scores to the postTFEQ scores, for each scale of the TFEQ. One test was run for all 36 subjects who completed a preTFEQ, then separate tests were run for each group of subjects that completed the preTFEQ, based on when the preTFEQ was completed.

Predictors of BMI at 12 Months Postpartum. It was hypothesized that prepregnancy BMI (preBMI), gynecological age (GA), pregnancy weight gain, postpartum dietary restraint, postpartum energy intake, percent of kcal from fat, postpartum activity level, and fatness of the subject's parents would be significant predictors of BMI at 12 months postpartum (postBMI). This hypothesis was tested with a stepwise multiple linear regression procedure, using postBMI as the dependent variable.

It was further hypothesized that percent of kcal from fat would not be a significant predictor of postpartum BMI (or percent body fat) if the subject's mother was thin. This hypothesis was tested by dividing subjects into groups based on the mother's fatness (mother either thin or not thin) and looking at the correlation between post BMI and percent of kcal from fat for each group separately. Further examination of the role of parent fatness was conducted by dividing subjects into groups based on father's fatness and on the fatness of both parents.

Predictors of Body Fat Percentage at 12 Months Postpartum. It was hypothesized that the same variables that were significant predictors of postBMI would also be significant predictors of body fat percentage at 12 months postpartum. This hypothesis was also tested by using the SAS stepwise selection procedure for multiple linear regression modeling. It was also hypothesized that BMIdiff would be positively correlated to percent body fat at 12 months postpartum. The correlation coefficient and its P value were used to test this hypothesis.

Relationship between Waist to Hip Ratio (WHR) and BMI Classification. It was hypothesized that mean WHR for subjects whose postBMI was above normal range would not differ from mean WHR for subjects whose postBMI was in the normal range. Since preliminary analysis showed that WHR and BMI were highly correlated, further testing was deemed unecessary for this hypothesis.

Postpartum Restraint Scores and Postpartum Caloric Intake. It was hypothesized that postpartum cognitive restraint scores would be negatively correlated to postpartum caloric intake. This hypothesis was evaluated by means of the correlation coefficient and its significance level.

Effect of Job/School on Energy Intake and TFEQ Scores. It was hypothesized that subjects who were employed or attended school would have lower energy intakes and different TFEQ scores than subjects who were not employed or attending school. This hypothesis was tested using the SAS GLM procedure for LSD T tests.

Further Examination of the Data

Because some of the correlations between variables revealed relationships that were not included in the hypotheses, effort was made to develop multiple regression equations which would utilize the most highly correlated variables to "predict" a dependent variable. BMIdiff, difference in weight between conception and 12 months

postpartum (Wtdiff), and body fat were the three variables for which models were developed.

Another method used to develop predictive models was to limit the sample to subjects whose BMI at conception was in the "normal" range. BMIdiff and Wtdiff were used as dependent variables in these equations.

CHAPTER 4

RESULTS

Description of Sample

General Composition

The total number of adolescents who completed interviews for the TN860 study in their third trimester of pregnancy was 146. Approximately 8% did not meet the study criteria, and approximately 5.5% did not provide all the information required for the study. Therefore, attempts were made to contact the remaining 86.5% (126 subjects) in the postpartum period. Of the 126 attempted contacts, 32 could not be reached, 6 had moved out of state, and 9 refused to continue their participation. As a result, only 79 were actually interviewed at one year postpartum. Of those 79, 11 were pregnant again, and one did not complete the portion of the interview necessary for this study. A total of 67 of the original 146 were included in the sample for this study. These figures are summarized in Table 4-1.

A total of 9 postpartum adolescents were recruited and interviewed to supplement the original sample. Of the 9, one did not provide complete information and also thought she might be pregnant. The sample for this study, then, consisted of 67 subjects who were originally interviewed in pregnancy, plus 8 subjects recruited at

Table 4-1. Follow-up of Pregnant Adolescents at Twelve Months Postpartum

	Number Lost	Remaining Number
Interviewed during pregnancy		146
- Did not meet study criteria	12	
- Data incomplete	8	
Attempted contacts at 12 months PP		126
- Not located	32	
- Moved out of state	6	
- Refused participation	9	
Interviewed at 12 months PP		79
- Pregnant again	11	
- Weight retention data missing	1	
Total eligible for inclusion in weight retention study		67

one year postpartum, giving a total of 75 subjects, the minimum number of participants determined at initiation of the study.

Demographic and Background Characteristics

Table 4-2 shows the frequency distribution of the age, education level, and socioeconomic status of the postpartum adolescents studied. The age shown is age at delivery, but the education level and SES were determined at 12 months postpartum. Mean age was 17.0 years, which was also the median age. Only 16% of the subjects were under 16 at delivery. Age was specified to the tenth of a year, allowing for months past a birthday to be considered. Almost 23% of the subjects were 18 at delivery.

Hollingshead suggests, based on research, that Four Factor Index scores can be divided into five groups which represent "the major strata symbolic of social standing in contemporary American society" (91). These five groups are based on the ranges of scores shown in Table 4-2. The majority of subjects in this study (90.4%) were in one of the lower 3 SES groupings. Of the five groups, the greatest percentage of subjects (42.7%) was classified in the second lowest range.

Education level of the postpartum adolescents ranged from one girl having only completed the 6th grade to four having started college or vocational training after high school. Table 4-2 shows a frequency distribution of highest grade completed at 12 months pospartum, while Table 4-3 compares percent enrolled, percent graduated, and

Table 4-2. Demographic & Background Characteristics of Adolescent Subjects (n=75)

Characteristic	Number of Girls	Percent of Girls
Age at delivery (years)		
14	5	6.6
15	7	9.3
16	25	33.3
17	21	28.0
18	17	22.7
Socioeconomic status[a]		
Major business, professional (55-66)	1	1.3
Medium business, minor professional, technical (40-54)	6	8.0
Skilled craftsmen, clerical, sales workers (30-39)	14	18.7
Machine operators, semiskilled workers (20-29)	32	42.7
Unskilled laborers, menial service workers (8-19)	22	29.3
Last grade completed		
6	1	1.3
8	5	6.7
9	11	14.7
10	15	20.0
11	15	20.0
12	16	21.3
GED	6	8.0
Attending vocational school or college	4	5.3
Unknown	2	2.7

[a] As determined by the Hollingshead Four-Factor Index scores (range: 8-66).

Table 4-3. Comparison of Demographic Characteristics of White Adolescent Girls During Pregnancy and at One Year Postpartum (n=75)

Characteristic	Pregnancy (%)	Postpartum (%)
School enrollment[a]		
Enrolled	89.3	28.0
Graduated or earned GED	1.3	34.7
Dropped out	9.3	37.3
Marital status[b]		
Single	61.5	51.4
Married	38.5	44.3
Separated or formerly married	0.0	4.4
Living arrangements[b]		
With one parent	16.9	17.1
With both parents	24.6	22.9
With spouse	20.0	34.3
With parents and spouse	15.4	7.1
With other relative	9.2	7.1
In group home	7.7	0.0
Other arrangements	6.2	11.4

[a] Pregnancy enrollment status was at time of conception.

[b] Pregnancy data collected in third trimester of pregnancy.

percent dropped out between time of conception and 12 months postpartum. At the time of conception, 89.3% of the subjects were enrolled in school. As of 12 months postpartum, 34.7% of the subjects had graduated from high school or earned their GED, and 37.3% had dropped out of school.

Table 4-3 also shows a frequency distribution of marital status and various living arrangements both at the time of the pregnancy interview and at 12 months postpartum. By the third trimester of pregnancy, 38.5% of the subjects were married. At 12 months pospartum, 44.3% were married, and 4.4% were separated or divorced. Both during pregnancy and at 12 months postpartum, the majority of the subjects lived either with their parents or with their spouse. During pregnancy, 7.7% of the subjects were living in a group home for pregnant teens. One noticeable change between pregnancy and postpartum was that the percentage of subjects living with their spouse and either his or her parents dropped from 15.4% in pregnancy to 7.1% postpartum.

Educational attainment of the subjects' parents is another socioeconomic variable of interest. Table 4-4 gives this information for both the mother and the father. Level of education of the subject's father was unknown for 17% of the subjects. About one-fourth of the fathers and 11% of the mothers had not gone past the junior high level in school. None of the fathers and only one of the mothers had graduated from college.

Table 4-4. Education Level of Parents of White Postpartum Adolescents (n=75)

Education Completed	Mother (%)	Father (%)
< 7th grade	4.3	4.3
Junior high school	11.4	25.7
Some high school	38.6	15.7
High school graduate	32.9	27.1
Some college	7.1	10.0
College graduate	1.4	0.0
Unknown	4.3	17.1

Relationships Between Demographic Factors and Postpartum Weight Retention

The correlation between BMIdiff and chronological age was not significant, nor was the correlation between socioeconomic status and BMIdiff. The correlation information for these and other variables is summarized in Table 4-5. BMIdiff was not significantly correlated with postpartum employment or changes in school, employment, or marital status during the study period.

Measures of Maturity, Reproductive History, and Reproductive Choices

Gynecological Age

Table 4-6 shows a frequency distribution of the gynecological ages (GA) of the 75 subjects. Mean GA at delivery was 4.09 years. A large majority of the subjects (76%) had GAs of 3.0 or greater. Only 5 of the subjects (6.7%) had GAs below 2.0. Table 4-7 shows the mean, median, standard deviation, and range for GA and other variables. GA was not significantly correlated with BMIdiff.

Parity

The majority (94.7%) of the subjects in this study were primiparous. The remainder of the subjects had only given birth to one child prior to the pregnancy studied here. Parity was not significantly correlated with BMIdiff; however, the number of multiparous subjects was very small.

Table 4-5. Correlation between BMIdiff[a] and Demographic Variables for White Adolescent Girls (n=75)

Variable	r	P
SES[b] at 12 months postpartum	-0.01	0.94
Months worked postpartum	0.01	0.92
Change in school/work[c]	0.12	0.32
Change in living/marital status[c]	0.04	0.74
Chronological age[d]	0.01	0.91
Gynecological age[d]	-0.03	0.83

[a] BMIdiff = Body Mass Index (BMI) at 12 mos. postpartum minus BMI at conception.

[b] SES=socioeconomic status as calculated by the Hollingshead Four Factor Index (91).

[c] Change from third trimester of pregnancy to 12 months postpartum.

[d] At delivery.

Table 4-6. Frequency Distribution of Adolescent Girls' Gynecological Age[a] at Delivery (n=75)

Gynecological Age[a] (yrs)	Number of subjects	Percent of subjects
0 - 0.9	1	1.3
1.0-1.9	4	5.3
2.0-2.9	13	17.3
3.0-3.9	22	29.3
4.0-4.9	11	14.7
5.0-5.9	12	16.0
6.0-6.9	9	12.0
7.0-7.9	2	2.7
8.0 and above	1	1.3

[a] Gynecological age = chronological age minus age at menarche.

Table 4-7. Statistical Information for Demographic Variables for White Adolescent Mothers (n=75)

Variable	Mean	Median	SD	Range
SES[ab] at 12 months postpartum	25.45	24	8.4	11-53
Chronological age at delivery (yrs.)	17.01	17	1.1	14.3-18.7
Gynecological age[c] at delivery (yrs.)	4.09	3.8	1.6	0.8-9.2

[a] Socioeconomic status as calculated by the Hollingshead Four Factor Index (91).

[b] Scores can range from 8 (low SES) to 66 (high SES).

[c] Gynecological age = chronological age minus age at menarche.

Nausea and Weight Loss in Pregnancy

More than half of the subjects reported having experienced nausea that significantly affected their eating pattern during pregnancy. More than one-third of the subjects (40%) reported at least some weight loss during pregnancy. Because the figure used for pregnancy weight gain in this study was the difference between weight just prior to delivery and weight at conception, pounds regained from loss were not counted as part of "pregnancy weight gain". Nausea was not significantly related to BMIdiff.

Postpartum Oral Contraceptive Use

There was a significant negative correlation ($r = -0.25$, $P=0.03$) between months of postpartum oral contraceptive use and BMIdiff. A large percentage (45.3%) of the subjects reported taking oral contraceptives for at least 11 months of the first postpartum year. Only 13.3% did not use oral contraceptives at all after delivery, and 22.7% percent reported only 1 to 3 months of use.

Breastfeeding

Information on months of breastfeeding was only available for 56 of the subjects. Of those 56, a large percentage (84%) elected not to breastfeed at all, and 7% breastfed for less than one month. The remaining 9% breastfed for 1 to 4 months. Based on the data available, there was no significant relationship between months of breastfeeding and BMIdiff ($r=0.05$, $P=0.74$).

Dietary Information

Dieting History and Intake Changes

Over one-third of the subjects (37.3%) had dieted at least once prior to pregnancy, 20% said they made some effort to control pregnancy weight gain, and 16% made some effort to diet between delivery and 12 months postpartum. Eight of the subjects had lost significant amounts of weight by dieting prior to pregnancy. Amount of weight lost ranged from 10 pounds to 45 pounds. The average loss for the eight subjects was 29.4 pounds. Table 4-8 summarizes the above information, as well as information about percieved changes in intake postpartum compared to before pregnancy. Table 4-9 shows a frequency distribution for age at first weight loss attempt.

There was a large variation in the amount of time it took for subjects to reach their minimum postpartum weight. Some were at their minimum weight just after delivery, and others were still losing weight at 12 months postpartum. The mean "time to reach minimum postpartum weight" was 2.85 months $\pm$ 3.84 (SD), but the median was 1 month.

Food Intake After Pregnancy vs. Before Pregnancy

Close to half of the subjects (46.7%) said they ate the same amount of food after pregnancy as before. About one quarter (25.3%) of the subjects said they ate less postpartum, and 28% said they ate more.

Table 4-8. Dieting History Before, During, and After Pregnancy for White Adolescent Mothers (n=75)

Question	Percent Yes
Dieted before pregnancy?	37.3
Control effort during pregnancy?	20.0
Dieted after pregnancy?	16.0
Ate more postpartum?	28.0
Ate less Postpartum?	25.3

Table 4-9. Age of Adolescent Girls at First Weight Loss Attempt[a]

Age in years	11	12	13	14	15	16
Number of subjects	2	4	10	2	7	1

[a] n=75, but 49 had never attempted weight loss.

Measurement of Dietary Intake

Because this study focuses on body weight, the dietary information selected for study was limited to postpartum energy intake and fat intake. The basic information of average kcal intake per day and average grams of fat per day was used to calculate kcal/kg/day and percent of calories from fat. Table 4-10 shows mean, median, standard deviation, and range for these dietary variables. Table 4-11 shows the correlation coefficients for each of the variables with BMIdiff. There was a highly significant (P=0.0001) negative correlation between kcal/kg/day and BMIdiff. There was also a significant (P=0.04) negative correlation (r= - 0.24) between kcal/day and BMIdiff. There was no significant correlation between grams of fat per day and BMIdiff or percent of calories from fat and BMIdiff.

Three-Factor Eating Questionaire

Of the 75 subjects, 73 completed the TFEQ for the postpartum period, but only 36 completed and returned the TFEQ for pre-pregnancy. Mean scores, standard deviation, median, and range for each of the three scales for both pre-pregnancy and postpartum are shown in Table 4-12. Because differences between prepregnancy TFEQ scores and postpartum TFEQ scores were hypothesized, these scores will be discussed further in the section on hypothesis testing.

