THE MEASUREMENT OF ENERGY EXPENDITURE IN WOMEN PREGNANT WITH TWINS OR TRIPLETS USING INDIRECT CALORIMETRY

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MAY, 1999

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The purpose of this study was to compare the resting energy needs of women who are pregnant with multiple fetuses with protocol recommended caloric intakes. Participant's resting energy needs were measured using indirect calorimetry. A 24 hour dietary recall, an upper arm circumference, a pre-pregnancy BMI, and a weight gain chart were done as well. These data were compared to the outcomes of the twin and triplet pregnancies of the participants.

Participants were recruited from the practice of Dr. Bannie Tabor, MD. There were five women who participated in this study ranging in age from 29-36. Two were pregnant with twins and three with triplets. All were fertility driven pregnancies except one of the triplet pregnancies. Procedures included an initial questionnaire giving number of fetuses, the due date, weeks of gestation, their prepregnancy weight, their current weight, height, whether this was a first pregnancy, their birthdate, activity level, any health issues, and any supplements. It also included a 24 hour

dietary recall. Each time a participant was seen for this study, this information was updated, upper arm measurement was done, a prenatal weight gain chart was maintained, and REE was measured using a Metabolic Cart.

Results of this study did not reflect any valid differences in REE between twin and triplet moms. It did show that the REE was substantially lower in the third trimester than the second even when kcals were high. The real value to outcomes however, was seen in the tracking of their weight gain and caloric intake. Each participant's weight was tracked against ideal weight gain for twin or triplet pregnancies for optimum outcome. When there was a consistant weight gain and caloric intake closely reflecting recommendations, the outcomes of the pregnancies were positive. When a participant had difficulty in gaining weight, the lengths of gestation and outcomes were far less successful.

Currently, accepted protocol for a multiple fetus pregnancy is to track the fetuses through sonogram measurements as a determination for pregnancy development, with little emphasis on maternal weight gain or caloric intake. This study illustrated the need for a much larger and longer study to determine if growth of the pregnant woman herself should be followed more closely and become a valid protocol tool for assisting pregnancy outcomes, especially in multiple fetus pregnancies.

DEDICATION

This research study is dedicated to the wonderful women who participated in this research. These women had been through so much just to become pregnant and were so willling to do whatever they needed to in order to try to have healthy babies. I admire their courage and respect their tenacity.

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CHAPTER I

INTRODUCTION

Historically, multiple gestations only account for about 1% of all births. However, they generate 10% of perinatal mortality and a great deal of morbidity (1). An adequate understanding of etiologies, developmental mechanisms, and possible preventative methods remains an important part of obstetric knowledge. The number of women with multiple gestation pregnancies is rising in this country and around the world. Multiple gestation varies by geographic and ethnic regions. The Yoruba tribe in Nigeria represents the high of 1 in 22 pregnancies and Japan with 1 in 150 pregnancies is the low. The historic rate of twinning in the United States is 1 in 80 pregnancies, in spite of some regional variation (2). Triplets occur in 1 in 6750 live births. Higher order gestations should occur only once or twice in every million pregnancies (2).

Since 1980, twin and multiple gestations of higher order have become more common. In recent years, the advent of ovulation induction (OI), ovarian hyperstimulation (OR) and assisted reproductive techniques (ART) have had a large impact on the incidence of multiple gestations, particularly higher order gestations. Nearly all quadruplet (95%) and higher order multiples and as many as 80% of triplets are initiated through such treatments (3). This increased incidence has brought on significant increases in morbidity, mortality, and severe disabilities compared to singleton gestations. A twin or higher-order pregnancy is definitely considered a high-risk pregnancy (4).

There are two primary ways to approach the etiology of multiple gestation. The first is the endogenous, or natural, rate of twin, triplet and other multiple pregnancies. The second is the exogenous multiple gestation created by ART. In the endogenous setting, twin fetuses result from either the fertilization of two separate ova, creating dizygotic, or fraternal twins, or from the single fertilized ovum that subsequently divides at some time within the first 2 weeks of embryonic life. These twins are monozygotic or identical (2). Two thirds of all natural twins are dizygotic and one third are monozygotic. Their incidence depends on Geography, race, maternal age, maternal past history, and size (2). The identical twinning (monozygotic) is usually considered a chance phenomenon. It is associated with delayed implantation and possible lack of oxygen and nutrients. This theory is believed to explain the higher incidence of malformations compared to dizygotic twins. There is a significant increase in perinatal mortality rate compared to dichoronic placentas (26% versus 9%). Unfortunately, knowledge of embryology for monozygotic twinning is lacking (2). Dizygotic twinning occurs when the follicle-stimulating hormone (FSH) is overstimulated and a surge of luteinizing hormone (LH) results. Infertility therapy raises the serum FSH levels, causing multiple ovulation and multiple births (2).

Perinatal mortality rates (PMR) are significantly higher in multiple gestations, although the rate has been decreasing over the past 20 years. PMR rates for twins are 139 in 1000 births versus PMR for singletons of 33 in 1000 births. The deaths were caused from numerous conditions with the most common one being amniotic fluid infections (16%). The perinatal mortality rate for twins and higher multiples was slightly less in patients undergoing in vitro fertilization (72.7 in 1000 births) (5).

Birth weight seems to be a major contributing factor to the excess morbidity and mortality rates of twins and triplets (6). Although the infant mortality rate in very low birth weight infants of multiple gestation is about half as much as in 1960, it still falls short of the United States health objectives for the year 2000 (7). The singleton target goals are below the objectives as well. However, twins and particularly triplets are significantly below goals compared to singletons (8). Infants from multiple births are at a greater risk for neonatal mortality because of their birth weight distributions and the postneonatal survivors are at higher risk for a birth-related handicap (8).

The mean gestational age of twins at delivery is 36 weeks; for triplets it is 34 weeks and for quadruplets it is 31 weeks. Low birth weight (LBW) and short gestational ages are directly related to morbidity and the subsequent development of moderate and severe handicapping conditions. Multiple gestation birth weights are lower than birth weights of infants from singleton gestations of the same gestational age's (9). However, infants from a multiple gestation are more mature at the same weights as LBW singletons and their survival rates are better (10). Clinical and objective evidence indicates that intrauterine growth retardation (IUGR) is present in as many as 66% of twin infants and is a major factor in neonatal morbidity (11). The risk of IUGR is greatly increased after 38 weeks. Growth patterns are similar for singletons and twins until 30 weeks gestation. Significant differences are observed at 35 weeks (12). The peak growth rate for singletons is about 250 grams per week at 33 weeks compared to 31 weeks for twins. After 31 weeks of gestation, the average twin's birth weight falls significantly behind that of singletons. Neonatal morbidity in twins is comparable to singletons in the absence of IUGR due to the accelerated maturation in twin gestation (13).

Multiple gestation pregnancies significantly increase maternal medical complications compared with singleton gestations. Maternal complications include an increased incidence of hypertension, anemia, abruptis placentae, urinary tract infections, preterm premature rupture of membranes, preterm delivery, and IUGR (2,14). Maternal hypertension in mothers of twins is 2.5 times as likely. This is independent of age, race, weight gain, or weight at delivery. An Abruptis placenta is diagnosed three times more often in mothers of twin's (15). Triplet pregnancies are complicated by a significantly higher incidence of preterm labor and delivery, growth retardation discordance, and necessity neonatal intensive care compared to twin pregnancies (16).

A potentially preventative strategy to offset some of the neonatal and maternal complications is that of an adequate early weight gain (24 pounds by 24 weeks for twin gestation, 34-36 pounds for triplet gestation) and a total weight gain of greater than 45 pounds. An increase of as little as 500 grams in fetal weight can significantly improve outcome (2,17).

Generally, the weight gain with multiple pregnancy is greater and of a different pattern than in singleton pregnancies. Studies indicate that weight gain during a twin pregnancy is higher than the weight accounted for by the additional mass of the second fetus (18). Significant deviations from singleton growth and twin growth begin to diverge at about 30 weeks, and differences become significant by 35 weeks. Inadequate weight gain may limit the full hormonal response to twin pregnancy, whereas excess weight gain may bring on preterm labor and hypertension (18). Research seems to point toward weight gains of 44 lbs. for optimum pregnancy outcomes of twins. The

Committee on Nutritional Status During Pregnancy and Lactation, 1990, recommends 35-45 lbs. The most widely accepted medical protocol for kilocalories per day to achieve optimum weight gain is about 300-500 kilocalories per fetus per day of additional calories (19). However, this recommendation is based on birth outcomes, not actual daily requirements of the mother based on weight gain or BMI. Currently, there are no recommendations on maternal weight gain in triplet and higher-order gestation (20).

Although there is a great deal of data to support the value of ideal weight gains and optimum pregnancy outcomes, no firm numbers have been developed for either singleton or multiple pregnancies. This is mainly due to the difficulty in measuring energy expenditures in pregnant women (20). The ability of an individual to do internal and external work is the definition of energy expenditure (EE). Resting energy expenditure (REE) is defined as basal energy expenditure (BEE) plus approximately 10% increase as a result of being awake and the thermic effect of food. Basal energy expenditure describes the minimal heat production 12-18 hours after ingestion of food and at complete rest measured during sleep, with the subject in the supine position in a thermoneutral environment (21). The resting energy expenditure of an individual accounts for 75-90% of total energy expenditure. Metabolism for the brain, heart, and kidneys accounts for 60-70% of the REE. Resting energy expenditure values are affected by a number of basic factors. Energy expenditure increases with increasing height and weight. Fat-free lean body mass closely correlates with REE, increasing with higher lean body mass. REE decreases with increasing age because fat mass increases as lean body mass diminishes (22).

Various formulas can be used to estimate energy expenditure. Using a calorimeter to measure body heat given off by the body mass is a direct estimation, while an indirect calorimeter (Metabolic Cart) is used for measuring indirectly (23). Indirect calorimetry is the method of measuring in vivo, the type and rate of substrate oxidation and heat production starting from gas exchange measurements. The technique measures oxygen consumption (VO_2) and carbon dioxide production (VCO_2) to calculate resting energy expenditure. Approximately 75-90% of the total energy expenditure (TEE) is accounted for in REE calculations. The remaining 10-25% is accounted for by thermogenesis of food, shivering and physical activity. Consequently, REE is multiplied by 1.1 to 1.3 to calculate TEE (21).

Most indirect calorimeters are open-circuit systems. These systems do not increase the work of breathing, so both ventilated and spontaneously breathing patients can be measured for energy expenditure. The system used for this nutritional assessment is a MEDtech MetaScope Metabolic Analyzer, which is an open-circuit system. The patient breathes room air and expires into the gas sampling system, eventually venting the expired air back into the room. The inspired and expired gas concentration differences and minute ventilation is measured to determine VO_2 (21). The metabolic cart has become a valuable tool in assessing energy expenditure, evaluating the way in which the body uses nutrient fuel, and designing nutritional regimens to fit the patient's needs. The use of this procedure has mainly been seen in trauma patients. However, because of its noninvasiveness and relative ease of measuring, indirect calorimetry is viewed as a tool for clinical research (24).

The metabolic cart is a self-contained mobile unit with a microprocessor and printer that utilizes the principles of indirect calorimetry (25). It measures oxygen consumption and carbon dioxide production by using a pre-programmed value for respiratory quotient, and calculates energy expenditure. It can then be used with an external carbon dioxide analyzer to calculate carbon dioxide production and thus respiratory quotient directly (26). This information may give the patient and her medical team a better understanding of what her individual energy requirements are in order to support optimum pregnancy outcome.

PURPOSE

The purpose of this study is to compare the resting energy needs of women who are pregnant with multiple fetuses with protocol recommended caloric intakes. Participants' resting energy needs will be measured using the Metabolic Cart. A 24-hour dietary recall showing current caloric intakes, an upper arm circumference to assist in the determination of body fat. In addition, a pre-pregnancy BMI to determine low, normal or obese pre-pregnancy body type, and a weight gain chart plotted against recommended weight gain for twins or triplets will be used as well. These data will be compared to the outcomes of the twin and triplet pregnancies of the participants.

OBJECTIVES

1. Measure resting energy expenditure in women pregnant with twins and triplets beginning whenever the patient is first seen by the doctor and continuing once every 2 weeks for a period of 2 months.
2. Document total weight gains of the participants.
3. Document the upper arm circumference and pre-pregnancy BMI of the participants.

4. Compare resting energy expenditures to recommended energy requirements.

5. Compare food intake to weight gain.

NULL HYPOTHESIS

The current protocol for kilocalories during a single or multiple fetus pregnancy is 300-500 kcals per fetus per day for the duration of the pregnancy. Resting energy expenditure of pregnant women with multiple fetuses does not increase during the course of their pregnancy. Weight gain during the course of the pregnancy does not coincide with outcomes of these multiple fetus pregnancies.

CHAPTER II

LITERATURE REVIEW

Nutrition plays an important role in pregnancy outcomes for all populations, and is a powerful, although often unrecognized, mechanism by which to augment intrauterine growth and enhance duration of gestation (27). The importance of proper nutrition during pregnancy is receiving increased attention as perinatal care shifts from crisis to preventative care (28). Although the amount of maternal weight gain during pregnancy is not known, the amount of weight added through the pregnancy has been studied repeatedly. No recommendations for daily kilocalories/kilogram or kilocalories/BMI are provided for singleton or multiple pregnancy (29).

Nutrition and reproduction do not operate within a vacuum. Genetic, social, economic, and other factors inter-relate and make it extremely difficult to identify the independent influence of maternal nutritional status on pregnancy outcome. It is, however, well established that both maternal prepregnancy body mass index and weight gain during pregnancy is determinants of fetal growth. In addition, some studies suggest an association between these factors and preterm delivery as well (30). Underweight women or women with low pregnancy weight gains are at a higher risk of delivering an infant weighing less than 2500 grams. Although the relationship between maternal weight gain and birth weight appears to be weak in very obese women, these pregnancies are at a higher risk for both maternal complications and fetal mortality (31).

There is a large amount of literature on total weight gain during pregnancy. However, much less is known about the pattern of gestational weight gain. Some studies show that the pattern of maternal weight gain is predictive of both fetal size and preterm delivery (31). There is no evidence to suggest that it is safe or appropriate to impose a restrictive diet or encourage weight loss during pregnancy for any pregnant woman (32,33).

During the early 1920's, quantifying and monitoring gestational weight gain became an integral part of prenatal care in the United States. Since then, research on gestation weight gain has mainly centered around three major themes: 1. Influencing the size of the newborn and facilitating delivery 2. Detecting and preventing pregnancy induced hypertension and 3. Preventing maternal obesity after delivery (34). As research became more sophisticated in the early 1950's, gestational weight gain was viewed as a therapeutic measure to correct the mother's pregravid weight deficit, reduce antepartum complications and support fetal growth, which resulted in better birthweights (35). However, total weight gain recommendations for the mother of a singleton have varied through history from a low of 15 lbs. to the current 25-35 lbs. for normal-weight women (35). Pregravid weight and the concurrent Body Mass Index (BMI) of the expectant mother determine whether she is underweight, normal weight, or overweight. Current guidelines define prepregnancy BMI of less than 19.8 as underweight, BMI of 19.8-26.0 as normal body weight, and BMI greater than 26.0 as overweight or obese (figure A, page 31).