Table 4-10. Dietary Variables[a] for Postpartum Adolescent Girls (n=75)

Variable	Mean	Median	SD	Range
Kcal/day	1916	1852	540.2	879-3271
Kcal/kg/day	32.9	31	12.7	8.6-71.5
Grams fat/day	75.3	73	25.2	29-158
% kcal from fat	35.3	35	5.2	19.2-49.5

[a] From 2-day food records and two 24-hour recalls.

Table 4-11. Correlation of Dietary Variables[a] with BMIdiff[b] for Postpartum Adolescent Girls (n=75)

Variable	r	P
Kcal/day	-0.24	0.04
Kcal/kg/day	-0.57	0.0001
Grams fat	-0.17	0.17
% kcal from fat	0.09	0.44

[a] From 2-day food records and two 24-hour recalls.

[b] BMIdiff = Body Mass Index (BMI) at 12 mos. postpartum minus BMI at conception.

Table 4-12. TFEQ Score Statistics[a] for Adolescent Girls Before Pregnancy[b] and at Twelve Months Postpartum[c]

Scale	Mean	SD	Median	Range
PreHunger[d]	5.0	3.2	4.5	1 - 12
PostHunger[d]	5.7	2.9	6.0	0 - 14
PreRestraint[e]	7.2	4.8	6.0	0 - 19
PostRestraint[e]	7.3	4.5	6.0	1 - 18
PreDisinhibition[f]	4.1	3.6	3.0	0 - 13
PostDisinhibition[f]	4.7	2.9	4.0	0 - 15

[a] Three-Factor Eating Questionnaire, Stunkard & Messick, *J Psychosom Res*, 1985.

[b] n=36 because 39 girls did not return this questionnaire, as requested.

[c] n=73 because 2 girls did not complete this questionnaire in the interview.

[d] Scores could range from 0 to 14, with 14 indicating strongest hunger.

[e] Scores could range from 0 to 21, with 21 being the greatest restraint.

[f] Scores could range from 0 to 15, with 15 being the greatest disinhibition.

The TFEQ hunger scores were significantly correlated with the TFEQ disinhibition scores. For example, the correlation coefficient (r) for postpartum hunger and postpartum disinhibition was 0.53 (P=0.0001). The only TFEQ score (either prepregnancy or postpartum) that was significantly correlated with BMIdiff was the postpartum restraint score (r=.34, P=0.003).

Physical Activity

Mean physical activity score was 38.5, with a standard deviation of 15.16. The median score was 40 (which was the baseline score before addition of active waking hours/wk and subtraction of sedentary waking hours/wk), and scores ranged from 9 to 75. There was not a significant correlation between activity score and BMIdiff.

Smoking

The PPWRF included several questions about smoking. Although information was collected about whether a subject had ever smoked, how long she had smoked, and how many cigarettes she smoked per day, the information used for statistical analysis was limited to the following:

1. Was the subject a smoker at conception?
2. Did she quit smoking for most of her pregnancy?
3. Did she smoke for most of her first postpartum year?

Almost half of the subjects (46.7%) were smokers at conception. Of these 35 subjects, 22 (63%) quit smoking during pregnancy. Of those 22, only six did not resume smoking after pregnancy. Four of the subjects who were not smokers at conception began smoking after delivery and smoked most of their postpartum year. So, about half the subjects were smoking at one year postpartum.

Table 4-13 shows the significant Spearman correlation coefficients between smoking variables and other variables of interest. BMIdiff was negatively correlated with smoking in pregnancy (r= -0.19. P=0.11) and positively correlated with permanently quitting smoking (r= 0.23, P=0.05). Variables which measured postpartum fatness were negatively correlated with smoking in pregnancy and postpartum smoking. Quitting smoking during pregnancy was positively correlated with gestational weight gain. Smoking at conception, during pregnancy, and postpartum were all negatively correlated with infant birthweight.

Anthropometric Data and Parent Fatness

Height

Mean height of the subjects in this study was 161.7 cm, or 63.7 inches. Median height was 162.5 cm (64 inches). Heights ranged from 150.5 cm (59.25 in) to 172.3 cm (67.8 in). Although a few of the subjects felt that their height had increased after conception, there was no substantiating evidence for this.

Table 4-13. Correlation Coefficients for Variables Significantly Correlated with Smoking Variables ($p \leq 0.1$) for White Postpartum Adolescents

Variable	Smoked at Conception	Smoked in Pregnancy	Smoked PP	Quit in Pregnancy	Quit Permanently
Mother's fatness[a]	0.30	0.25	0.39	ns[b]	ns
PostWt[c]	ns	-0.27	ns	ns	ns
Waist[d]	ns	-0.26	-0.22	ns	0.19
Hip[d]	ns	-0.31	-0.26	ns	0.27
Body fat percent[e]	ns	-0.36	-0.33	ns	0.24
Infant birthweight	-0.28	-0.24	-0.31	ns	ns
PreBMI[fg]	ns	-0.27	-0.21	ns	ns
PostBMI[h]	ns	-0.26	-0.24	ns	0.25
BMIdiff[i]	ns	-0.19	ns	ns	0.23
Gestational gain	ns	ns	ns	0.20	ns

[a] Mother fatness = fatness of subject's mother based on silhouette chosen by subject.

[b] ns = not statistically significant.

[c] PostWt = body weight at 12 mos. postpartum.

[d] Measured at 12 mos. postpartum.

[e] Body fat percent as estimated by bioelectrical impedance analysis.

[f] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[g] PreBMI = BMI at conception, based on self-reported weight.

[h] PostBMI = BMI at 12 mos. postpartum, based on measured weight and height.

[i] BMIdiff = BMI at 12 mos. postpartum minus BMI at conception.

Body Mass Index

At Conception. Mean BMI at conception was 21.55, with a standard deviation of 4.17, and a median of 21.37. BMI before pregnancy ranged from 15.49 to 38.87. Table 4-14 shows a frequency distribution of BMI at conception, based partly on ranges defined by the Committee on Nutritional Status During Pregnancy and Lactation, National Academy of Sciences (3). This committee suggested that pregnancy weight gain recommendations be based upon BMI at conception, as shown in the following chart:

Category	BMI Range	Recommended Weight Gain
Low	< 19.8	28 - 40 lbs.
Normal	19.8 to 26	25 - 35 lbs.
High	26.1 to 29	15 - 25 lbs.
Obese	> 29	≥ 15 lbs.

In this study, 33.4% of the subjects were in the "Low BMI" category at conception. Only 6.6% were classified as obese, while 2.7% were in the "High BMI" range, and 57.3% were in the "Normal BMI" range.

BMI at conception (preBMI) was significantly correlated with many of the other variables. It was expected that preBMI would be correlated with the variables that measured weight, circumferences, and body fat. For example, the correlation coefficient for preBMI and preWt was 0.90 (P=0.0001), and the correlation coefficient for preBMI and percent body fat was 0.62 (P=0.0001). The correlations shown in Table 4-15 are those which could not be as readily assumed to occur.

Table 4-14. BMI[a] at Conception in White Adolescent Girls (n=75)

BMI Range	n	Percent	BMI Class[b] Percent
Under 16	2	2.7	
16 - 16.99	3	4.0	
17 - 17.99	9	12.0	
18 - 18.99	6	8.0	
19 - 19.79	5	6.7	33.4
19.8 - 20.99	10	13.3	
21 - 21.99	10	13.3	
22 - 22.99	12	16.0	
23 - 23.99	6	8.0	
24 - 24.99	5	6.7	
25 - 25.99	0	0.0	57.3
26 - 29	2	2.7	2.7
29.1 - 35	4	5.3	
Over 35	1	1.3	6.6

[a] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[b] BMI classes: Low < 19.8, Normal = 19.8 to 26, High = 26 to 29, Obese > 29.

Table 4-15. Correlations of Selected Variables with BMI[a] of Adolescent Girls at Conception and at 12 Months Postpartum (n=75)

	PreBMI[b]		PostBMI[c]	
Variables	r	P	r	P
PostTFEQ restraint score[d]	0.24	0.04	0.46	0.0001
Pre-pregnancy weight loss attempt	0.37	0.001	0.44	0.0001
Ate more postpartum	0.10	0.38	0.36	0.002
Dieted postpartum	0.32	0.007	0.32	0.007
Gestational weight gain	-0.20	0.08	0.30	0.009
Effort to control pregnancy gain	0.14	0.24	0.30	0.01
Smoked in pregnancy	-0.27	0.02	-0.26	0.02
Quit smoking permanently	0.17	0.16	0.25	0.03
Smoked postpartum	-0.21	0.07	-0.24	0.04
Time at current weight (mos.)	0.04	0.78	-0.28	0.04
PP oral contraceptive use (mos.)	-0.05	0.66	-0.21	0.07
Change in school/work (yes/no)	-0.10	0.38	-0.19	0.10
Parity	0.21	0.07	0.19	0.10
Pregnancy weight loss	0.20	0.09	0.19	0.11
Age at menarche	-0.20	0.08	-0.14	0.23

[a] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[b] BMI at conception, based on self-reported weight.

[c] BMI at 12 mos. postpartum, based on measured weight and height.

[d] A measure of intentional dietary restraint from delivery to 12 mos. postpartum.

PreBMI was positively correlated with postpartum dieting, and with postpartum dietary restraint scores. Subjects who smoked during pregnancy tended to have a lower preBMI. PreBMI was marginally related to parity, (P=0.07), age at menarche (r= -0.20, P=0.08), and gestational weight gain (r= -0.20, P=0.08). Gynecological age was not significantly correlated with preBMI (r=0.15, P=0.21) nor was BMIdiff (r=0.03, P=0.78).

At 12 months Postpartum. Mean BMI at 12 months postpartum (postBMI) was 23.7. Median was 22.7, and standard deviation was 5.63. Values ranged from a low of 15.58 to a high of 39.17. Table 4-16 shows a frequency distribution of postBMI. There was a noticeable change in the percentage of subjects in each BMI classification from conception to 12 months postpartum. These changes will be discussed further in the next section. The percentage of subjects in the "low BMI" category decreased from 33.3% to 26.6%. There was a slight decrease in the percentage in the "normal BMI" category, from 57.3% to 50.7%. The "High BMI" and "Obese" category percentages increased, with "High" rising from 2.7% to 8%, and "Obese" rising from 6.6% to 14.7%.

Correlations of postBMI with various measures of body weight and circumferences were significant, as expected. For example, the correlation coefficient for postBMI and waist circumference was r=0.94 (P=0.0001), and the correlation

Table 4-16. BMI[a] at 12 Months Postpartum in Adolescent Girls (n=75)

BMI Range	n	Percent	BMI Class[b] Percent
Under 16	1	1.3	
16 - 16.99	2	2.7	
17 - 17.99	4	5.3	
18 - 18.99	10	13.3	
19 - 19.79	3	4.0	26.6
19.8 - 20.99	7	9.3	
21 - 21.99	4	5.3	
22 - 22.99	10	13.3	
23 - 23.99	8	10.7	
24 - 24.99	5	6.7	
25 - 25.99	4	5.3	50.7
26 - 29.0	6	8.0	8.0
29.1 - 35.0	5	6.7	
35.1 - 35.9	3	4.0	
$\geq$ 36	3	4.0	14.7

[a] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[b] BMI classes: Low < 19.8, Normal = 19.8 to 26, High = 26 to 29, Obese > 29.

coefficient for postBMI and percent body fat was r=0.89 (P=0.0001). The correlation coefficient for postBMI and preBMI was r=0.67 (P=0.0001). Table 4-15 shows the correlations. Some of the variables were included in the table for purposes of comparison with preBMI correlations. Variables that were significantly correlated with postBMI, but were not significantly correlated with preBMI, were "eating more" postpartum, weight control effort in pregnancy, permanently quitting smoking, smoking postpartum, and time at current weight. For most of these variables, it seems logical that they would correlate with postBMI only. The correlation between smoking and postBMI was negative, as with preBMI..

Change in BMI. This variable was calculated by subtracting preBMI from postBMI, and therefore is also called "BMIdiff". The mean BMIdiff was +2.11, and the standard deviation was 3.56. Median BMIdiff was +1.43, and values ranged from -6.85 to 11.88. Some increase in BMI would be expected even in non-pregnant adolescent girls over the 21 month time frame that was studied. Of most interest in this study is which variables are associated with unusual, undesirable increases in BMI following pregnancy. One way of differentiating between desirable and undesirable changes in BMI is to compare BMI classification (low, normal, high, or obese) at conception to BMI classification at 12 months postpartum. On the whole, based on the changes in the percentage of subjects in each category, it appears that there were some desirable changes (from low to normal) and some undesirable changes (from low or normal to high or obese). Table 4-17 shows a frequency distribution of BMIdiff.

Table 4-17. BMI[a] Change (BMIdiff) from Conception to 12 Months Postpartum in Adolescent Girls (n=75)

BMIdiff Range	n	Percent Subtotal
< - 6.0	1	
- 6 to - 4	1	
- 3.99 to - 2.0	4	
- 1.99 to - 1.0	4	13.3
-.99 to 0.0	12	
0.01 to 1.0	11	30.7
1.01 to 2.0	9	
2.01 to 3.0	9	
3.01 to 4.0	6	
4.01 to 6.0	7	
6.01 to 8.0	6	
8.01 to 10.0	3	
10.01 to 12.0	2	56.0

[a] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

Of the 25 subjects who were initially in the "low BMI" category, 16 (64%) still had low BMI at 12 mos. postpartum, seven (28%) had normal BMI, and two (8%) had BMIs in the low end of the "high" range. Of the 43 subjects who initially were in the "normal" BMI range, 31 (72%) were also in the normal range at 12 mos. postpartum, nine (21%) were in the "high" range, and three (7%) had decreases in BMI which placed them in the "low" range. Of the seven subjects who initially had a BMI of 26 or greater, five (71.4%) had higher BMI at 12 months postpartum, one had a slightly lower BMI, and one was in the "low" BMI category as a result of weight loss related to zero gain in pregnancy. Table 4-18 summarizes the preceding figures and also classifies subjects by the amount of weight gained in pregnancy.

Because BMIdiff is considered as the dependent variable in this study, relationships of other variables with BMIdiff are of considerable importance. Table 4-19 lists variables which were significantly correlated with BMIdiff, in the order of the significance and magnitude of the correlation. Many of the variables that were highly correlated with BMIdiff were measures of postpartum body size, weight, or fatness. It is interesting to note that pre-pregnancy BMI was <u>not</u> significantly correlated with BMIdiff (r=0.03, P=0.78). Variables highly correlated with BMIdiff were pregnancy weight gain (r=0.60, P=0.0001), kcal/kg/day (r= -0.57, P=0.0001), and time at current weight (r= -0.41, P=0.003). Both the perception of eating more postpartum (r=0.43, P=0.0001) and the postpartum dietary restraint score (r=0.34, P=0.003) were positively correlated to BMIdiff. A history of attempted weight control, either before or

Table 4-18. PostBMI[ab] Class[c] of Adolescent Subjects Sorted by PreBMI[d] and Gestational Weight Gain (n=75)

PreBMI Class & Gestational Gain	n	PostBMI Low	PostBMI Normal	PostBMI High
Low preBMI				
< 28 lb gain	6	6	0	0
28-40 lb gain	10	7	2	1
> 40 lb gain	9	3	5	1
Ave preBMI				
< 25 lb gain	7	2	5	0
25-35 lb gain	20	1	15	4
> 35 lb gain	16	0	10	6
High preBMI				
< 15 lb gain	1	1	0	0
> 25 lb gain	1	0	0	1
Obese preBMI				
< 15 lb gain	1	0	0	1
15-25 lb gain	1	0	0	1
> 25 lb gain	3	0	0	3

[a] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[b] PostBMI = BMI at 12 months postpartum.