The United States ranks 22nd of 28 industrialized nations in infant mortality. The major contributor in two thirds of all infant deaths is low birth weight (36). The importance of appropriate weight gain during pregnancy cannot be overemphasized. The objective of a nutrition and weight gain program in pregnancy is to help ensure the most favorable outcome for both the mother and her infant (28). Animal studies have determined the maternal needs for fetal wellbeing. Observations during historical events, such as famines or food deprivation during times of war have led to the conclusion that maternal nutritional status has a major influence on the pregnancy outcome (37).

Soon after conception, pregnancy causes many physiologic and anatomic changes in the pregnant woman. The complex hormonal mechanisms mediating intrauterine growth may be influenced by increases in body fat during pregnancy. Maternal body weight, including body fat, may affect birth weight through the presence or absence of energy reserves and by influencing the hormonal response to pregnancy. Body fat is a significant extragonadal source of estrogen and storage for steroid hormones. Consequently, inadequate weight gain may limit the full hormonal response to twin pregnancy, whereas excess weight gain may bring on preterm labor and hypertension (9).

Energy and calorie requirements are increased during pregnancy for deposition of new tissue, increased metabolic expenditure, and increased energy needed to move the pregnant body around (37). Weight gain during pregnancy is distributed between the developing fetus and the mother's increase in body fluids and breast tissue. The largest percent of gain is in the fetus, placenta, and amniotic fluid. Maternal fat stores, tissue stores, and blood (36) follow this. A total weight gain of 3 lbs. is recommended for the first trimester of pregnancy and then 1 lb. per week for the remaining trimesters (38). During the second trimester, the gain is primarily in the mother and in the third trimester, it is mostly fetal growth. The first trimester nutritional needs are more qualitative than quantitative. This would mean that the diet of a pregnant woman during this period should be well balanced but not necessarily higher in energy intake (36). Weight gain alone should not be used to determine the adequacy of specific nutrient intakes. The quality, not quantity of the gain may be a more important factor in overall fetal development (39).

The placenta must grow adequately in order to facilitate transfer of maternal nutrients to the fetus (40). A key aspect of fetal growth is not only the rate of change in fetal body weight, but also the changing body composition as gestation advances. The human fetus grows at approximately 1.5% per day (41). During the first trimester, fetal organs develop as well as the central nervous system. Skeletal structure hardens from cartilage to bone. The second trimester sees continued growth and development. Teeth calcify and at 24 weeks the fetus can survive outside the womb. During the third trimester, the fetus continues to grow, storage of iron and other nutrients occurs, and there is the development of necessary fat stores (40). Most women gain an additional 7 to 10 lbs. of fat as part of their total weight gain during pregnancy. Accumulation of this extra fat begins early in pregnancy, reaches a maximum during the second trimester and is completely absent during the last trimester. This is opposite to the growth pattern of the fetus (42).

Profound alterations in fetal metabolism are associated with pregnancy. Circulating levels of glucose and amino acids are reduced while levels of free fatty acids, ketones, and triglycerides are increased. In addition, insulin secretion is augmented in response to glucose load. This metabolic profile has been characterized as "accelerated starvation" (43). The developing fetus meets its fuel requirements primarily by glucose. This nutrient both provides the energy necessary for protein synthesis and serves as a precursor for the synthesis of fat and the formation of glycogen. The human neonate has a glucose turnover rate that is almost double that observed in the normal adult (43).

Next to gestational age, a woman's weight prior to pregnancy and the amount of weight gained through pregnancy are the two strongest determinants of the infant's birth weight (44). The optimal amount of weight gain during pregnancy is not known. Recently, the Committee on Nutritional Status during Pregnancy and Lactation revised its previous weight gain recommendations of 22-26 lbs. to be based on the patient's prepregnancy weight status. It is suggested that women of normal prepregnant weight should gain 25-35 lbs., underweight women should gain 28-40 lbs., and overweight women should gain 15-25 lbs. (28). Prior to 1960, weight gain was restricted to less than 15 lbs. (40). The percentage of low birthweight is highest among women with lowest pregravid weights and lowest gestational weight gains. However, with weight gains of 26 lbs. or more, the differences between maternal pregravid weight categories no longer exist (27). Higher gestational weight gains exert the greatest effect on the birthweights of underweight women. Among term births, mean birthweight of about 3400 grams was achieved with weight gains of 36 lbs. or more in underweight women. This compared to 21-25 lbs. in normal-weight women, and 16-20 lbs. in overweight women (45). Maternal pregravid weight and the rate of gestational weight gain are each independently associated with birthweight and length of gestation. Inadequate early rate of gain (<9.5 lbs. by 24 weeks) is associated with an increase risk of small-for-gestational-age birthweight. Inadequate late rate of gain (<0.9 lbs./week after 24 weeks) is associated with a significant increase in preterm delivery (27).

The total energy requirement of pregnancy varies. Estimates range from 55,000 kcals to 80,000 kcals during the course of the pregnancy (28,30). This would reflect an increase in caloric intake by 150kcal/day during the first trimester and 350kcal/day for the remaining two trimesters for the lower total range, to 300kcal/day for the entire pregnancy for the higher range. These varying results suggest that not all pregnant women need to increase their energy substrate intake as much as previously believed. In addition, overall nutrition seems more important than caloric intake alone (30,39).

The number and proportion of all births to women over the age of 30 continues to rise. The rate of low birthweight infants rose slightly to 7.2% between 1992-1993. This occurred mainly among white infants of multiple birth (46). The incidence and type of twinning worldwide vary by a number of maternal characteristics including age and race, especially with dizygotic (DZ) twinning. Ethnic groups in the U.S. with the highest incidence of twinning are Blacks (25.8%), Alaskan natives (24.9%), and whites (19.6%) (47). The multiple birth ratios for women aged 30-34 are more than twice that of women under the age of 20. The proportion of twin births to women aged 35 and older has doubled between 1982 and 1992. Several studies have reported that twinning rates are higher among overweight and obese women (48,49). In addition, mothers of multiples had an earlier age at menarche and shorter menstrual cycles. Obese women have elevated levels of circulating estrogen, and presumably higher levels of follicle stimulating hormones which increases with twinning (50).

Twins are 5 times more likely to be born preterm (<37 weeks) than singletons and 8.5 times as likely to have low birthweight (<2400 grams) (27). The intrauterine growth of singletons and twins, as measured by birthweight, diverges from about 30 weeks of gestation. Significant differences increase from the 35th week to delivery. After 31 weeks of gestation, twin birthweight falls progressively behind that of singletons. Twins born at 40 weeks gestation are usually lighter than those born at 38 and 39 weeks (27).

Adaptation to multiple pregnancy is in many ways an exaggerated version of the maternal response to a singleton pregnancy (47). The trigger to the physiologic response is hormonal. These hormonal changes in multiple pregnancy also result in alternations in metabolism. Changes in the cardiovascular system are some of the earliest physiologic adaptations that take place in the pregnant woman. Singleton pregnancies see the mean arterial blood pressure decrease from early in the pregnancy and continuing until late in the second trimester. At that point, the arterial blood pressure begins to rise and continues that pattern until term, returning to the woman's prepregnancy blood pressure. Diastolic blood pressures are even lower in the second trimester for twin gestations and exhibit a greater increase near term. The twin gestation systolic pressures are similar to those of singletons throughout the pregnancy. The increase in maternal heart rate of about 15% is similar in both twin and singleton gestations (51).