[c] BMI classes: Low < 19.8, Normal = 19.8 to 26, High = 26 to 29, Obese > 29.

[d] PreBMI = BMI at conception.

Table 4-19. Variables Significantly ($P \leq 0.05$) Correlated with BMIdiff[ab] for Postpartum Adolescent Girls

Variable	r	P	n[c]
Hips (inches) at 12 mos. postpartum	0.74	0.0001	74
Weight at 12 months postpartum	0.71	0.0001	74
BMI at 12 months postpartum	0.71	0.0001	74
Waist (inches) at 12 mos. postpartum	0.68	0.0001	74
Percent body fat[d] at 12 mos. postpartum	0.67	0.0001	58
Gestational weight gain	0.60	0.0001	74
Minimum postpartum weight	0.59	0.0001	51
Kcal/kg/day @ 12 months postpartum	-0.57	0.0001	69
Maximum pregnancy weight	0.48	0.0001	74
Ate more postpartum	0.43	0.0001	74
Difference in disinhibition	0.50	0.002	35
Time at current weight (mos.)	-0.41	0.003	52
Postpartum dietary restraint score	0.34	0.003	72
Waist to hip ratio	0.32	0.006	74
Desired weight	0.33	0.01	66
Prepregnancy weight loss attempt	0.28	0.02	74
Mos. of postpartum oral contraceptives	-0.25	0.03	74
Kcal/day at 12 months postpartum	-0.24	0.04	69
Quit smoking permanently	0.23	0.05	74
Quit school postpartum	0.23	0.05	72

[a] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.
[b] BMIdiff = BMI at 12 mos. postpartum minus BMI at conception.
[c] Values less than 74 indicate incomplete data.
[d] Percent body fat as estimated by bioelectrical impedance.

during pregnancy, was also significantly correlated with BMIdiff. Three other variables significantly correlated with BMIdiff were months of postpartum oral contraceptive use (r=-0.25, P=0.03), permanently quitting smoking, and quitting school postpartum.

Waist to Hip Ratio

The mean waist to hip ratio (WHR) for the 75 subjects was 0.758, with a standard deviation of 0.045. The median was 0.754, and values ranged from 0.678 to 0.974. The WHR was highly correlated with all measures of weight, circumference, and fatness, including pre-pregnancy weight and BMI. Although the WHR is intended to be a measure of body fat distribution rather than body fat itself, it seems that it is highly affected by total weight and body fat. Other variables that correlated significantly (P<.05) with WHR were postpartum dieting (+), BMIdiff (+), kcal/kg/day (-), and difference in restraint scores (+). These correlations were not surprising; the same variables also were correlated with measures of weight and body fatness.

Percent Body Fat

Mean percent body fat (for the 58 subjects whose body fat was estimated by BIA) was 25.7%, with a standard deviation of 10.6. The median was 24.5, and values ranged from 6% to 52%. As was expected, body fat was significantly correlated with weight variables, the correlation being highest with weight at 12 months postpartum (r=0.88, P=0.0001). Body fat percent was also highly correlated with prepregnancy

weight (r=0.63, P=0.0001). Other variables significantly correlated with percent body fat were weight control effort in pregnancy, postpartum dieting, eating more postpartum, smoking in pregnancy or postpartum, and, at a lower significance level, pregnancy weight gain. Correlation coefficients and significance figures for these variables are shown in Table 4-20. Percent body fat was not significantly correlated with the mother's fatness (r=-0.12, P=0.39) or the father's fatness (r=0.17, P=0.21).

Parent Fatness

Fatness of mothers and fathers was rated on an eight point scale, with 1 equal to "very thin" and 8 equal to "very heavy". Median fatness was 5 for mothers and 4 for fathers. Scores ranged from 1 to 7 for mothers and from 1 to 8 for fathers. There were several unexpected correlations between parent fatness and other variables. Neither parent's fatness was significantly correlated with the subjects' percent body fat. There were only weak correlations between parent fatness and measures of subject weight or fatness. The sum of both parent fatness scores was correlated with the prepregnancy weight of the subjects (r=0.21, P=.08). Also, subjects with thinner fathers apparently were more likely to weigh less, as is evidenced by the correlation between thinness of the father (scored as 1 for a thin father and zero for a father rated 5 or above in fatness) and the prepregnancy weight of the subject (r=-0.22, P=.07).

Other variables which were significantly correlated (P<0.10) with parent fatness are shown in Table 4-21. These included use of oral contraceptives, time worked postpartum, postpartum restraint scores, changes in restraint scores, infant birth

Table 4-20. Selected Correlations of Other Variables with Percent Body Fat[a] of Postpartum Adolescent Girls

Variable	r	P	n[b]
BMI[c] at 12 months postpartum	0.89	0.0001	58
BMIdiff[d]	0.67	0.0001	58
Postpartum dietary restraint score	0.52	0.0001	56
Smoking in pregnancy	-0.36	0.005	58
Ate more postpartum	0.34	0.008	58
Smoking postpartum	-0.33	0.01	58
Dieted postpartum	0.31	0.02	54
Weight control in pregnancy	0.27	0.04	58
Gestational weight gain	0.25	0.06	58

[a] Percent body fat as estimated by bioelectrical impedance at 12 mos. postpartum.

[b] Bioelectrical impedance analysis was completed for 58 subjects.

[c] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[d] BMIdiff = BMI at 12 mos. postpartum minus BMI at conception.

Table 4-21. Correlations ($P \leq 0.05$) Between Fatness[a] of Parents and Characteristics of Postpartum Adolescent Girls

Variable Combination	r	P	n
Parent fatness[b] & infant birthweight	-0.39	0.004	54
Mother thin and PP restraint change[c]	-0.47	0.005	35
Father thin & PP use of oral contraceptives	-0.27	0.02	71
Mother fatness[d] & subject height	0.24	0.04	73
Father thin & postpartum restraint score	-0.26	0.03	69
Father fat & subject's age at 1st wt loss attempt	-0.43	0.03	26
Parent fatness & postpartum HS graduation	0.24	0.05	69

[a] Fatness rating of parents based on silhouette selection by subject.

[b] Parent fatness = sum of fatness ratings of both parents.

[c] Restraint change = postpartum dietary restraint score minus prepregnancy restraint.

[d] Mother or father fatness = fatness rating of respective parent.

weight, subject's height, and subject's postpartum graduation from high school. Subjects with thinner fathers showed less use of oral contraceptives and less dietary restraint. Subjects with fatter parents were more likely to smoke and to deliver infants that weighed less. Subjects with thinner parents tended to be shorter in height, but more likely to graduate from high school after giving birth.

Self-reported Pregnancy Weight Gain

Mean pregnancy weight gain (self-reported) was 36 pounds, with a standard deviation of 17 pounds. Median pregnancy gain was 34 pounds, and values ranged from a loss of 3 pounds to a gain of 92 pounds. Table 4-22 shows a frequency distribution of pregnancy weight gain, in addition to indicating preBMI distribution within each weight gain group. One-third of the subjects gained between 25 and 35 pounds, 21% gained 36 to 45 pounds, and 21% gained over 45 pounds. All those who gained over 45 pounds had either normal or low preBMI.

As has been discussed previously, pregnancy weight gain was highly correlated with BMIdiff. Pregnancy weight gain was also significantly correlated with all weight and fatness variables, including preBMI. Other related variables were time at 12 month postpartum weight, eating more postpartum, weight control effort in pregnancy, kcal/kg/day at 12 months postpartum. Table 4-23 shows the correlation coefficients and significance levels for these variables.

Table 4-22. Gestational Weight Gain Distribution of White Adolescent Girls (n=75)

Gestational Gain	n	Group %	PreBMI[ab] Class[c] Distribution
Net loss	1		Low = 0
0 to 5 lbs.	2		Normal = 4
6 to 10 lbs.	1		High = 1
11 to 15 lbs.	2	8	Obese = 1
16 to 20 lbs.	5		Low = 5, Normal = 6
21 to 25 lbs.	7	16	High = 0, Obese = 1
26 to 30 lbs.	11		Low = 7, Normal = 16
31 to 35 lbs.	14	33.3	High = 1, Obese = 1
36 to 40 lbs.	6		Low = 6, Normal = 8
41 to 45 lbs.	10	21.3	High = 0, Obese = 2
46 to 50 lbs.	2		
51 to 55 lbs.	4		Low = 7
56 to 60 lbs.	5		Normal = 9
61 to 70 lbs.	3		High = 0
71 to 80 lbs.	1		Obese = 0
over 80 lbs.	1	21.3	

[a] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[b] PreBMI = BMI at conception, based on self-reported weight.

[c] BMI classes: Low < 19.8, Normal = 19.8 to 26, High = 26 to 29, Obese > 29.

Table 4-23. Variables Correlated (P<.10)[a] with Gestational Weight Gain of White Adolescent Girls

Variable	r	P	n
BMIdiff[bc]	0.60	0.0001	74
Maximum gestational weight	0.52	0.0001	75
Time at 12 months postpartum weight	-0.47	0.0004	53
Ate more postpartum	0.34	0.003	75
Minimum postpartum weight	0.41	0.003	52
Hips at 12 months postpartum	0.32	0.006	75
PostBMI[d]	0.30	0.001	74
Weight control in pregnancy	0.29	0.01	75
Waist at 12 months postpartum	0.27	0.02	75
Kcal/kg/day at 12 months postpartum	-0.26	0.03	70
Body fat percent[e]	0.25	0.06	58
Postpartum TFEQ[f] restraint score	0.21	0.07	73
PreBMI[g]	0.20	0.08	74
Quit smoking in pregnancy	0.20	0.09	75

[a] Correlations with P>0.05 listed because of importance in multiple regression analysis.

[b] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[c] BMIdiff = BMI at 12 mos. postpartum minus BMI at conception.

[d] BMI at 12 mos. postpartum, based on measured weight and height.

[e] Percent body fat as estimated by bioelectrical impedance at 12 mos. postpartum.

[f] Three Factor Eating Questionnaire (Stunkard & Messick, *J Psychosom Res*, 1985).

[g] BMI at conception, based on self-reported weight.

Medical Record Data

Prepregnancy Weight

It is rare for a medical record to contain a weight which was actually measured and recorded just prior to conception. Self-reported weight is the norm, if there is a mention of prepregnancy weight at all. Only 32 of the 58 records reviewed contained any indication of prepregnancy weight. The correlation coefficient between self-reported prepregnancy weight (from study interviews) and medical record prepregnancy weight was 0.735, with P=0.0001.

Complications of Pregnancy or Delivery

Of the 58 records reviewed, 3 indicated notable problems with edema during pregnancy. Twelve of the records indicated that the subject's blood was negative for the Rh factor. Thirteen of the 58 records indicated that the subject's infant was delivered by Caesarean Section.

Gestational Age and Infant Information

Mean gestational age at delivery for the 58 subjects was 39.2 weeks. Although one infant was reported to have been born at 32 weeks gestation, its weight was 7.6 lbs. Only two of the 58 records reviewed reported low birth weights (under 5.5 lbs.), with one infant weighing 5.1 pounds at 38 weeks gestation, and the other weighing 5.25 pounds at 37 weeks gestation. The number of male infants was only slightly less than the number of female infants.

Tests of Hypotheses

Predictors of BMIdiff

Table 4-24 shows the results of the multiple linear regression analysis which tested all six TFEQ scores, prepregnancy weight, and gestational weight gain as predictors for BMIdiff. With preTFEQ scores only available for 36 subjects, the sample size was small. Only gestational weight gain and postpartum restraint scores remained in the model after the stepwise selection procedure. Gestational weight gain explained 36% of the variation in BMIdiff, and postpartum dietary restraint explained an additional 12% of the variation, resulting in a model R-square of .48.

A second model was tested that excluded preTFEQ scores. Without preTFEQ scores, sample size was increased to 74. In this second model, gestational weight gain was still the strongest predictor, explaining 43% of the variation in BMIdiff. Prepregnancy weight was the only other predictor which remained in the model, explaining an additional five percent of the variation in BMIdiff. The R-square for this model was .48. Results of the analysis of this model are shown in Table 4-25.

Changes in TFEQ Scores

When differences in TFEQ scores were tested for significance, the first set of scores tested was the whole set of 36 subjects who had completed the TFEQ for both the prepregnancy and postpartum periods. The results indicated that only the

Table 4-24. Model for the Prediction of BMIdiff[ab] for White Adolescent Girls, Based on Stepwise Selection from Pre- and Post-TFEQ[c] Scores, Prepregnancy Weight, and Gestational Weight Gain (n=36) (Model F=14.76, P=0.0001)

Variable	Regression Coefficient	P (for step)	Cumulative R-square
Gestational weight gain	0.13	0.0002	0.36
Postpartum restraint[c] score	0.31	0.01	0.48
Constant	-4.77		

[a] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[b] BMIdiff = BMI at 12 mos. postpartum minus BMI at conception.

[c] Three Factor Eating Questionnaire, Stunkard & Messick, *J Psychosom Res*, 1985.

Table 4-25. Model for the Prediction of BMIdiff[ab] for White Adololescent Girls, Based on Stepwise Selection from Postpartum TFEQ[c] Scores, Prepregnancy Weight, and Gestational Weight Gain (n=73)

Variable	Regression Coefficient	P (for step)	Cumulative R-square
Gestational weight gain	0.15	0.0001	0.43
Pre-pregnancy weight	0.03	0.0084	0.48
Constant	-7.52		

[a] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[b] BMIdiff = BMI at 12 mos. postpartum minus BMI at conception.

[c] Three Factor Eating Questionnaire, Stunkard & Messick, *J Psychosom Res*, 1985.

"Hunger" scale scores were significantly different (higher) after pregnancy than before (P=0.03).

The second set of scores tested was the subset of 22 subjects who completed the preTFEQ after a period of two weeks had elapsed since the appointment at which they completed the postTFEQ. There were 22 subjects in this group. The results indicated that both "Disinhibition" scores (P=0.07) and "Hunger" scores (P=0.03) were significantly different (higher) after pregnancy than before.

The third set of scores tested was the subset of 14 subjects who had completed the preTFEQ sooner than two weeks after the interview. The results of this test indicated that the differences between pre- and post-pregnancy scores were not significant for any of the three scales. This finding indicates that a minimum time lapse of two weeks was an important factor.

Predictors of BMI at 12 Months Postpartum

Results of the multiple linear regression analysis with postBMI as a dependent variable showed that preBMI, gestational weight gain, and postpartum kcal/kg/day were significant predictors of postBMI. The R-square for the resulting model, shown in Table 4-26, was 0.84. Sixty percent of the variation in postBMI was explained by preBMI, 21 percent was explained by gestational weight gain, and 3 percent was explained by kcal/kg/day. None of the other variables tested (gynecological age, postpartum dietary restraint, percent kcal from fat, activity score, mother's fatness, and father's fatness) remained in the model after the stepwise selection procedure.

Table 4-26. Model[a] for Prediction of BMI[b] for White Adolescent Girls at 12 Months Postpartum

Variable	Regression Coefficient	P (for Step)	Cumulative R-square
BMI at conception	1.05	0.0001	0.60
Gestational weight gain	0.13	0.0001	0.81
Kcal/kg/day postpartum	-0.10	0.0011	0.84

[a] Model based on significant variables from the 8 variables listed in Hypothesis 2.