Blood volume increases significantly in pregnancy with singleton pregnancies increasing by 48%, twin pregnancies by 67% and triplet pregnancies by 96%. The total maternal red cell volume only increases by approximately 25%, beginning in early pregnancy and continuing until term. Consequently, the disproportionate increase in plasma volume versus red cell volume causes the hematocrit of the pregnant woman to drop (51). A higher incidence of iron deficiency and folic acid deficiency is more common in multiple gestation pregnancies because of this large plasma volume increase. However, the incidence of clinically significant anemia is usually not found (51).

Uterine growth patterns for the first trimester is similar in singleton and multiple pregnancies. However, the intrauterine volume of twin pregnancies is two times that of a singleton by 18 weeks of gestation. By 25 weeks, the intrauterine volume of a twin pregnancy is equal to a full-term singleton. Triplet and higher order gestations have an even greater intrauterine volume (53).

Increases in maternal serum cortisol, aldosterone, and free thyroxine are associated with both singleton and multiple fetus pregnancies. Maternal serum human chorionic gonadotropin (hCG) was 2.5 times higher in multiple gestations compared to singleton pregnancies. The human placental lactogen (hPL) is also higher. Maternal progesterone levels in twin pregnancies is double that of singleton pregnancies. Serum estradiol, estriol, and alpha-fetoprotein levels are all about 2-2.5 times higher in multiple fetus pregnancies compared to singleton (54).

Respiratory rate does not increase during pregnancy. However, the volume of air breathed per minute increases 40%. This is accomplished by a similar increase in tidal volume. The tidal volume is believed to be greater in twin pregnancies as compared to singleton. There is a 20% decrease in residual volume in both twin and singleton pregnancies (54).

During the early stages of pregnancy, many women experience nausea and vomiting which is commonly referred to as morning sickness. Most women experience relief from these symptoms by the end of the first trimester and an increase in appetite develops. This pattern seems similar whether it is a singleton or multiple pregnancy (34). Gastric changes that do appear to differ is in the alimentary system where the changes seem to be exaggerated in multiple pregnancies and in the rate of excretion of sulfobromophthalein from liver cells to bile. In a normal singleton pregnancy, this excretion process is decreased. However, in a multiple pregnancy, the rate of excretion is even slower. The rate of the transfer of sulfobromophthalein from plasma to the liver cells is increased in twins. This is probably due to the increase hepatic blood flow (54).

Because there is an increase in renal blood volume, the kidneys increase in size during pregnancy. Beginning in the first trimester, the glomerular filtration rate increases. By 20 weeks, the creatinine clearance rate increases by 50%. This filtration rate is even higher in multiple pregnancy (55).

There is normally a decrease in the maternal fasting blood glucose rate in a singleton pregnancy. In mothers of twins, the fasting blood glucose levels are significantly lower. However, the glucose levels in twin pregnancies after one, two, or three hours of the glucose tolerance test are not significantly different from singleton pregnant mothers (55). The incidences of hyperglycemia and hypoglycemia are usually higher in mothers pregnant with twins. However, one study showed blood glucose levels and insulin levels are usually lower than mothers pregnant with singletons suggesting that twin gestations do not place the mother at a higher risk for gestational diabetes (5).

Maternal weight gain varies widely in a singleton pregnancy. Beginning early in a pregnancy, multiple fetus pregnancies generally gain more weight during the course of the mother's pregnancy (56). The ideal twin pregnancy has been described as having a weight gain of greater than 8/10 lb. per week until 24 weeks' gestation, increasing to 1 lb. per week or more until term. Improved intrauterine growth has been associated with this ideal pattern, especially with good weight gain before the 24 weeks (12). In twin gestations, birthweight is better correlated with maternal weight gain than maternal height or pregravid weight (12).

The weight gain recommendation from the Institute of Medicine for mothers of twins is about 1 1/2 lb. per week during the second and third trimester for a total weight gain of 35-45 pounds (57). For mothers of triplets, the recommendation is 45-50 lbs. by 34 weeks. A weight gain of over 50 lbs. is recommended for quadruplet pregnancy (57).

The ideal caloric intake for pregnancy is not clear. The current protocol recommends that women pregnant with singletons consume 2400kcal per day. This equates to about 300-500 additional kcals/day for most women's pregravid diets (58). There is no generally agreed upon standard for twin or higher order pregnancies. The most common recommendations are 300-500 kcals/day per fetus or 2800 kcals/day for a twin pregnancy, and 3200 kcal/day for triplet's (57). Generally, the weight gain with multiple pregnancy is greater and of a different pattern than in singleton pregnancies (47).

Theoretically, the nutritional needs of the woman pregnant with more than one fetus should increase because she has both a larger volume and a greater fetoplacental mass. Studies to date indicate that weight gain during a twin pregnancy is higher than the weight accounted for by the additional mass of the second conceptus (28). Weight gain in the first trimester is usually much higher in mothers with twins. On average, women with twins gain 32.1 lbs. compared to 24.4 lbs. for singletons. The maximum rate of gain in twin pregnancy occurs during early and late weeks of gestation compared to mid-gestation for singletons (49). However, there has been no formal evaluation of needs and specific guidelines have not been developed (59). There is much less data and currently no recommendations on maternal weight gain in triplet and higher-order gestation (47). An average maternal weight gain of 1138 mothers of triplets was 45.1 lbs. in 33.8 weeks of gestation. Consequently, the recommended weight gain for triplet pregnancies is 36 lbs. by 24 weeks and a rate of gain of 1.25 lbs./week thereafter (20).

Nutritional needs for twin pregnancies are unlikely to be doubled (57). Inadequate weight gain, particularly during the first half of pregnancy, has been shown to be a risk for preterm birth in both singleton and twin pregnancies (42). In the outcome of twin births delivered at term, there is a positive linear relationship between gestational weight gain and infant birth weights in women who were underweight or normal weight before conception (45). There was no similar relationship for those women who were overweight or obese. The proportion of low birthweight infants declined as pregravid weight increased. The mean gestational weight gain of underweight women who delivered twin infants at term with the lowest perinatal mortality was 44.2 lbs. The corresponding figure for normal pregravid weight women was 40.9 lbs. (45). Regardless of maternal pregravid weight, twin birth weight >2500 grams was associated with higher maternal weight gains at 24 weeks gestation, higher rate of gain and total gain, shorter newborn length of hospital stay, and higher birth weight rations (47). Total weight gain of 40-45 lbs. and a rate gain of 1.25 lbs./week were significantly associated with higher twin birth weights and better intrauterine growth for gestational age. The recommended rate of gain for twin gestation is 24 lbs. by 24 weeks and 1.25 lbs./week thereafter (36).

This compares to a singleton pregnancy recommendation of a total of 3 lbs. for the first trimester, and thereafter a steady gain of about 1 lb./week (28).

The prediction of caloric requirements is very difficult because of the tremendous variability in resting energy expenditure of individuals (60). This is especially true during pregnancy (61). How fluid weight and dry weight are distributed in multiple gestations has not been studied (61). There are several components of energy expenditure. They are: Basal energy expenditure (BEE) or basal metabolic rate (BMR), Diet induced thermogenesis (DIT) or specific dynamic action (SDA), Resting energy expenditure (REE) or resting energy metabolism (REM), Activity energy expenditure (AEE), and Total energy expenditure (TEE). By definition, the equation is: REE = BEE + DIT and TEE = REE + AEE (62). Indirect calorimetry is a valuable tool for assessing these components of energy expenditure, evaluating the way in which the body uses nutrient fuel, and designing nutritional regimens that best fit the clinical condition of the patient (63). It is primarily concerned with fuel needs and the ratio of gas exchange to the oxidation of a given food (62,63).