[a] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

Effect of Parent Fatness on Predictive Value of Percent kcal from Fat

For the entire sample, it has already been stated that percent kcal from fat was not predictive of BMI at 12 months postpartum. For the 28 subjects whose mothers were classified as "thin" (fatness = 1 to 4), postBMI was not significantly correlated with percent kcal from fat. There was also no correlation for the subset of subjects with heavier mothers. Subsets with thin fathers, fatter fathers, two fatter parents, one fatter parent, and zero fatter parents also were analyzed for correlation between percent kcal from fat and postBMI. None of the correlations was statistically significant. These results support the hypothesis that percent of kcal from fat would not be a significant predictor of postpartum BMI if the subject's mother was thin. However, subjects whose mothers were thin did not differ from other groupings of subjects (fat mothers, fat fathers, fat parents, thin parents) in that respect.

Predictors of Body Fat Percent at 12 Months Postpartum

The same model tested for the prediction of postBMI also was tested for the prediction of percent body fat (%BF) at 12 months postpartum. Results were very similar, in that preBMI explained a large percentage of the variation in %BF (50%), gestational weight gain explained about 17% of the variation, and kcal/kg/day explained about 5% of the variation. Again, none of the other hypothesized predictors remained in the model when the selection procedure was complete.

It was hypothesized that BMIdiff would be significantly correlated with %BF at 12 months postpartum. The correlation coefficient for %BF and BMIdiff was 0.67 (P=0.0001), thus supporting the hypothesis.

Relationship Between WHR and BMI Classification

As was mentioned earlier, WHR was significantly correlated with postBMI (r=0.55, P=0.0001). Although WHR was intended to be a measure of body fat distribution which was independent of body fatness, this appeared not to be the case.

Postpartum Restraint Scores and Postpartum Caloric Intake

The correlation coefficient for postpartum restraint scores and kcal/day was -0.27 (P=0.02). The correlation coefficient for postpartum restraint scores and kcal/kg/day was -0.45 (P=0.0001). These figures support the hypothesis that postpartum restraint scores would be negatively correlated with postpartum caloric intake.

Effect of Job/School on Energy Intake and TFEQ Scores

There were only six subjects who neither worked nor attended school at some time during their first postpartum year. There was no significant difference between TFEQ scores or energy intakes for these six compared to the rest of the subjects. These results do not support the hypothesis that subjects who worked or attended school would have lower energy intakes than subjects who stayed at home. However, results may be affected by the small sample size.

Further Examination of the Data

Discussion of the additional multiple linear regression models developed for the prediction of percent body fat (at 12 months postpartum), BMIdiff, and Wtdiff is located in Appendix Q.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

Predictors of BMIdiff

This study of postpartum weight development differed from prior studies in that all subjects were white adolescents, and sample size was larger than for a previous study which included white postpartum adolescents (7). Although most of the influencing factors included in this study have been examined in other groups also, no single study has examined all the factors that were examined in this study.

In agreement with other postpartum studies (28,34,35,38) the results of this study showed gestational weight gain to be the strongest predictor of postpartum weight retention in most models tested. Two models, however, showed postpartum kcal/kg/day to be a stronger predictor of weight retention than weight gain during pregnancy. These two models were developed for the prediction of Wtdiff for subjects with normal preBMI. Although a strong relationship between kcal/kg/day is not surprising, the direction of the relationship is the opposite of what might be expected; kcal/kg/day were negatively correlated with Wtdiff.

One possible explanation for the strong negative relationship between energy intake and Wtdiff is that those who retained the most weight were more likely to be dieting to reduce their weight. Another possibility is that heavier subjects might have

been more likely to under-report their dietary intake. Other studies have shown that under-reporting of intake is more likely for heavier subjects (93,94). The Restraint Score on the postpartum TFEQ provided a second way to assess energy intake somewhat, and it was correlated with energy intake, as hypothesized. Dietary restraint actually was found to be a significant predictor of BMIdiff in the model for Hypothesis 1. Rather than simply accepting the assumption of under-reporting of energy intake, it seems appropriate to consider the possibility that dietary restriction was not working for these subjects as a way to reduce their retained weight. Considering the evidence that dietary restriction can lower metabolic rate and create a weight cycling effect (59-63,65), it is possibl e that energy intake reports were accurate. Care was taken to request that subjects report all of their intake, and subjects were asked for details about added fats and sugars, when such details seemed to be missing. Another possible explanation for the negative relationship between Wtdiff and kcal/kg/day is that heavier subjects may or may not require as many kcal/kg as leaner subjects (95-98). On the other hand, kcal/day were also negatively correlated with Wtdiff. Aposteriori Model 2 for the prediction of Wtdiff was proposed in order to test the relative predictive strength of kcal/kg/day compared to kcal/day. The SAS stepwise procedure did not select kcal/day as a significant predictor of Wtdiff in this model. The variable kcal/day was also proposed as a predictor of BMIdiff in aposteriori Model B, but again was not selected as a significant predictor. These results lead to the conclusion that the strong relationship between kcal/kg/day

and postpartum weight retention is a result of the strong relationship between Wtdiff or BMIdiff and actual postpartum weight.

Percentage of kcal from fat as well as grams of fat per day were other dietary variables that were measured. Neither of these was significantly correlated with BMIdiff, preBMI, or postBMI, thus implying that dietary fat does not play an important role in the determination of BMIdiff.

Some of the models tested showed that a variable representing the interaction between preBMI and gestational weight gain was the strongest predictor of BMIdiff. This finding lends support to the 1990 NAS guidelines for gestational weight gain, which base recommended gain on preBMI. Prior studies have found an association between preBMI and BMIdiff or Wtdiff (20,28,31,32,35,38,51). In this study, preBMI was not significantly correlated with BMIdiff (P=0.8), but it was shown to be a significant predictor (positive coefficient) of Wtdiff in one of the models for normal weight subjects. Prepregnancy weight was also a significant predictor (positive coefficient) of BMIdiff in one of the models developed for all subjects.

WHR is another weight-related variable which was selected as a significant predictor of weight retention in some of the models developed. The predictive value of WHR is probably related to its correlation with actual postpartum weight and postBMI, thus making an elevated WHR more likely to be a result of postpartum weight retention rather than a "cause".

Interrelationships among variables which affect BMIdiff make it difficult to develop a statistical model which accurately reflects the relative influence of each

variable. It is possible that some metabolic, hormonal, or behavioral variables could be influencing both gestational weight gain and postpartum weight retention, thus enhancing the strength of the correlation between gestational gain and BMIdiff. In addition, the difference in results when models were tested only with normal weight (preBMI) subjects shows that the relationship among variables may differ for each category of preBMI. Prior studies have pointed out the wide range of individual variation in pregnancy weight gain and postpartum weight retention (21,41), which is even greater among initially overweight or obese subjects (23,34). In studies which have categorized women according to whether their gestational weight gain complied with recommendations, there have been women who gained less weight than recommended, yet still appeared to be retaining some of their weight gain as late as six months to one year postpartum (32,39). Black women, on average, tend to gain less weight than is recommended, yet apparently retain more of their weight gain than white women (32).

Although gestational weight gain is a strong "predictor" of BMIdiff, attempts to control pregnancy weight gain may not necessarily always be effective in preventing postpartum weight retention, or even controlling pregnancy weight gain. As Keppel and Taffel stated in their report (32), regarding gestational weight gain, "It appears as if medical guidelines are catching up with women's behavior." Furthermore, based on evidence from this study, attempts to lose weight postpartum through caloric restriction alone may not necessarily be effective in the long term.

Although gestational weight gain appears to be strongly predictive of postpartum weight retention in both adolescent and adult mothers, it is important to note that there may be a difference in how much pregnancy weight gain is likely to result in an increased risk of postpartum obesity in adolescent mothers, as compared to adult mothers. Keppel and Taffel (32) studied Wtdiff in a representative sample of U.S. women aged 15 and older who gave birth in 1988. Table 5-1 compares the Keppel and Taffel findings for white women (all ages combined) to findings in the present study.

Based on the data presented in Table 5-1, it appears that white adolescents in this study were more likely to achieve the minimum gains recommended during pregnancy, compared to the all-ages sample of white women. It also appears that white adolescents who did not achieve the recommended minimum gain were more likely to have a net weight loss at one year postpartum than more mature women. This evidence suggests that achieving the minimum recommended gestational gain is even more important for adolescents than for adult women. The percentage of adolescents who lost weight in spite of achieving recommended gains was very similar to the percentage of all-age women who had a net loss in spite of achieving recommended gains. This evidence suggests that current recommended minimum gains are just as appropriate for adolescents as they are for more mature women.

The most notable differences between the adolescent subjects of the present study and the women in the Keppel and Taffel study occured in the percentage of subjects that had retained 14 pounds or more at one year postpartum. Of the

Table 5-1. Comparison of Wtdiff[a] by PreBMI[bc] and Gestational Weight Gain, All Age White Mothers vs. Adolescent White Mothers, Separate Studies

	All-Age Whites[d]			White Adolescents[e]		
PreBMI and Gestational Gain	n 1000s	% Lost Weight	% Wtdiff ≥ 14 lbs.	n	% Lost Weight	% Wtdiff ≥ 14 lbs
Low preBMI	358			25		
<28 lb gain	158 (44%)	29.4	6.1	6 (24%)	66	0
28-40 lb gain	138 (39%)	18.4	8.5	10 (40%)	20	30
>40 lb gain	62 (17%)	14.2	23.2	9 (36%)	0	56
Ave. preBMI	859			43		
<25 lb gain	212 (25%)	35.6	9.3	7 (16%)	71	0
25-35 lb gain	320 (37%)	31.0	7.6	20 (40%)	32	26
> 35 lb gain	327 (38%)	17.4	20.9	16 (40%)	6	65

[a] Wtdiff = Weight at 12 mos. postpartum minus weight at conception.

[b] BMI = Body Mass Index = weight in kg/(ht in meters)^2.

[c] PreBMI = BMI at conception

[d] Source: Keppel KG, Taffel SM. Pregnancy-related weight gain and retention: Implications of the 1990 Institute of Medicine Guidelines. *Am J Public Health.* 1993; 83:1100-1103.

[e] Present study

adolescents who did not achieve the minimum recommended gain, none retained 14 pounds or more. Of the adolescents who did achieve recommended gains, 26% retained 14 pounds or more, compared to less than 10% in the Keppel and Taffel study. Of the adolescents who exceeded recommended gestational gains, more than 50% retained 14 pounds or more, compared to under 25% of the comparable group in the Keppel and Taffel study. These differences seem to indicate that adolescent girls are more likely to retain a large portion of their weight gain than are adult women. This difference between adolescents and adults could be due to the adolescents still being in a stage of growth, but could also be due to adolescents having less of the self-discipline required to lose the excess gain by dieting. For underweight adolescents, this retention usually represents an improvement in weight status. Even for adolescents in the low end of the normal BMI range prior to pregnancy, a 14 pound retention does not result in a shift from "normal" BMI to "high" BMI. But for adolescents in the upper end of the normal BMI range at conception, and for adolescents who are already in the "High" or "Obese" BMI category, a high level of weight retention contributes to an unhealthy increase in body fatness.

The present study demonstrated that postpartum smoking is a significant predictor of BMIdiff and Wtdiff in models developed with data from the whole postpartum sample. This finding is not surprising, since smoking has been consistently associated with lower postpartum weight retention in prior studies (24,34,38). It is interesting, however, that postpartum smoking was not a significant predictor of BMIdiff or Wtdiff in models developed with data for subjects with normal

preBMI. This phenomenon could be due to smoking being a variable which probably has an influence on preBMI. Although smoking is associated with lower weight retention, the health risks of smoking, both for the mother and her infant, are probably much greater than the health risks associated with moderate increases in weight.

Oral contraceptive use was also shown to be a significant predictor of BMIdiff in several of the models developed in the present study. This was true for the total sample in one model (forward selection), but more characteristic of models developed from data for subjects with normal preBMI. Prior studies have not shown a significant effect of oral contraceptives on postpartum weight retention, but prior studies have not measured oral contraceptive use in the same way. One possibility is that oral contraceptives may have a different effect in adolescents than in adults. Another possibility is that oral contraceptive use could be representative of a type of lifestyle attitude in the adolescent mothers that is less likely to be associated with postpartum weight retention.

Gynecological age was also a significant predictor of BMIdiff and Wtdiff in the models developed for subjects with normal preBMI. GA did not appear to be significantly correlated with BMIdiff based on simple correlations. The model coefficient for GA was negative, implying that girls with lower GA were likely to have a higher BMIdiff. This finding is consistent with Frisch's observations that yearly increases in weight due to continuing maturation are to be expected in the first few years after menarche, yet taper off to less than 1 kg per year by the fourth and

fifth years postmenarche (48). The finding is also consistent with the observations of Scholl and Hediger (47,49).

Socioeconomic status was selected as a predictor of Wtdiff in one model in the present study. Forward selection, rather than stepwise, was used to develop this particular model. The coefficient for SES was negative in this model, indicating that girls at lower SES levels were likely to retain more weight than girls at higher SES levels. This finding is consistent with the finding of Parker and Abrams (51). The variability of the apparent significance of SES from study to study is probably related to the group studied as well as to the complexity of the relationship among predictive variables.

Attempted weight loss prior to pregancy was selected as a significant predictor of BMIdiff in one model for subjects with normal preBMI. This variable may identify those girls who weighed less than their usual weight at the time of conception, and thus might be more susceptible to stabilizing at a higher weight postpartum.

Postpartum physical activity scores were not correlated with postpartum weight retention in this study. Similar findings have been reported in other studies (28,38), but some studies have shown lower average physical activity levels in subjects who retained more weight (8,34). Some studies have suggested that prepregnancy activity levels are significant (28,34) possibly because women who are very active before pregnancy tend to be less active postpartum. This study did not measure prepregnancy activity levels, except through measures of change in employment or school

enrollment. These two measures of change were not significantly correlated with BMIdiff.

Breastfeeding (measured in months of breastfeeding) was not correlated with BMIdiff in this study. This agrees with most studies that have examined the effect of breastfeeding on postpartum weight retention (20,28,29,31,34,38,39,50,51). Because the number of subjects who breastfed in this study was quite low, further comparisons were not made between mothers who breastfed and those who did not.

Genetic influences on postpartum weight retention have been examined only in one prior study. Segel and McAnarny (8) found that mothers of obese postpartum adolescents had a higher mean BMI than mothers of non-obese adolescents. In the present study, fatness rating of either individual parent was not significantly correlated with BMIdiff, but the sum of both parents' fatness ratings was correlated with prepregnancy weight ($p=.08$). This finding seems to indicate the importance of considering the fatness of both parents in examining genetic influences. Parent fatness (mother fatness + father fatness) was also shown to be a significant predictor of postpartum body fat percentage in the present study, but not a significant predictor of BMIdiff or Wtdiff. The insignificance of parent fatness as a predictor of postpartum weight retention may have been due to the influence of parent fatness being captured within the preBMI or preWt variable. On the other hand, genetic influences which contribute to obesity may not necessarily contribute to excessive pregnancy weight gain or postpartum weight retention. Two subjects in this study who had high BMIs at conception gained less than the recommended weight in pregnancy and weighed less

at one year postpartum than before conception. On the other hand, four of the seven subjects who had high BMIs at conception gained more than the recommended amount of weight and were heavier postpartum. This variability in pregnancy weight gain and weight retention among obese subjects has been noted in prior studies (23,34).

Body Fatness and Distribution of Fat

The Brewer et al. study (29) is the only prior postpartum study for which the measurement of percent body fat can be compared to the present study. Brewer et al. estimated body fat from three skinfold measurements. Mean percent body fat for formula-feeding mothers at 6 months postpartum was 26.09% in the Brewer et al. study, compared to 25.74% for all subjects at 12 months postpartum in the present study. Subjects in the Brewer et al. study were mostly white and all were at least 18 years of age. Based on this comparison, mean postpartum body fat in white adolescent mothers appears similar to mean postpartum body fat in white adult mothers who did not breastfeed.

The relationship of other variables to body fat percentage appears to be quite complex, probably due to multicollinearity. It is interesting that percent body fat was significantly correlated to both eating more postpartum and dieting postpartum. Another seeming contradiction is that body fat percent was significantly correlated to both weight control efforts in pregnancy and pregnancy weight gain. The fact that percent body fat was also highly correlated to BMIdiff could be interpreted to infer

that weight retained postpartum was largely composed of fat. This conclusion would be consistent with the findings from other studies (39-41).

Waist to hip ratio (WHR) was expected to be an independent measure of body fat distribution in this study, but strong correlations between WHR and measures of body fatness indicated that WHR was not independent of total fatness. Since WHR was not measured prior to pregnancy in this study, conclusions regarding the effect of pregnancy on fat distribution were not possible. Comparisons can still be made, however, between this study and other studies with regard to mean WHR in parous women. Smith et al. (40) found that mean WHR for the young white nulliparous women (ages 18-30) in their sample (n=595) was 0.73, with a standard deviation of 0.06. For the group of women in the sample who had a single pregnancy within a five-year study period (n=48), average increase in WHR was 0.032. Adding this mean change to the baseline measure gives a sum of 0.762, which is close to the mean of .758 for the present study. This similarity could be interpreted as indicating that adolescent mothers and young adult mothers experience a similar change in WHR associated with pregnancy.

General Comparisons of Data

Mean Wtdiff is the dependent variable that is most comparable with other postpartum studies. Mean Wtdiff in the present study was 12.14 pounds, but median Wtdiff, which may be more representative, was 8.25 pounds. This figure compares

most closely to the findings of Scholl et al. (39) for low-income women ages 12 to 29 with moderate gestational gain rates, and the findings of Potter et al. (36) for WIC clients, aged 14 to 37, who were receiving Aid for Dependent Children. The median Wtdiff in the present study was higher than the mean Wtdiff for most studies of white postpartum women, but a higher Wtdiff is expected for adolescents. Because the mean GA for this sample was 4.1 years, and expected weight gain for each of the fourth and fifth years after menarche is 1.76 pounds, expected weight gain for the 21 month period from conception to 12 months postpartum would be 1.75 years times 1.76 pounds, or 3.1 pounds for normal growth, in addition to whatever weight was retained from the pregnancy.

The Meserole et al. study (7) was the only postpartum study that also reported gestational weight gain in adolescents, as opposed to adolescents mixed with other ages. Mean gestational gain in the Meserole et al. study was 36.8 pounds, compared to a mean of 36 pounds in the present study. Mean age of the girls studied by Meserole et al. was 15.7 years, compared to a mean age in the present study of 17 years at delivery. Scholl et al. (47) reported mean gestational gains of 33.4 pounds in growing adolescents, and 28.2 pounds in non-growing adolescents. The Scholl et al. sample included a high percentage of black teens, so racial differences may have contributed to differences in mean gestational gains between the present study and the Scholl et al. study. Mean age at conception of the adolescents in the Scholl et al. study was 15.9 years for growers and 16.0 years for nongrowers. These ages are similar to mean age at conception in the present study.

Conclusions and Recommendations

For adolescents, as for adult women, pregnancy weight gain appears to be the strongest predictor of postpartum weight retention. Results of this study appear support the gestational weight gain guidelines published by the National Academy of Sciences in 1990 as appropriate for adolescent girls. Of the adolescents who gained less than the recommended amount of weight during pregnancy, 73% weighed less at one year postpartum than at conception. Of that group, 36% were already underweight initially, and 22% fell from the average BMI classification to the low BMI classification. Of those whose weight gain was within the recommended range, only 26% weighed less at one year postpartum, and only one of those girls (12.5%) dropped into the low BMI category, while 25% remained within the low BMI category, and 62% remained within the average BMI category.

Ideally, underweight adolescents should not have a net weight loss following pregnancy, and preferably would actually have enough weight retention to place them in the average BMI category. For this reason, it may be appropriate for initially underweight pregnant teens to gain more than the recommended gain of 28 to40 pounds. Of the underweight subjects who gained above the recommended limit of 40 pounds, none had a net weight loss at one year postpartum, 33% remained in the low BMI category, one girl (11%) gained so much that she was subsequently in the high BMI category, and the remainder were in the average BMI category at one year postpartum.

Of the subjects who were initially in the average preBMI category and gained more weight than the recommended maximum, one (6%) had a net weight loss but remained within the average BMI category. On the other hand, 38% retained sufficient weight to place them in the high BMI category at 12 months postpartum. Among those who gained the recommended amount of weight when BMI was initially normal, 20% retained sufficient weight to place them in the high BMI category at 12 months postpartum. In conclusion, weight gain which exceeds the NAS guidelines does not necessarily always lead to excessive weight retention in teens, but it does increase the risk of weight retention, which can contribute to obesity. Consideration should be given to whether initial weight is in the upper or lower part of the designated BMI range in order to tailor weight gain recommendations and guidance to the individual.

Based on the finding in this study that higher weight retention was associated with lower energy intake, it may be that restricting energy intake in order to lose excess weight accumulated during pregnancy is not necessarily the best option for preventing long-term postpartum weight retention. Prevention of the accumulation of excess weight would be preferable, but not necessarily any easier. It is impossible to predict the exact weight gain that will lead to the optimum outcome for both the infant and the mother, because individual variation is great. It is also not appropriate to be overly restrictive with energy intake during pregnancy, due to risks for the fetus. Possibly the best approach to weight management during pregnancy, as well as in other stages of life, is to teach "normal eating". The teaching of "normal eating" is

emerging as part of a new paradigm in the approach to providing nutritional guidance for prevention of excessive weight gain (99,100). "Normal eating" has been defined by Satter (100) as follows:

> Normal eating is being able to eat when you are hungry and continue eating until you are satisfied. It is being able to choose food you like and eat it and truly get enough of it -- not just stop eating because you think you should. Normal eating is being able to use some moderate constraint on your food selection to get the right food, but NOT being so restrictive that you miss out on pleasurable foods. Normal eating is giving yourself permission to eat sometimes because you are happy, sad, or bored, or just because it feels good. Normal eating is three meals a day, or four or five, or it can be choosing to munch along the way. It is leaving some cookies on the plate because you know you can have some again tomorrow, or it is eating more now because they taste so wonderful. Normal eating is overeating at times; feeling stuffed and uncomfortable. It is also undereating at times and wishing you had more. Normal eating is trusting your body to make up for your mistakes in eating. Normal eating takes up some of your time and attention, but keeps its place as only one important area of your life.
>
> In short, normal eating is flexible. It varies in response to your hunger, your schedule, your proximity to food, and your feelings. (p. 117)

Pregnancy is a life-changing event, regardless of a woman's age, socioeconomic status, race, marital status, or employment status. This life-changing event is especially stressful for adolescents who may be experiencing unplanned pregnancies. Many, but not all, are highly motivated to do what is best for the unborn child, and most also have concerns about maintaining their prepregnancy body size and health. Trying to change one's eating habits is also stressful, especially at a time when a woman may be experiencing nausea at some points and a voracious appetite at other times. Adding guilt for enjoying favorite foods does not seem to be a health-enhancing approach to

preventing excessive weight gain. On the other hand, teaching a young pregnant woman to pay attention to her needs and related feelings, both physiological and psychological, to acknowledge them as important, and to address them in a positive way perhaps would be a health-enhancing approach to nutritional guidance that could carry over into nutritional care of the infant as well as general self-care for the mother. Ideally, nutritional guidance would only be one part of a more comprehensive effort to provide the type of support which will help the adolescent mother to approach her new role and her life choices in a positive, constructive manner.

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LIST OF REFERECES

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APPENDICES

APPENDIX A

STATEMENT OF INFORMED CONSENT

TN 860 Code Number _____

Statement of Informed Consent

I understand that this is a continuation of the research study focusing on beliefs and practices of adolescent females. I have had the following explained to me:

1. I will be asked to respond to several questionnaires. These will contain questions about such things as my eating habits and food preferences, my weight history, and the foods that I feed my baby.

2. Certain portions of the interview today will be taped.

3. My baby will be weighed and measured.

4. I will be weighed and measured, and a measure of body fatness will be made.

5. I will receive $5.00 for the interview today.

6. I will be asked to keep a record of the food I eat for two days, and I will be asked to fill out 2 questionnaires at home. After I mail these in, I will be contacted by phone to answer a few quick questions. Then, I will receive another $5.00.

7. I am willing for project personnel to get medical information about me and my baby from our doctors.

8. There are no specific risks to me or my baby anticipated from my participation in this project.

9. The results from this project are expected to be helpful to professionals who work with other teenagers.

10. Nobody other than project staff will be given any information about me.

11. If I have questions, I can contact Dr. Betty Ruth Carruth or Dr. Jean Skinner, Department of Nutrition and Food Sciences, The University of Tennessee, Knoxville, Tennessee 37996-1900, 974-5445.

Based on this information, I agree to participate in this project.

Date _____ Signature _____

Witness _____

APPENDIX B

SUBJECT INFORMATION FORM

TN860

Code Number _____

Date _____

Information Form

Name: _____ Phone Number: _____

Address: _____

_____

Name and address of person(s) through whom client may be reached:

Name: _____ Phone Number: _____

Address: _____

_____

Name: _____ Phone Number: _____

Address: _____

_____

Appointments:

Date	Time	Place	Comments

APPENDIX C

RECRUITMENT REFERRAL FORM

YOU ARE NEEDED

YOU ARE NEEDED TO TAKE PART IN A STUDY ABOUT FOOD HABITS OF TEENS AFTER PREGNANCY. YOU WILL BE PAID $5.00 FOR A 30-MINUTE INTERVIEW PLUS $5.00 MORE FOR MAILING IN SOME FORMS. IF YOU ARE INTERESTED IN KNOWING MORE ABOUT THE STUDY, YOU NEED TO GIVE PERMISSION TO

_____ TO GIVE YOUR NAME TO
AGENCY/SCHOOL

TEACHERS AT THE UNIVERSITY OF TENNESSEE, KNOXVILLE. THESE TEACHERS WILL CONTACT YOU TO TELL YOU MORE ABOUT THE STUDY AND SET UP AN APPOINTMENT FOR YOUR INTERVIEW.

I AGREE THAT MY NAME MAY BE GIVEN TO TEACHERS AT THE UNIVERSITY OF TENNESSEE.

_____
NAME

_____
ADDRESS

_____
CITY/STATE/ZIP

_____
PHONE NUMBER

AGENCY/SCHOOL COPY

APPENDIX D

RECRUITMENT POSTCARD

I am interested in hearing more about the survey of adolescents conducted by The University of Tennessee. Please contact me to discuss the study in more detail.

Name _____

Mailing Address _____

_____

Telephone # _____ Alternate Telephone # _____

APPENDIX E

RECRUITMENT LETTER FOR SUPPLEMENTAL SAMPLE

$$ ATTENTION TEENAGE MOTHERS $$

Were you 18 or younger when your baby was born?
Is your baby between 6 and 12 months old?
If you answered yes to both questions, please read this letter!

Dear young mother,

I would REALLY like to talk to you! I am writing a paper about how pregnancy affects the weight and eating habits of teenage mothers, and I need to talk to as many teenage mothers as possible. If you are willing to talk with me for about 45 minutes, I will pay you $5.00 for your time. I will pay you $5.00 more when you mail in some simple forms that I will ask you to fill out. Your name will not be mentioned in the paper, and your name will not be written on any of the forms.

I am a graduate student at the University of Tennessee in the Department of Nutrition. I am writing this paper to help doctors, nurses, nutritionists, and others learn more about the way pregnancy affects teenagers. I think you will find that the interview is simple and interesting, and an easy way to make a little money to spend on yourself or your baby.

If you are willing to talk with me, or you want to know more about the interview, please fill out the form below and mail it to me, or call me. I would really appreciate your help.

Sincerely,

Brenda Stephens

Brenda Stephens

My professor's name:
Dr. Jean Skinner
Her phone: 974-6244
My phone: 432-5687
My personal address:
P.O. Box 2386
Cookeville TN 38502

Yes, I am willing to talk with you about the paper you are writing for your studies at the University of Tennessee.

Your Name _____

Mailing address _____

City, State, Zip _____

Phone number(s) _____

Best time to call? _____

Your baby's birthdate _____

Your age _____ Your birthday _____

APPENDIX F

PPWRF QUESTIONNAIRE

TN860

Code Number_____

Date_____

POSTPARTUM WEIGHT AND RELATED FACTORS

Introduction to the Interview

___(Name)____, I'm going to ask you some questions about your weight now, because we'd like to know more about how a teenage girl's weight changes after she has had a baby.

You probably know that there are lots of things that can affect how much you eat and how easily you lose or gain weight, so I hope you'll understand why I need to ask you so many questions!

PART A: Reproductive Status and History

1. Do you have more than one child of your own?

   no _____ yes_____ How many?_____

   Birthday(s) _____

2. Are you pregnant now? no _____ yes_____

   a. If you are pregnant now, how old was your baby when you became pregnant this time?

   _____months

   b. How much did you weigh when you got pregnant this time?

   _____pounds

3. Have you taken birth control pills since your baby was born?

   no_____ yes_____ How many months?_____

4. a. How old were you when you had your very first monthly period?

   _____ years

   b. Do you remember what season or what month you had your first period?

   Season_____ Month_____

PART B: Weight Control Before Pregnancy

1. Before you ever became pregnant (for the first time, if you have been pregnant more than once) did you ever make any special effort to control your weight or to change your weight?

   no_____ yes_____

2. If yes, how old were you when you first made an effort to control your weight or change it?

   _____

3. If yes, what have you done?_____

   _____

   _____

   _____

   _____

THE QUESTIONS I AM ABOUT TO ASK ARE ABOUT YOUR PREGNANCY WITH YOUR ONE YEAR OLD CHILD.

PART C: Weight Changes During and After Pregnancy

1. How much did you weigh when you got pregnant with your baby?

_____ pounds

2. a. Did you feel sick at your stomach at all during your pregnancy?

no _____ yes_____

b. If yes, how did it affect your eating and for how long?

_____

_____

3. Did you lose any weight during your pregnancy?

no____

yes_____ (How many pounds?_____)

(When?_____)

4. a. Did you make any effort to control your weight during your pregnancy?

no _____ yes_____

b. (If yes) Please tell me what you did to control your weight and why you did it.

_____

_____

_____

5. How much did you weigh just before your baby was born, or how much weight did you gain altogether?

Total gain = _____pounds or Weight = _____pounds

6. Please tell me how your weight has changed from the time your baby was born until now, and tell me if you did anything special to cause your weight to change, or if something happened to cause your weight to change.

_____

_____

_____

_____

7. a. How do you feel about your weight right now?

_____

b. If you would like to change your weight, what would you like your weight to be and why?

_____pounds

Reasons: _____

_____

8. a. Do you eat differently now than you did before your pregnancy?

no _____ yes_____

b. (If yes) What is different now and why?