There are many indirect calorimetric instruments available. Various companies manufacture metabolic measurement carts. They are microprocessor-based systems that can be used in the exercise, canopy, and bedside modes. The cart is a self-contained mobile unit and can measure to within 0.01% accuracy. The instrument provides VO_2, VCo_2, and Ve graphically on a video screen and prints hard copies from an attached printer (26). Although it is very safe and non-invasive, apparently the cart has not been used before to measure energy expenditures of pregnant women. This computer measures oxygen consumption and by using either a preprogrammed value for respiratory quotient or, when used with an external carbon dioxide analyzer and calculating carbon dioxide production, calculates energy expenditure (41).

CHAPTER III

METHODS

The participants were recruited from the practice of Dr. Bannie Tabor, MD. Dr. Tabor is a board-certified perinatologist in Tarrant County, Texas. His practice only sees high-risk pregnancy patients. There are usually six to eight twin and triplet pregnancy patients at any given time in this practice.

An approval was obtained from the Human Studies Review Committee (appendix A) and a metabolic cart was located for the study. The doctor wanted all testing to be done in his office so his supervision would be easily accessed, and the cart would be out of the flow of office traffic. The investigator began seeing potential participants in October 1997 during their regular doctor appointments.

There were nine women pregnant with multiple fetuses at the time the final study began. Five of these women were pregnant with triplets and four with twins. The subjects ranged in age from 28-46. All were non-smokers. Only one participant had not used some infertility treatment to get pregnant.

The gestational age of the participants at the time that the study began ranged from 16 weeks to 34 weeks.

The investigator met with each woman during her regular office visit and explained that the study was to measure resting energy expenditure in women pregnant with multiple fetuses using a metabolic cart to determine their actual energy use. If the woman was interested in participating, the investigator went over the consent form (appendix B), gave the subject the option of taking it home with her to further review it, and requested that it be signed and returned to the investigator before the subject's next appointment. The investigator provided a stamped and addressed envelope. The only exclusion criterion for participating in the study was if the subject smoked or had smoked for up to a year prior to becoming pregnant. Smoking effects a person's metabolic rate. Eight of these women were interested in participating and met the non-smoking requirement. Three of the eight did not complete the consent form for various reasons. Consequently, a total of five women participated in the study.

The Human Subjects Review Committee had approved this study and had recommended the consent form that was the form provided. After the completion of the consent form, the actual procedure for the study was explained to the patient. The patient was encouraged to ask any questions or voice any concerns about what this study would involve. The researcher then discussed the metabolic cart itself and how it worked. The MEDtech MetaScope Metabolic Analyzer was the cart that was used for this study. This cart was a compact, stand-alone instrument mounted on a mobile-cart making it a complete, portable and easy-to-use indirect calorimeter system. Operation of the MetaScope was organized into three basic areas: Test, Report and Utility. The test section obtains and analyzes samples from the patient, generating the data that will be used in the Reports. The Utility section supports various system functions such as sensor calibration and archiving of patient files onto a host system. The system incorporates an infrared touch-sensitive screen, which guides the user through the instrument's operations. Two gas tanks were located on the rear of the MetaScope and were used to calibrate the instrument. Tank one contains 100% N_2; the other one contains 95% O_2 and 5%CO_2 (62).

The procedures related to participation of the subjects began with an interview process at which time a questionnaire was completed (Table 1, page 30). Questions included: number of fetuses, the due date, weeks of gestation, their prepregnancy weight, their current weight, height, whether this was a first pregnancy, their birthdate, activity level (active, moderately active, sedentary), any concerning health issues, and any supplements taken. It also included a 24-hour diet recall. A dietary analysis was performed using Nutritionist IV software. The participant's right upper arm circumference was taken using a tape measure. A prenatal weight gain chart (Figure A, page 31) was begun for

Table I

Chart for Recording Dietary Information

Appointment Date ______________

Name _______________________ # Fetuses _____ Due Date _______

Weeks Gestation ______ Prepreg. Wt. __________ Current Wt. ________

Height ________ Arm Measurement _________ First Pregnancy _______

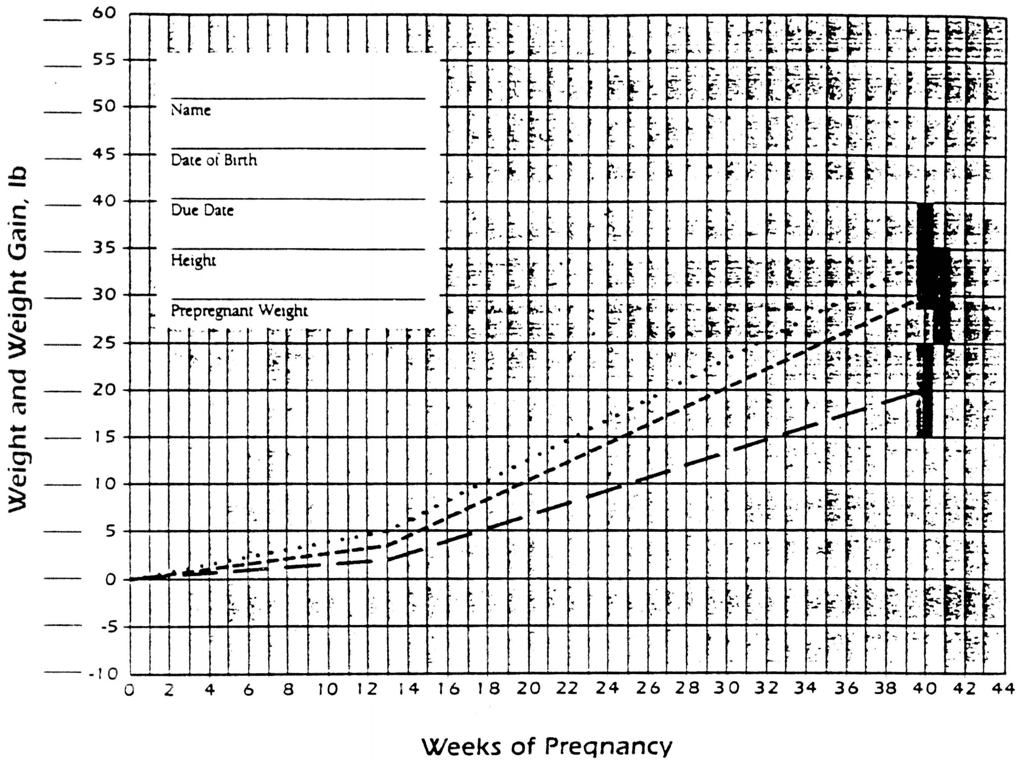
Birthdate __________ Activity Level ________ Health Issues _________

Vitamin Supplements ____

24- hour diet recall	Amount	Time Eaten	Preparation
Breakfast			
AM Snack			
Lunch Food			
PM Snack			
Dinner			
Bedtime Snack			

Prenatal Weight Gain Chart in Pounds

Prepregnancy BMI <19.8 (· · · · · · ·), Prepregnancy BMI 19.8–26.0 (Normal Body Weight) (- - - - - -), Prepregnancy BMI >26.0 (—— ——)



Weight Record

Date	Weeks of Gestation	Weight	Notes

Please bring this chart with you to each prenatal visit.

Food and Nutrition Board, Institute of Medicine, 1992

Figure A. Record for Prenatal Weight Gain each participant (IOM Prenatal Weight Gain Chart 1992, for singleton pregnancies). No published weight gain charts for multiples were available. The chart was in pounds and was based on prepregnancy BMI. The pregravid weight-for-height status of each participant was characterized as underweight (BMI <19.8), normal weight (19.8-26.0), or overweight (BMI>26) (Figure B, page 33). The participants were advised that they would need to refrain from eating anything for two hours prior to their appointment for the REE measurement using the Metabolic Cart.