_____

_____

PART D: Postpartum Health

1. Have you been sick at all since your baby was born?

no_____ yes_____

2. If yes, please tell me about each time you got sick, how long it lasted, and how it affected your eating and activity.

_____

_____

_____

_____

PART E: Work and/or School

1. Have you had any jobs since your baby was born?

   no _____ yes_____ (Hours worked per week:_____)

   (Months of work:_____)

   Place(s) of employment:_____

   _____

2. Do you have a job now? no_____ yes_____

3. a. Were you in school when you got pregnant?

   no_____ yes_____

   b. (If yes) Did you keep going to school until your baby was born?

   no _____ (What pregnancy month stopped?_____)

   yes_____

4. a. Have you attended school since your baby was born?

   no_____ yes_____ (How many months?_____)

   b. (If yes) Did you or do you stay at school the whole day?

   no _____ (Portion of day attended_____)

   yes_____

PART F: Physical Activity

1. (If she has a job) I'd like to know about much exercise you get at work. About how much of the time are you ...

   a. Sitting _____

   b. Standing still _____

   c. Walking around _____

   d. Lifting, carrying, mopping, etc. _____
   (More strenuous activities)

2. (If employed, say, "When you are not at work...")
About how much time do you spend on your feet each day?

_____ hours

List the activities:_____

_____

_____

3. Please tell me about any kind of exercise or physical work that you do at least once a week but not every day.

Activity	Hours/week

PART G: Smoking History

1. Do you smoke or use tobacco? no_____ yes_____

2. (If no) Have you ever smoked regularly? no_____ yes_____

If NO, go to Part H.

If YES, complete this section (Part G).

3. At the time you got pregnant, did you smoke regularly?

no_____ yes_____ (# packs per day?_____)

4. Did you smoke during your pregnancy?

no_____ yes_____ (# packs/day?_____)

(# of months smoked _____)

5. Have you been smoking at all since your baby was born?

no_____ yes_____ (# of months?_____)

(# packs/day?_____)

6. a. If you are or were a smoker, do you think that cutting down on smoking affects your weight?

no_____ yes_____

b. (If yes) Does your weight have anything to do with your decision about whether or not you will be a smoker?

no_____ yes_____

Comments:_____

PART H: Parent Weights

Since we tend to inherit a shape that is similar to our parents, we would like to know a little about how your parents look. If you haven't seen one or both of your parents in a very long time, then we would rather you say that you don't know how they look instead of guessing.

1. Please choose the drawing that looks most like your mother.

Selection:_____

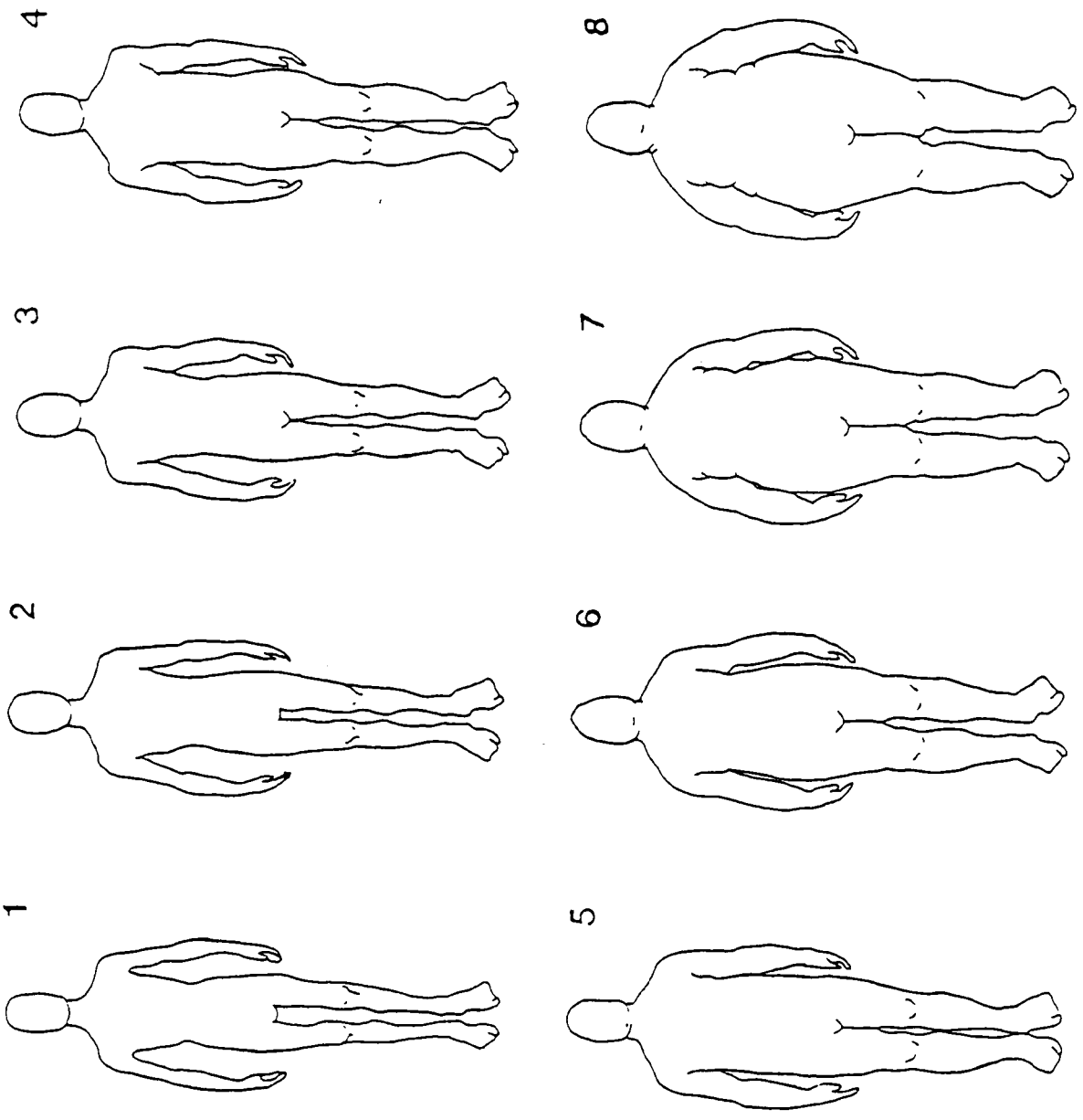
2. Please choose the drawing that looks most like your father.

Selection:_____

APPENDIX G

BODY IMAGE SILHOUETTES

from Profile Associates, Chapel Hill, NC



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APPENDIX H

ANTHROPOMETRY RECORDING FORM

TN860 Code number_____

Date_____

Mother's Anthropometry Recording Form

I. Bioelectrical Impedance

Resistance Readings (ohms) Ave._____

1._____ 2._____ 3._____

Comments_____

_____

II. Height and Weight

Height _____cm _____cm Ave._____

(initials)(_____) (_____)

Weight _____lb. _____lb. Ave._____

(initials)(_____) (_____)

Comments_____

_____

III. Circumference Measurements

Waist _____cm _____cm Ave._____

(initials)(_____) (_____)

Hip _____cm _____cm Ave._____

(initials)(_____) (_____)

Comments_____

_____

APPENDIX I

MEDICAL RECORD INFORMATION FORM

Code No._____ TN 860
Date_____ Researcher_____

MEDICAL RECORD INFORMATION FORM

1. Pre-pregnancy weight_____pounds

2. Weight entering hospital_____pounds

3. Gestational age_____

4. Delivery date mo._____day_____yr._____

5. Infant birth weight gm_____ or pounds____oz___Sex M____F____

6. Infant birth length cm_____or in_____

7. APGAR Score 1 min_____5 min_____

8. Fetal complications_____

9. Complications of pregnancy (yes or no, explain details of Hx)

Gestational diabetes_____

C-Section_____

Abruptio placenta_____

Toxemia_____

Hypertension_____admission BP_____

Extended labor_____HRS_____

Anemia_____inital Hgb____Hct____final Hgb____Hct____

Edema_____

Rh factor_____

APPENDIX J

PREPREGNANCY THREE-FACTOR EATING QUESTIONNAIRE

TN 860

Code No. _____
Date _____

Your Eating Habits Before Your Pregnancy

Please circle the answer that describes what your eating habits were like before you got pregnant with your baby.

Part I

		True	False
1.	When I smelled a sizzling steak or saw a juicy piece of meat, I found it very difficult to keep from eating, even if I had just finished a meal.	T	F
2.	I usually ate too much at social occasions, like parties and picnics.	T	F
3.	I was usually so hungry that I ate more than three times a day.	T	F
4.	When I had eaten my quota of calories, I was usually good about not eating any more.	T	F
5.	Dieting was so hard for me because I just got too hungry.	T	F
6.	I deliberately took small helpings as a means of controlling my weight.	T	F
7.	Sometimes things just tasted so good that I kept on eating even when I was no longer hungry.	T	F
8.	Since I was often hungry, I sometimes wished that while I was eating, an expert would tell me that I had eaten enough or that I could have something more to eat.	T	F
9.	When I felt anxious, I found myself eating.	T	F
10.	I thought that life was too short to worry about dieting.	T	F
11.	Since my weight went up and down, I went on reducing diets more than once.	T	F
12.	I often felt so hungry that I just had to eat something.	T	F
13.	When I was with someone who is overeating, I usually ate too.	T	F
14.	I had a pretty good idea of the number of calories in common food.	T	F
15.	Sometimes when I started eating, I just couldn't seem to stop.	T	F
16.	It was not difficult for me to leave something on my plate.	T	F
17.	At certain times of the day, I got hungry because I had gotten used to eating then.	T	F
18.	While on a diet, if I ate food that was not allowed, I consciously ate less for a period of time to make up for it.	T	F
19.	Being with someone who was eating often made me hungry enough to eat also.	T	F
20.	When I felt blue, I often overate.	T	F
21.	I enjoyed eating too much to spoil it by counting calories or watching my weight.	T	F
22.	When I saw a real delicacy, I often got so hungry that I had to eat right away.	T	F
23.	I often stopped eating when I was not really full as a conscious means of limiting the amount that I ate.	T	F
24.	I got so hungry that my stomach often seemed like a bottomless pit.	T	F
25.	I was always hungry so it was hard for me to stop eating before I finished the food on my plate.	T	F
26.	When I felt lonely, I consoled myself by eating.	T	F
27.	I consciously held back at meals in order not to gain weight.	T	F
28.	I sometimes got very hungry late in the evening or at night.	T	F

29. I ate anything I wanted, any time I wanted. T F

30. Without even thinking about it, I took a long time to eat. T F

31. I counted calories as a conscious means of controlling my weight. T F

32. I did not eat some foods because they would make me fat. T F

33. I was always hungry enough to eat at any time. T F

34. I paid a great deal of attention to changes in my figure. T F

35. While on a diet, if I ate a food that was not allowed, I often then splurged and ate other high calorie foods. T F

Part II

Directions: Please answer the following questions by circling the number above the answer that describes you.

36. How often were you dieting in a conscious effort to control your weight?

1	2	3	4
rarely	sometimes	usually	always

37. Did a weight change of 5 lbs. affect the way you lived your life?

1	2	3	4
not at all	slightly	moderately	very much

38. How often did you feel hungry?

1	2	3	4
only at mealtimes	sometimes between meals	often between meals	almost always

39. Did your feelings of guilt about overeating help you to control your food intake?

1	2	3	4
never	rarely	often	always

40. How difficult would it have been for you to stop eating halfway through dinner and not eat for the next four hours?

1	2	3	4
easy	slightly difficult	moderately difficult	very difficult

41. How conscious were you of what you were eating?

1	2	3	4
not at all	slightly	moderately	extremely

42. How frequently did you avoid "stocking up" on tempting foods?

1	2	3	4
almost never	seldom	usually	almost always

43. How likely were you to shop for low calorie foods?

1	2	3	4
unlikely	slightly unlikely	moderately unlikely	very likely

44. Did you eat sensibly in front of others and splurge alone?

1	2	3	4
never	rarely	often	always

45. How likely were you to consciously eat slowly in order to cut down on how much you ate?

1	2	3	4
unlikely	slightly likely	moderately likely	very likely

46. How frequently did you skip dessert because you were no longer hungry?

1	2	3	4
almost never	seldom	at least once a week	almost every day

47. How likely were you to consciously eat less than you wanted?

1	2	3	4
unlikely	slightly unlikely	moderately unlikely	very likely

48. Did you go on eating binges though you were not hungry?

1	2	3	4
never	rarely	sometimes	at least once a week

49. On a scale of 0-5, where 0 means no restraint in eating (eating whatever you want, whenever you want it) and 5 means total restraint (constantly limiting food intake an never "giving in"), what number would you have given yourself before your pregnancy?

0
ate whatever you wanted, whenever you wanted it

1
usually ate whatever you wanted, whenever you wanted it

2
often ate whatever you wanted, whenever you wanted it

3
often limited food intake, but often "gave in"

4
usually limited food intake, rarely "gave in"

5
constantly limited food intake, never "gave in"

50. To what extent does this statement describe your eating behavior before your pregnancy? "I started dieting in the morning, but because of any number of things that happened during the day, by evening I had given up and ate what I wanted, promising myself to start dieting again the next day."

1	2	3	4
not like me	little like me	pretty good description of me	described me perfectly

APPENDIX K

POSTPARTUM
THREE-FACTOR EATING QUESTIONNAIRE

TN 860

Code No _____
Date _____

Your Eating Habits Since Baby's Birth

Please circle the answer that describes you best.

Part I

		True	False
1.	When I smell a sizzling steak or see a juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal.	T	F
2.	I usually eat too much at social occasions, like parties and picnics.	T	F
3.	I am usually so hungry that I eat more than three times a day.	T	F
4.	When I have eaten my quota of calories, I am usually good about not eating any more.	T	F
5.	Dieting is so hard for me because I just get too hungry.	T	F
6.	I deliberately take small helpings as a means of controlling my weight.	T	F
7.	Sometimes things just taste so good that I keep on eating even when I am no longer hungry.	T	F
8.	Since I am often hungry, I sometimes wish that while I am eating, an expert would tell me that I have had enough or that I can have something more to eat.	T	F
9.	When I feel anxious, I find myself eating.	T	F
10.	Life is too short to worry about dieting.	T	F
11.	Since my weight goes up and down, I have gone on reducing diets more than once.	T	F
12.	I often feel so hungry that I just have to eat something.	T	F
13.	When I am with someone who is overeating, I usually overeat too.	T	F
14.	I have a pretty good idea of the number of calories in common food.	T	F
15.	Sometimes when I start eating, I just can't seem to stop.	T	F
16.	It is not difficult for me to leave something on my plate.	T	F
17.	At certain times of the day, I get hungry because I have gotten used to eating then.	T	F
18.	While on a diet, if I eat food that is not allowed, I consciously eat less for a period of time to make up for it.	T	F
19.	Being with someone who is eating often makes me hungry enough to eat also.	T	F
20.	When I feel blue, I often overeat.	T	F
21.	I enjoy eating too much to spoil it by counting calories or watching my weight.	T	F
22.	When I see a real delicacy, I often get so hungry that I have to eat right away.	T	F
23.	I often stop eating when I am not really full as a conscious means of limiting the amount that I eat.	T	F
24.	I get so hungry that my stomach often seems like a bottomless pit.	T	F
25.	I am always hungry so it is hard for me to stop eating before I finish the food on my plate.	T	F
26.	When I feel lonely, I console myself by eating.	T	F
27.	I consciously hold back at meals in order not to gain weight.	T	F
28.	I sometimes get very hungry late in the evening or at night.	T	F

29. I eat anything I want, any time I want. T F

30. Without even thinking about it, I take a long time to eat. T F

31. I count calories as a conscious means of controlling my weight. T F

32. I do not eat some foods because they make me fat. T F

33. I am always hungry enough to eat at any time. T F

34. I pay a great deal of attention to changes in my figure. T F

35. While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high calorie foods. T F

Part II

Directions: Please answer the following questions by circling the number above the answer that describes you.

36. How often are you dieting in a conscious effort to control your weight?

1	2	3	4
rarely	sometimes	usually	always

37. Would a weight fluctuation of 5 lbs. affect the way you live your life?

1	2	3	4
not at all	slightly	moderately	very much

38. How often do you feel hungry?

1	2	3	4
only at mealtimes	sometimes between meals	often between meals	almost always

39. Do your feelings of guilt about overeating help you to control your food intake?

1	2	3	4
never	rarely	often	always

40. How difficult would it be for you to stop eating halfway through dinner and not eat for the next four hours?

1	2	3	4
easy	slightly difficult	moderately difficult	very difficult

41. How conscious are you of what you are eating?

1	2	3	4
not at all	slightly	moderately	extremely

42. How frequently do you avoid "stocking up" on tempting foods?

1	2	3	4
almost never	seldom	usually	almost always

43. How likely are you to shop for low calorie foods?

1	2	3	4
unlikely	slightly unlikely	moderately likely	very likely

44. Do you eat sensibly in front of others and splurge alone?

1	2	3	4
never	rarely	often	always

45. How likely are you to consciously eat slowly in order to cut down on how much you eat?

1	2	3	4
unlikely	slightly unlikely	moderately unlikely	very likely

46 How frequently do you skip dessert because you are no longer hungry?

1	2	3	4
almost never	seldom	at least once a week	almost every day

47 How likely are you to consciously eat less than you want?

1	2	3	4
unlikely	slightly likely	moderately likely	very likely

48. Do you go on eating binges though you are not hungry?

1	2	3	4
never	rarely	sometimes	at least once a week

49. On a scale of 0-5, where 0 means no restraint in eating (eating whatever you want, whenever you want it) and 5 means total restraint (constantly limiting food intake an never "giving in"), what number would you give yourself?

0
eat whatever you want, whenever you want it

1
usually eat whatever you want, whenever you want it

2
often eat whatever you want, whenever you want it

3
often limit food intake, but often "give in"

4
usually limit food intake, rarely "give in"

5
constantly limiting food intake, never "giving in"

50. To what extent does this statement describe your eating behavior? "I start dieting in the morning, but because of any number of things that happen during the day, by evening I have given up and eat what I want, promising myself to start dieting again tomorrow."

1	2	3	4
not like me	little like me	pretty good description of me	describes me perfectly

APPENDIX L

SCORING KEY
THREE-FACTOR EATING QUESTIONNAIRE

SCORING KEY FOR PREPREGNANCY AND POSTPARTUM THREE-FACTOR EATING QUESTIONNAIRE

Disinhibition Scale

Item numbers 1, 2, 7, 9, 11, 13, 15, 20, 26, and 35 score one point each when answered "True".

Item numbers 16 and 30 score one point each when answered "False".

Item numbers 44, 48, and 50 score one point each when rated 3 or 4.

Maximum score: 15

Hunger Scale

Item numbers 3, 5, 8, 12, 17, 19, 22, 24, 25, 28, and 33 score one point each when answered "True".

Item numbers 38 and 40 score one point each when rated 3 or 4.

Item number 46 scores one point each when rated 1 or 2.

Maximum score: 14

Restraint Scale

Item numbers 4, 6, 14, 18, 23, 27, 31, 32, and 34 score one point each when answered "True".

Item numbers 10, 21, and 29 score one point each when answered "False".

Item numbers 36, 37, 39, 41, 42, 43, 45, 47, and 49 score one point each when rated 3 or higher.

Maximum score: 21

APPENDIX M

DEMOGRAPHIC INFORMATION FORM

TN860

Code Number _____

Date _____

Demographics and Background Information

Age _____ Date of Birth _____

Grade in school or last grade completed _____

Living Arrangements (check one):
_____ live with one parent
_____ live with both parents
_____ live with spouse
_____ live with parents and spouse
_____ live with other relative, specify: _____
_____ live in group home
_____ other, specify: _____

Mother's Education: (check highest level)
_____ < 7th grade
_____ junior high school
_____ some high school
_____ high school graduate
_____ some college or specialized training
_____ college graduate
_____ graduate school or professional training
_____ not applicable

Father's Education: (check highest level)
_____ < 7th grade
_____ junior high school
_____ some high school
_____ high school graduate
_____ some college or specialized training
_____ college graduate
_____ graduate school or professional training
_____ not applicable

Spouse's Education:
_____ < 7th grade
_____ junior high school
_____ some high school
_____ high school graduate
_____ some college or specialized training
_____ college graduate
_____ graduate school or professional training
_____ not applicable

Mother's Occupation _____

Father's Occupation _____

Spouse's Occupation _____

Estimated Date of Delivery _____

Doctor's Name _____

Place of Delivery _____

APPENDIX N

FOOD RECALL/RECORD FORM

TN860

Code Number _____
Date _____

Instructions for Completing Food Records Forms

1. Use the attached pages to record your food intake for two days. Please keep your records for _____ and _____. Do not change your normal eating pattern for those days.

2. Record everything you eat and drink (except water) in each 24-hour period.

3. Remember to record the time you eat, where you eat, who you eat with, and if you are watching TV.

4. It is easier to complete this form as you go, rather than waiting until the end of the day. Carry the form with you, and record each food when you eat it.

5. Describe in as much detail as possible each food eaten, and indicate how it was prepared and served.

   a. Tell whether fruits and vegetables are eaten raw or cooked.

   b. Identify preparation methods. Are foods fried, boiled, or steamed?

   c. Indicate brand names where possible (e.g., 2 c. Campbells Chicken and Noodle soup; 3 Mrs. Paul's Fish Sticks with 1 Tbsp. catsup; 1 Burger King Whopper Junior with tomato, mustard, catsup, and pickles).

   d. For mixed dishes and sandwiches, estimate and record amounts of major ingredients (e.g., Vegetable Salad - 1 c. lettuce, 1/2 c. tomato, 1/4 c. broccoli, 1/4 c. carrots, 1/2 egg, 1/4 c. Kraft reduced calorie French dressing; Ham and Cheese Sandwich - 2 slices whole wheat bread, 1 slice Mr. Turkey smoked turkey ham, 1 slice American cheese, 2 slices tomato, 1 leaf lettuce, 1/2 Tbsp. mayonnaise).

   e. Do not forget to record anything you add to foods and beverages before eating (e.g. butter, salad dressings, gravies, sauces, sugar, cream).

   f. Also, don't forget to record foods eaten between meals and desserts eaten after meals.

   g. Sometimes you can get information from labels (e.g., 1 1/2 oz. milky way candy bar).

6. Estimate as closely as possible the amounts of each food eaten. Use the following abbreviations for measures:

   cup = c.
   tablespoon = T. or Tbsp.
   teaspoon = t. or tsp.
   ounce - oz.

7. If you have questions, please contact Dr. Jean Skinner, Dr. Betty Ruth Carruth, or Janet Pope, Department of Nutrition and Food Sciences, The University of Tennessee, Knoxville, TN 37996-1900, 974-5445.

First Name _____
Telephone Number _____

TN860

Code Number _____
Date _____
Record _____ Recall _____

Food Recall/Record Form

	Food and Description	Amount
1st time food was eaten: time _____ am ___ pm ___ where _____ who, if anyone ate with you? _____ watching TV, yes__ no __		
2nd time food was eaten: time _____ am ___ pm ___ where _____ who, if anyone ate with you? _____ watching TV, yes__ no___		
3rd time food was eaten: time _____ am ___ pm ___ where _____ who, if anyone ate with you? _____ watching TV, yes__ no___		
4th time food was eaten: time _____ am ___ pm ___ where _____ who, if anyone ate with you? _____ watching TV, yes__ no___		
5th time food was eaten: time _____ am ___ pm ___ where _____ who, if anyone ate with you? _____ watching TV, yes__ no___		

6th time food was eaten: time _____ am ___ pm ___ where _____ who, if anyone ate with you? _____ watching TV, yes__ no __		
7th time food was eaten: time _____ am ___ pm ___ where _____ who, if anyone ate with you? _____ watching TV, yes__ no__		
8th time food was eaten: time _____ am ___ pm ___ where _____ who, if anyone ate with you? _____ watching TV, yes__ no__		
9th time food was eaten: time _____ am ___ pm ___ where _____ who, if anyone ate with you? _____ watching TV, yes__ no__		

If you ate more than 9 times use the back of this sheet.

After completing this form, check yourself by answering the following questions:

1. Have you listed everything you ate and drank during the day?
2. Did you include the amount (i.e., 1 orange, 1 cookie, or 1 cup, 1 Tbsp., 1 tsp.) of each item consumed?
3. Did you describe the way the foods were prepared (i.e., egg - scrambled, fried, poached)?
4. Did you describe, in as much detail as possible, the ingredients in casseroles, salads, sandwiches, soups, and other mixed dishes?
5. Did you remember to list everything you added to your food before you ate it (i.e., sauces, gravies, butter, salad dressings)?
6. Did you add anything to your beverages (sugar, cream, milk, etc.)?

APPENDIX O

PRE-INTERVIEW INSTRUCTION LETTER

IMPORTANT REMINDER

1. Please DO NOT DRINK or EAT ANYTHING (not even water) after _____ on the day of your appointment with us. We will be using a special instrument to measure the amount of fat in your body. If you eat or drink anything after _____, the instrument will be fooled by the amount of fluid in your body, and the measurement it gives us will be wrong. We will measure your body fat before we do anything else, then we'll give you as much water as you want.

2. Please remember NOT to wear pantyhose. The instrument must be connected to your bare foot, so we are trying to save you the trouble of taking off pantyhose.

3. Please wear slacks, jeans, or shorts if possible, because you will be lying down to have your body fat measured, and it is important for your legs not to touch each other.

4. We will be measuring your waist and hips, because this is a way of finding out where most of the fat is on your body. This is important because fat in some places is more dangerous to your health than fat in other places. Since you will NOT be taking off your clothes to be measured, try to wear something that will not interfere with measuring.

WE REALLY APPRECIATE YOUR HELP AND COOPERATION!!!

APPENDIX P

SCORING SCALES
HOLLINGSHEAD FOUR FACTOR INDEX
OF SOCIAL STATUS

SCORING SCALES
HOLLINGSHEAD FOUR FACTOR INDEX OF SOCIAL STATUS

Educational Attainment

1 = less than seventh grade
2 = completion of junior high school (ninth grade)
3 = some high school (tenth or eleventh grade)
4 = high school graduate
5 = some college (at least one year) or specialized training
6 = college graduate
7 = graduate school or professional training (graduate degree)

Occupations

1 = farm laborers, menial service workers
2 = unskilled workers
3 = machine operators and semiskilled workers
4 = skilled manual workers, craftsmen, and tenant farmers
5 = clerical and sales workers
6 = technicians, semi professionals
7 = managers, minor professionals
8 = administrators, lessor professionals
9 = high level executives

APPENDIX Q

ADDITIONAL REGRESSION MODELS

Regression Model for Body Fat

A regression model was developed which did not include measures of actual weight, in order that other variables affecting body fat would not be overshadowed by the relationship between body fat and body weight. The only weight variable which was included was gestational weight gain. Other variables included were postpartum disinhibition, parent fatness (both parents added together), postpartum smoking, and whether or not the subject had quit smoking permanently. Of the variables tested, only postpartum smoking, gestational weight gain, and parent fatness remained in the model after the forward selection procedure. Table A-1 shows the results of the analysis of this model. The R-square for this model was .33.

Table A-1. Aposteriori Model for Prediction of Body Fat Percentage[a] at 12 months Postpartum for White Adolescent Girls (n=52)

Variable	Regression Coefficient	P (for Step)	Cumulative R-square
Smoked postpartum	-12.73	0.006	0.14
Gestational weight gain	0.27	0.009	0.26
Parent fatness[bc]	1.35	0.025	0.33
Constant	10.39		

[a] As estimated by bioelectrical impedance analysis.

[b] Fatness rating was determined by silhouette selection by the subject.

[c] Parent fatness = sum of fatness ratings of both parents.

Regression Models for Weight Difference between Conception and 12 months Postpartum (Wtdiff)

Linear regression models tested for the prediction of Wtdiff are shown in Table A-2. The original models that were hypothesized for BMIdiff as a dependent variable (Models I & II in Table A-2) also were analyzed with Wtdiff as a dependent variable, yielding very similar results. The model that was hypothesized with postBMI as a dependent variable also was analyzed with Wtdiff as a dependent variable (Model III in Table A-2). Using the stepwise procedure, all variables were eliminated except for gestational weight gain and kcal/kg/day. The R-square for the resulting equation was .60, with gestational weight gain accounting for 46% of the variation in Wtdiff, and kcal/kg/day accounting for the remainder. Kcal/kg/day was negatively related to Wtdiff, as it was in the postBMI model. (See Table A-3.)

The same models were analyzed again using only data from subjects with normal preBMI. Sample size was very small for the Model I, but the only variable selected as significant with the stepwise procedure was gestational weight gain. Although the sample size was about doubled for Model II, the results were the same in that gestational weight gain was the only variable found to be a significant predictor. R-square for this model was .43. The stepwise procedure for Model III resulted in the selection of the variables kcal/kg/day, accounting for 46% of the variation, plus gestational weight gain, accounting for 20% of the variation, plus preBMI, accounting for 4% of the variation. The model R-square was .70, as shown in Table A-4.

Table A-2. Models Tested for the Prediction of Wtdiff[a] in White Adolescent Girls

Model I	Model II	Model III
Prepregnancy weight	Prepregnancy weight	BMI[c] at conception
Gestational weight gain	Gestational weight gain	Gestational weight gain
Postpartum restraint[b]	Postpartum restraint	Postpartum restraint
Postpartum hunger[b]	Postpartum hunger	Gynecological age
Postpartum disinhibition[b]	Postpartum disinhibition	Kcal/kg/day
Prepregnancy restraint		Percent kcal from fat
Prepregnancy hunger		Physical activity score
Prepregnancy disinhibition		Mother's fatness[d]
		Father's fatness[d]

[a] Weight at 12 mos. postpartum minus weight at conception.

[b] Three Factor Eating Questionnaire, Stunkard & Messick, *J Psychosom Res*, 1985.

[c] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[d] Mother or father fatness = fatness of respective parent based on silhouette selection.

Table A-3. Results of Analysis of Model III for Prediction of Wtdiff[a] for White Postpartum Adolescents (n=64[b])

Variable	Regression Coefficient	P (for step)	Cumulative R-square
Gestational weight gain	0.74	0.0001	0.47
Kcal/kg/day postpartum[c]	-0.66	0.0001	0.60

[a] Weight at 12 mos. postpartum minus weight at conception.

[b] Eleven subjects were excluded because of incomplete data.

[c] From 2-day food records and two 24-hour recalls at 12 mos. postpartum.

Table A-4. Results of Analysis of Model III for Prediction of Wtdiff[a] for White Postpartum Adolescents with Normal BMI[b] at Conception (n=35)

Variable	Regression Coefficient	P (for step)	Cumulative R-square
Kcal/kg/day postpartum[c]	-1.21	0.0001	0.46
Gestational weight gain	0.76	0.0001	0.66
BMI at conception	3.74	0.05	0.70
Constant	-60.96		

[a] Weight at 12 mos. postpartum minus weight at conception.