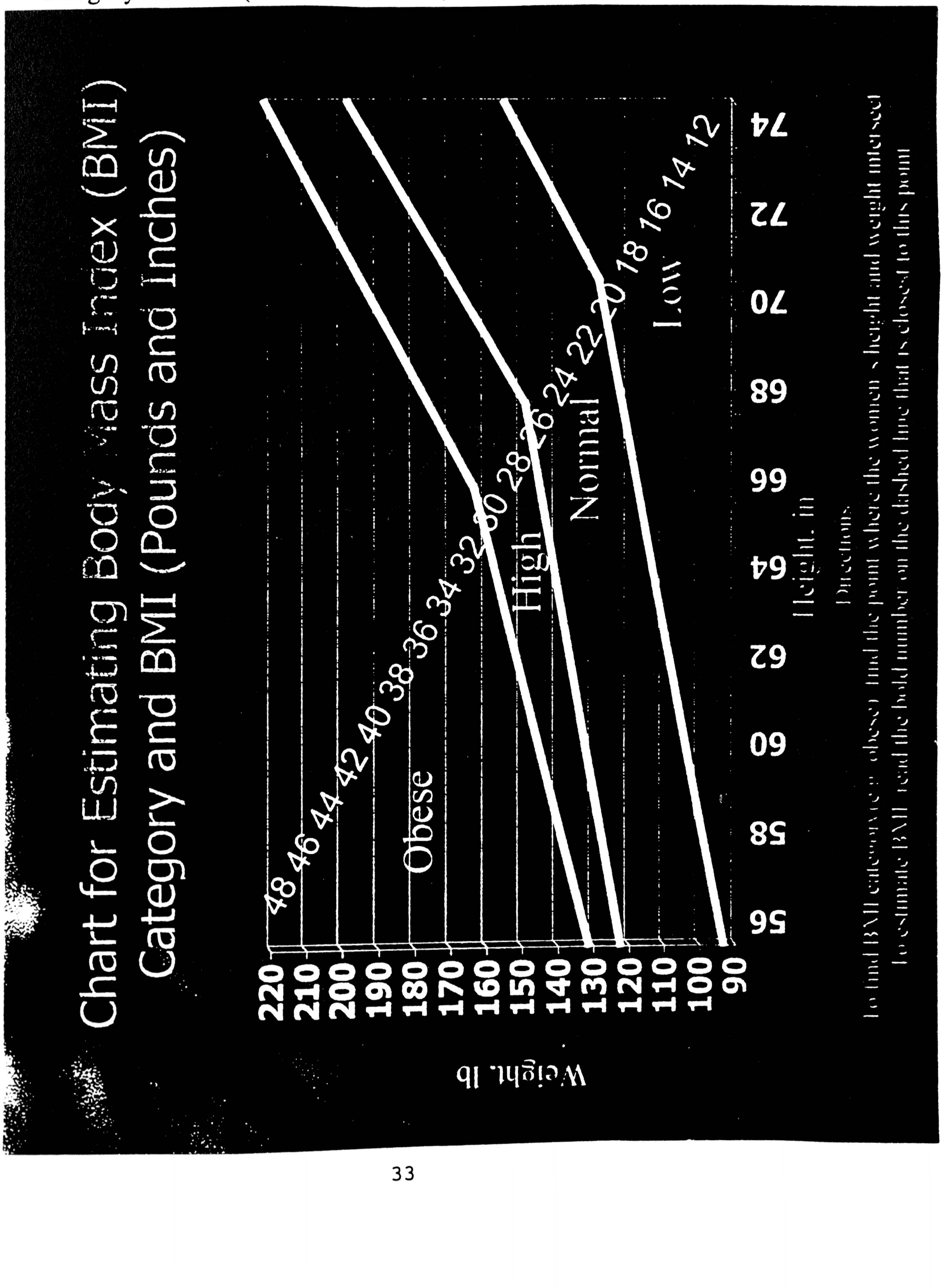
The measurements of energy expenditure were provided to the patient free of charge. There were no rewards, remuneration, or other incentives offered. No medical services were provided. The entire interview was completed at Dr. Tabor's office during the patient's regular check-up time.

The total time commitment for the subjects involved varied. Approximately 20 minutes was devoted to the initial interview, and then a maximum of approximately 30 minutes per measurement was needed for the actual testing procedure. The testing was begun once the signed consent form was returned. This usually occurred by the participant's next scheduled appointment. The investigator usually saw the subject after her appointment with the doctor. The metabolic cart was turned on approximately 20 minutes before the testing began. A patient file was created in the cart. This file

Figure B

Chart for Estimating Body Mass Index (BMI)

Category and BMI (Pounds and Inches)



contained her assigned identification number, date of birth, age, sex, height, weight, doctor's name, and test type (mask). The participant was take to the doctor's office, seated and made comfortable. She was asked when she last ate and what. While resting, the initial questionnaire and prepregnancy weight gain chart were updated. The participant's right upper arm was again measured and the 24-hour dietary recall was completed. The participant was then asked to put the MEDtech mask over her nose and mouth, adjust the straps for a snug fit and to begin breathing normally.

Oxygen consumption and carbon dioxide production were collected for a maximum of 20 minutes. The first 3 to 5 minutes were used as an equilibration period. This recalibration time was recommended by the manufacturer because the initial breathing of a subject is not always at a resting level and could give inaccurate readings. Data was printed minute by minute. When five consecutive minutes of data remained relatively flat, the data was considered valid, and the test was complete. This usually took a total of about fifteen additional minutes after the recalibration time. Once the test was complete, the participant removed the mask and rested for 1-2 minutes before getting up. The information was saved in the cart. The total time spent for each test period was about 30 minutes. Before each testing, the metabolic cart was calibrated against standard air. After each test, the mask and air tube were washed with antibacterial soap and water and air-dried thoroughly. A dietary analysis was then performed on the current 24-hour diet recall using Nutritionist IV software.

Table 2

Data Collected From Subjects

Weeks of Gestation	Interviewed	24 hr. Recall	Calorimetry	Delivery
13	A	A		
14	D	D		
15	B			
16		D	D	
17		A	A	
18				
19				
20				
21				
22				
23				
24				
25	E	E		D
26		B	B	
27		E	E	
28		B	B	
29				A
30				
31	C			
32				
33		C	C	B,E
34				
35		C	C	
36				
37				C

CHAPTER IV

RESULTS AND DISCUSSION

There were several problems encountered during the course of this study. The first one was to locate a portable metabolic cart that could be leased for the time frame of the study. Numerous companies were contacted. Unfortunately, the medical supply industry seldom leases portable carts due to high demand. Finally, a company in Colorado was located and they agreed to lease a used portable metabolic cart for six months at a slightly reduced leasing fee. The company was Trail Ridge Products. They sent the cart in September of 1997. The manager of Trail Ridge was very supportive, but was limited as to how much he could provide in the way of assistance or technical support. Once the MetaScope arrived, a portable cart and printer had to be purchased. Then the training had to be set up. Fortunately, the designer of the software that this particular cart used was a sales representative located in Oklahoma. He traveled to the Dallas/Fort Worth area monthly and a meeting was set up as soon as possible. He was gracious enough to spend half a day training the investigator.

The equipment was placed in the doctor's office at his practice. Although the cart was portable, it took up about a sixth of his office and had to be left there continually for the duration of the study. Initially, six subjects with multiple fetus pregnancies were interested in participating in the study and their initial interviews were begun in November 1997. The first REE measurements were conducted on these subjects in December 1997. In January 1998, the equipment began malfunctioning due to the unusually high humidity and a part had to be ordered. Unfortunately, the company was in the process of being bought by another medical Supply Company and no parts could be shipped until the merger was complete. The necessary part was shipped in late February 1998. The original data was invalid because of the gap in time, some inaccurate data was collected before the malfunctioning part was discovered, and all participants had since delivered. The study had to start over.

The doctor had been very supportive of this study, but he was ready to get the equipment out of his office. In addition, there were no funds available for any additional equipment rental. It was agreed that the study would be complete by June 1, 1998. Fortunately, Trail Ridge Products was very understanding and allowed the rental to extend for the additional time at no additional cost.

A total of eight patients agreed to participate in the study and met the non-smoking requirement. Five of these women were pregnant with triplets and three with twins. All but one had been using some form of fertility drug or treatment. Two of the subjects delivered before their first measurement with all fetuses being stillborn. One subject missed two appointments, so data were never collected. That left five women who participated. The remaining participants were all taking prenatal vitamins as well as a calcium supplement. Subject E was the only one that seemed to be concerned about gaining too much weight. Although studies suggest that term for multiples is less than 40 weeks (37 for twins, and 34 for triplets), all of these women were measured based on 40 weeks gestation as term because that was how the doctors measured them.

Testing was done at the patient's regular check-up time, and her pregravid BMI was determined at the first interview (Figure B, page 33). Each time the participant was seen, a 24-hour dietary recall was done, her weight was measured, and her Weight Gain Chart was updated. The participant's right upper arm was also measured to determine fat increases. Some research suggests that the upper arm circumference is a simple way to monitor excess body fat changes (42). None of the subjects' arm circumferences changed during the course of the testing time frame of three months. The subjects had refrained from eating for approximately two hours prior to testing. Only water was consumed. All of the REE test results for each participant showed them to be in a hypermetabolic state, which is defined as >24% above predicted REE using Harris Benedict equation.

Patient A was a 36 year old Caucasian female. She was 5'1" tall and her prepregnancy weight was 132. She was pregnant with triplets. This was her first pregnancy, although she had been undergoing fertility treatments for two years. Her activity level was low, her BMI was 25, which is in the normal range, and she exhibited no health problems. Her due date was 10-27-98; she weighted 142.5 at 13.5 weeks gestation when the first interview took place. Her 24-hour dietary recall showed 1428 kcals (Table 3, page 40). The recommended dietary protocol would be approximately 1340 plus 300 kcals per fetus or 900 additional kcals. The first time she was measured on the metabolic cart, she was 17 weeks pregnant and her dietary recall showed 2705 kcals. She weighed154 lbs. and her REE using the cart measured 1693 kcals. Her weight was charted on the Weight Gain graph (Figure C, page 41). She delivered 8-13-98 at approximately 29.5 weeks gestation and weighed approximately 195 lbs. Baby A1 was a male weighing 3 lbs. 13 ounces, Baby A2 was a male weighing 3 lbs. 2ounces, and Baby A3 was a female weighing 2 lbs. 14 ounces. Babies were delivered via Caesarian section. After five weeks in neonatal care, babies went home. Total weight gain for subject A's pregnancy was 63 lbs.

Patient B was a 35 year old African American female. She was 6'2" tall and her prepregnancy weight was 153. She was pregnant with triplets that were spontaneous. This was her second pregnancy. She was very active, her BMI of

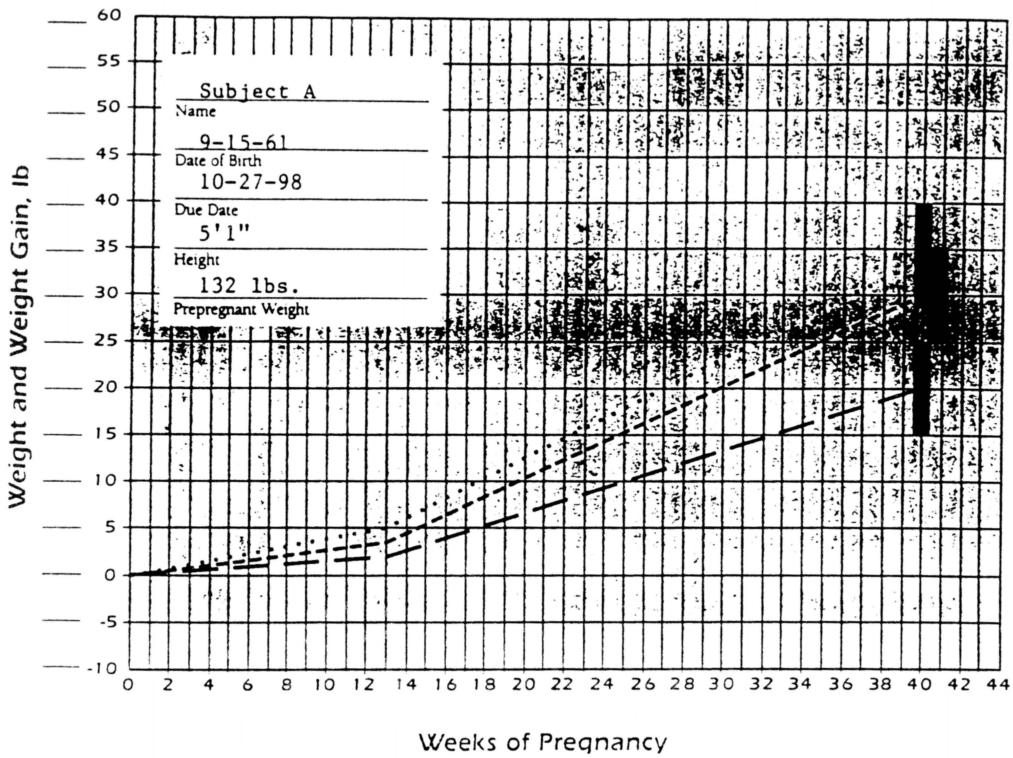
Table 3

Calorie Intakes of all Pregnant Women Subjects from 24-hour Dietary Recall

Subject	24-Hour Recall #1	24-Hour Recall #2
A	1428 kcals	2705 kcals
B	1677 kcals	2423 kcals
C	2032 kcals	1952 kcals
D	1743 kcals	1992 kcals
E	1672 kcals	2152 kcals

Prenatal Weight Gain Chart in Pounds

Prepregnancy BMI <19.8 (· · · · · · ·), Prepregnancy BMI 19.8–26.0 (Normal Body Weight) (-25---), Prepregnancy BMI >26.0 (— —)



Weight Record TRIPLETS

Date	Weeks of Gestation	Weight	Notes
	13.5	142	10.5
	17	154	22
	19	160	28
	20.5	162.5	30.5
	23.75	171	39
	25.75	184	52
	27	188	56
	27.5	191	59
	29.33	197	delivered

Please bring this chart with you to each prenatal visit.