[b] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[c] From 2-day food records and two 24-hour recalls at 12 mos. postpartum.

An attempt was made to find the best possible predictive model for Wtdiff by proposing a model which included all the following variables: gestational weight gain, preBMI, WHR, GA, parity, SES, use of oral contraceptives, PP activity score, months of work postpartum, months of school postpartum, kcal/kg, percent calories from fat, postpartum TFEQ scores, mother's fatness, father's fatness, PP smoking, quitting smoking in pregnancy, quitting smoking permanently, change in living or marital status, change in school or work, change in eating, eating more PP and eating less PP. The SAS forward selection procedure was then used to select the most predictive variables. The resulting model included only the following four variables: gestational weight gain, kcal/kg/day, waist to hip ratio, and months of PP oral contraceptive use. The R-square for this model was 0.66, with gestational weight gain contributing 46% of the variation, kcal/kg/day about 14%, and WHR and oral contraceptive use each contributing about 3% of the variation. This model is shown in Table A-5.

The same 23 variables listed above were then tested as predictors of Wtdiff with data from subjects with normal preBMI only, again using a forward selection procedure. The resulting model contained the following variables: gestational weight gain, kcal/kg/day, SES at 12 months postpartum, gynecological age, and use of oral contraceptives. (See Table A-6.) The R-square value for this model was .82.

In an effort to determine whether the strong relationship between kcal/kg/day and Wtdiff was due to the division of kcal by body weight, the same 23 variable model was tested again, but kcal/day was substituted for kcal/kg/day. When the model was tested with the entire sample, the SAS stepwise procedure selected gestational

Table A-5. Aposteriori Model 1 (based on forward selection) for Prediction of Wtdiff[a] for White Postpartum Adolescents (n=61[b])

Variable	Regression Coefficient	P (for step)	Cumulative R-square
Gestational weight gain	0.70	0.0001	0.46
Kcal/kg/day postpartum[c]	-0.49	0.0001	0.60
Waist to hip ratio[d]	95.04	0.03	0.63
PP oral contraceptive use[e]	-0.78	0.04	0.66
Constant	-62.94		

[a] Weight at 12 mos. postpartum minus weight at conception.

[b] Sample size under 75 because of incomplete data.

[c] From 2-day food records and two 24-hour recalls at 12 mos. postpartum.

[d] Waist circumference/hip circumference (measured at 12 mos. postpartum).

[e] Measured in months of contraceptive use between delivery and 12 mos. postpartum

Table A-6. Aposteriori Model 1 (based on forward selection) for Prediction of Wtdiff[a] for White Postpartum Adolescents with Normal BMI[b] at Conception (n=33)

Variable	Regression Coefficient	P (for step)	Cumulative R-square
Kcal/kg/day postpartum[c]	-1.22	0.0001	0.50
Gestational weight gain	0.59	0.001	0.65
SES[d] (postpartum)	-0.85	0.01	0.73
Gynecological age[e]	-4.02	0.02	0.78
Oral contraceptive use[f]	-0.99	0.03	0.82
Constant	73.84		

[a] Weight at 12 mos. postpartum minus weight at conception.

[b] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[c] From 2-day food records and two 24-hour recalls at 12 mos. postpartum.

[d] SES = socioeconomic status as calculated by the Hollingshead Four Factor Index.

[e] Gynecological age = chronological age minus age at menarche.

[f] Measured in months of contraceptive use between delivery and 12 mos. postpartum.

weight gain, WHR, and postpartum smoking for inclusion in the model. The R-square for this model was 0.60, with gestational weight gain explaining 46% of the variation, WHR explaining 11% of the variation, and postpartum smoking explaining about 3% of the variation. This model is summarized in Table A-7. When the same model was tested only with subjects who had normal preBMI, the SAS stepwise procedure selected gestational weight gain, use of oral contraceptives, and gynecological age for inclusion in the model. The R-square for the resulting model was .64, with partial R-square values as follows: gestational weight gain = .45; use of oral contraceptives = .12, and gynecological age = .07. This model is summarized in Table A-8.

Additional Regression Models for BMIdiff

In an attempt to find the best set of variables for predicting BMIdiff, additional models were tested (Table A-9.) Both new models included a variable which accounted for the interaction between preBMI and pregnancy weight gain. Other variables which were included in the first model (Model A) were gestational weight gain, use of oral contraceptives, parent fatness, postpartum smoking, attempted weight loss prior to pregnancy, and quitting school postpartum. The SAS stepwise procedure selected only two variables from the proposed model: the interaction variable (preBMI x gestational weight gain) and postpartum smoking. The R-square for this model was .55, with the interaction variable explaining slightly under 51% of

Table A-7. Aposteriori Model 2[a] for Prediction of Wtdiff[b] for White Postpartum Adolescents (n=61)

Variable	Regression Coefficient	P (for step)	Cumulative R-square
Gestational weight gain	0.89	0.0001	0.46
Waist to hip ratio[c]	152.61	0.0004	0.57
Postpartum smoking	-8.66	0.025	0.60
Constant	-131.78		

[a] Substituted kcal/day for kcal/kg/day in proposed predictors.

[b] Weight at 12 mos. postpartum minus weight at conception.

[c] Waist circumference/hip circumference (measured at 12 mos. postpartum).

Table A-8. Aposteriori Model 2[a] for Prediction of Wtdiff[b] for White Postpartum Adolescents with Normal BMI[c] at Conception (n=33)

Variable	Regression Coefficient	P (for step)	Cumulative R-square
Gestational weight gain	0.875	0.0001	0.45
Oral contraceptive use[d]	-1.70	0.006	0.57
Gynecological age[e]	-4.33	0.03	0.64
Constant	9.5		

[a] Substituted kcal/day for kcal/kg/day in proposed predictors.

[b] Weight at 12 months postpartum minus weight at conception.

[c] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[d] Measured in months of contraceptive use between delivery and 12 mos. postpartum.

[e] Gynecological age = chronological age minus age at menarche.

Table A-9. Aposteriori Models Tested for Prediction of BMIdiff[ab] for White Postpartum Adolescents

Model A	Model B
PreBMI[c] x Gestational weight gain	PreBMI x Gestational weight gain
Postpartum oral contraceptive use[d]	Postpartum oral contraceptive use
Parent fatness[e]	Parent fatness
Postpartum smoking	Postpartum smoking
Attempted wt loss before conception	Attempted wt loss before conception
Quit school postpartum	Kcal/day[f]
Gestational weight gain	Gynecological age[g]
	SES at 12 months postpartum[h]

[a] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[b] BMIdiff = BMI at 12 mos. postpartum minus BMI at conception.

[c] PreBMI = BMI at conception.

[d] Measured in mos. of contraceptive use between delivery and 12 mos. postpartum.

[e] Parent fatness = sum of fatness ratings of both parents.

[f] From two-day food records and two 24-hour recalls at 12 mos. postpartum.

[g] Gynecological age = chronological age minus age at menarche.

[h] SES = socioeconomic status as calculated by the Hollingshead Four Factor Index.

the variation in BMIdiff, and postpartum smoking explaining about 4.5% of the variation. Table A-10 shows the results of the analysis of this model.

Model A was also tested with only the subset of subjects whose preBMI was in the normal range. The resulting model contained three variables: the interaction between preBMI and gestational weight gain (explaining 47% of the variation), months of oral contraceptive use (explaining 10% of the variation), and attempted weight loss prior to pregnancy (explaining 5% of the variation). The R-square for this model was .62. A summary of this model is shown in Table A-11.

Because other models tested for the dependent variable Wtdiff revealed some significant predictors not yet tested as predictors of BMIdiff, the following variables were included in a second model (Model B): preBMI x gestational gain, kcal/day, gynecological age, postpartum SES, postpartum use of oral contraceptives, postpartum smoking, parent fatness, and attempted weight loss prior to pregnancy. When the model was tested with all subjects, the SAS stepwise procedure selected the interaction variable (preBMI x gestational weight gain) and postpartum smoking as the bestpredictors of BMIdiff. None of the other variables added significantly to the R-square of this model, which was .57. The interaction variable explained 53% of the variation in BMIdiff, and postpartum smoking accounted 4% of the variation. The resulting set of variables was the same for Model B as for Model A, but the coefficients and R-squares differed somewhat because the subject set was not identical. When Model B was tested with subjects with normal preBMI, the SAS stepwise procedure selected the interaction variable (preBMI x gestational weight gain),

Table A-10. Aposteriori Model A for Prediction of BMIdiff[ab] in White Adolescent Subjects (n=68): Stepwise Selection Results

Variable	Regression Coefficient	P (for step)	Cumulative R-square
BMI at conception x Gestational weight gain	0.0075	.0001	.51
Postpartum smoking	-1.538	.01	.55
Constant	-2.913		

[a] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[b] BMIdiff = BMI at 12 mos. postpartum minus BMI at conception.

Table A-11. Aposteriori Model A for Prediction of BMIdiff[ab] for White Adolescents with Normal BMI at Conception (n=37): Stepwise Selection Results

Variable	Regression Coefficient	P (for step)	Cumulative R-Square
BMI at conception x Gestational weight gain	0.006	0.0001	0.47
PP oral contraceptive use[c]	-0.24	0.008	0.57
Attempted weight loss[d]	1.75	0.05	0.62
Constant	-1.99		

[a] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[b] BMIdiff = BMI at 12 mos. postpartum minus BMI at conception.

[c] Measured in months of contraceptive use between delivery and 12 mos. postpartum.

[d] Attempted weight loss at least once prior to conception.

postpartum use of oral contraceptives, and gynecological age as the best set of predictors for the model. The R-square for this model was .65, with the following partial R-square values for each variable: interaction between preBMI and gestational gain = .48, postpartum use of oral contraceptives = .11, and gynecological age = .06. Results of Model B analysis are shown in Tables A-12 and A-13.

Tables A-14 and A-15 summarize the results of most of the models tested for the prediction of BMIdiff and Wtdiff. In general, the model R-square tended to be higher for the models developed with data limited to subjects with a normal preBMI.

Table A-12. Aposteriori Model B for Prediction of BMIdiff[ab] in White Adolescent Subjects (n=61): Stepwise Selection Results

Variable	Regression Coefficient	P (for step)	Cumulative R-square
BMI at conception x Gestational weight gain	0.0078	.0001	.53
Postpartum smoking	-1.5	.02	.57
Constant	-3.1		

[a] BMI = Body Mass Index = (weight in kg)/(height in meters)^2

[b] BMIdiff = BMI at 12 mos. postpartum minus BMI at conception.

Table A-13. Aposteriori Model B for Prediction of BMIdiff[ab] for White Adolescents with Normal BMI at Conception (n=35): Stepwise Selection Results

Variable	Regression Coefficient	P (for step)	Cumulative R-Square
BMI at conception x Gestational weight gain	0.007	0.0001	0.48
PP oral contraceptive use[c]	-0.26	0.007	0.59
Gynecological age[d]	-0.71	.03	0.65

[a] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[b] BMIdiff = BMI at 12 mos. postpartum minus BMI at conception.

[c] Measured in months of contraceptive use between delivery and 12 mos. postpartum.

[d] Gynecological age = chronological age minus age at menarche.

Table A-14. Summary of Aposteriori Models Developed for the Prediction of BMIdiff[ab] in White Postpartum Adolescents

Model for All Subjects with Sufficient Data	Cumulative R-square	Model for Subjects with Normal PreBMI	Cumulative R-square
Aposteriori Model A[c]		Aposteriori Model A	
PreBMI[d] x Gest. gain (+)	0.51	PreBMI x Gest. gain (+)	0.47
Postpartum smoking (-)	0.55	Oral contraceptive use[e] (-)	0.57
		Prepreg wt loss attempt(+)	0.62
Aposteriori Model B[f]		Aposteriori Model B	
PreBMI x Gest. gain (+)	0.53	PreBMI x Gest. gain (+)	0.48
Postpartum smoking (-)	0.57	Oral contraceptive use (-)	0.59
		Gynecological age[g] (-)	0.65

[a] BMI = Body Mass Index = (weight in kg)/(height in meters)^2.

[b] BMIdiff = BMI at 12 mos. postpartum minus BMI at conception.

[c] Aposteriori Model A was derived from a set of 8 variables, listed in Table 4-35.

[d] PreBMI = BMI at conception.

[e] Months of postpartum oral contraceptive use.

[f] Aposteriori Model B was derived from a set of 9 variables, listed in Table 4-35.

[g] Gynecological age = chronological age minus age at menarche.

Table A-15. Summary of Aposteriori Models Developed for the Prediction of Wtdiff[a] in White Postpartum Adolescents

Model for All Subjects with Sufficient Data	Cumulative R-square	Model for Subjects with Normal PreBMI	Cumulative R-square
Aposteriori Model 1[b]		Aposteriori Model 1	
Gestational wt. gain (+)	0.46	Kcal/kg/day PP (-)	0.50
Kcal/kg/day PP (-)	0.60	Gestational wt. gain (+)	0.65
Waist to hip ratio[c] (+)	0.63	SES at 12 mos. PP[e] (-)	0.73
Oral contraceptive use[d] (-)	0.66	Gynecological age[f] (-)	0.78
		Oral contraceptive use (-)	0.82
Aposteriori Model 2[g]		Aposteriori Model 2	
Gestational wt. gain (+)	0.46	Gestational wt. gain (+)	0.45
Waist to hip ratio (+)	0.57	Oral contraceptive use (-)	0.57
Postpartum smoking (-)	0.60	Gynecological age (-)	0.64

[a] Wtdiff = weight at 12 mos. postpartum minus weight at conception.

[b] Model derived from 23 variables listed on p.208, based on SAS forward selection.

[c] Waist circumference/hip circumference (measured at 12 mos. postpartum).

[d] Months of postpartum oral contraceptive use.

[e] SES = socioeconomic status as calculated by the Hollingshead Four Factor Index.

[f] Gynecological age = chronological age minus age at menarche.

[g] Model derived from same variables as Aposteriori Model 1, except substituting kcal/day instead of kcal/kg/day, and using stepwise selection.

VITA

Brenda Sheffield Stephens was born on June 9, 1954 in Beaumont, Texas. She attended schools in the following cities and towns: Port Lavaca, Texas; Lafayette, Louisiana; Evansville, Indiana; New London, North Carolina; Poços de Caldas, Minas Gerais, Brazil; São Paulo, São Paulo, Brazil; and Henderson, Kentucky. She graduated from Henderson County High School in June, 1972, and received a Bachelor of Science degree in Dietetics from Lousiana State University at Baton Rouge in December, 1975. She also married Mark Stephens in December, 1975, and moved to Knoxville, Tennessee, where she was employed in the food service department at Lakeshore Mental Health Institute until entering graduate school in September, 1980. She received a Master of Science degree in Nutrition Science from the University of Tennessee at Knoxville in August, 1981, then worked as a public health nutritionist in Cookeville, Tennessee until the birth of her son in 1985. From September, 1986 to December 1989, she taught foods and nutrition courses at Tennessee Technological University.

In August, 1989, she re-entered graduate school at The University of Tennessee in Knoxville. Requirements for the Doctor of Philosophy degree were completed in January, 1997. Brenda has been residing in Marietta, Georgia since August, 1993, and has been employed as a public health nutritionist in Dekalb County, Georgia and an instructor in foods and nutrition at Life College in Marietta.