Food and Nutrition Board, Institute of Medicine, 1992

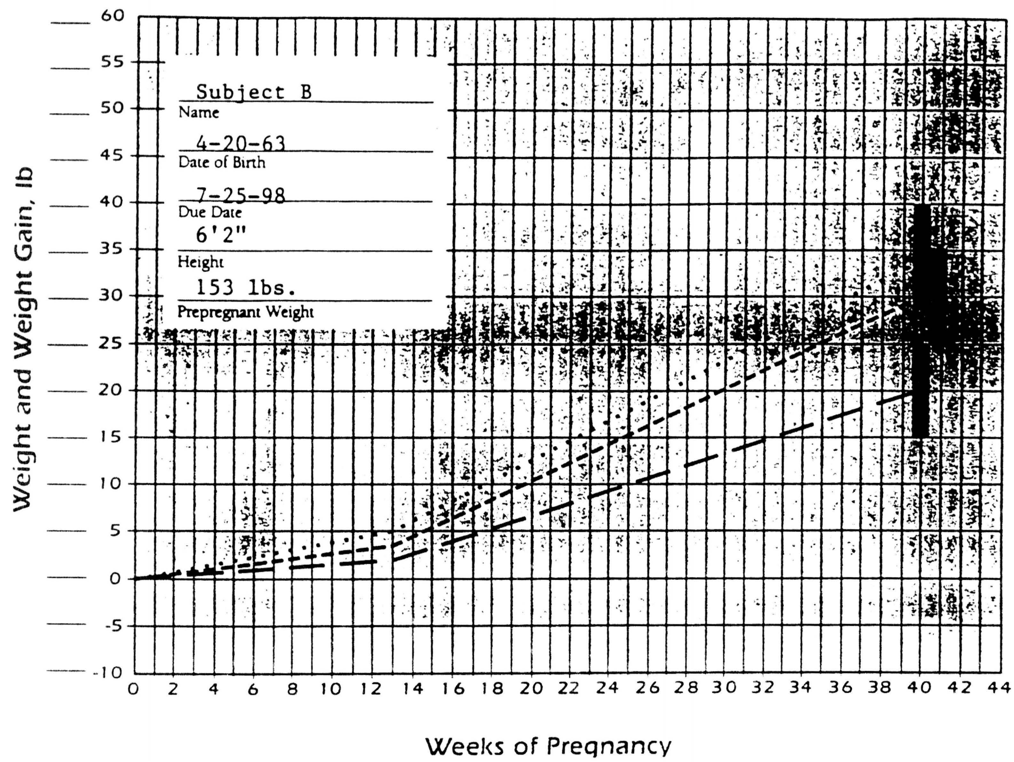
Figure C. Prenatal Weight Gain for Subject A

20.5 was in the low range of normal, and she had no health issues. Her due date was 7-25-98 and she was 26 weeks pregnant when she was first tested. Patient B's recommended daily kcals were approximately 1420 plus 300 per fetus (900 kcals). Her 24-hour dietary recall reflected food intake of 1677 kcals. (Table 3, page 40). The first test showed the subject's REE kcals to be 1859 and her weight was 180. The second test was done at 27.5 weeks of gestation and the REE was 1903 kcals and her weight was 181. The dietary recall showed food intake of 2423 kcals. Her weight was charted on the Weight Gain graph (Figure D, page 43). She was hospitalized 5-15 (30 weeks gestation) for preterm labor and delivered 6-10-98 at approximately 33.5 weeks gestation. Her weight at 5-15 was 186 lbs. She gained an additional 5 pounds while hospitalized. Male Baby B1 weighed 3 lbs. 14 ounces, male Baby B2 weighed 4 lbs. 12 ounces, and male Baby B3 weighed 3 lbs. 10 ounces. They remained in neonatal care about two weeks and then went home. They were delivered via Caesarian section. Participant B had a pregnancy total weight gain of 38 lbs.

Patient C was a 34 year old Caucasian female. She was 5'0" and her prepregnancy weight was 100. She was pregnant with twins. This was her first pregnancy and fertility treatments were involved. She considered herself to be moderately active, her BMI was 19.5, in the high range of low and she had no health issues. Her due date was 6-8-98 and she was 33 weeks pregnant when

Prenatal Weight Gain Chart in Pounds

Prepregnancy BMI <19.8 (. . .19.6.), Prepregnancy BMI 19.8–26.0 (Normal Body Weight) (------), Prepregnancy BMI >26.0 (— —)



Weight Record TRIPLETS

Date	Weeks of Gestation	Weight	Notes
	14.75	163	10
	25.75	180	27
	27.75	181	28
	30	186	33
	33.5	191	delivered

Please bring this chart with you to each prenatal visit.

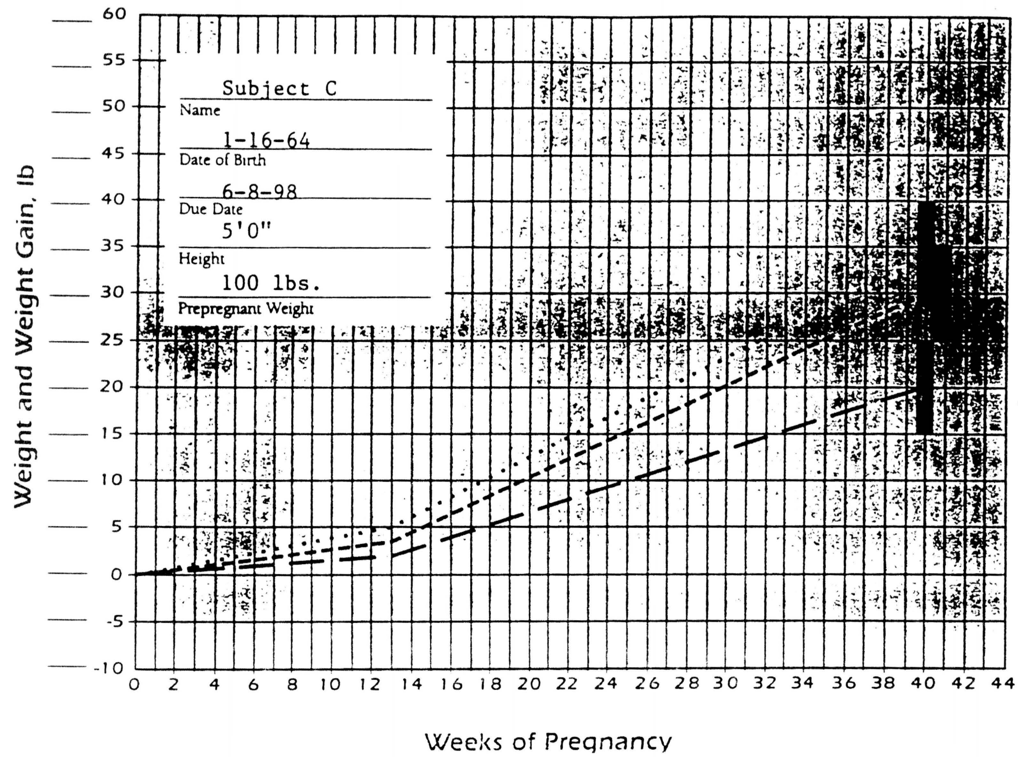
Food and Nutrition Board, Institute of Medicine, 1992

Figure D. Prenatal Weight Gain for Subject B first tested. The subject's weight was 132 and her REE measured 1283 kcals. Her protocol dietary intake would be approximately 1320 plus 300 kcals per fetus (1920 kcals total). The 24-hour dietary recall showed 2032 kcals (Table 3, page 40). The second test was done at 35.5 weeks of gestation, the weight was 135 and the REE measured 1389 kcals. Her weight was charted on the Weight Gain chart (Figure E, page 45). The 24-hour dietary recall showed food intake of 1952 kcals. Patient C delivered 5-18-98 at approximately 37 weeks gestation and weighed approximately 136 lbs. Labor had to be induced. Male Baby C1 weighed 4 lbs. 10.5 ounces; female Baby C2 weighed 4 lbs. 15.5 ounces. Both babies went home with the mother after 5 days of hospitalization. Subject C had a pregnancy total weight gain of 36 lbs.

Patient D was a 31-year-old Hispanic female. She was 5'2" tall and her prepregnancy weight was 123. She was pregnant with triplets from fertility treatments. She was relatively active, her BMI was 22.5, in the normal range, and she had no health issues. Her due date was 11-2-98 and she was first seen at 14 weeks weighing 142 lbs. The subject's recommended dietary intake protocol was 1350 plus 300 kcals per fetus (2250 kcals total) and her 24 hour dietary recall reflected 1743 kcals. (Table 3, page 40). She was 16 weeks pregnant when tested on the metabolic cart. The participant's weight at the time of the test was 144 lbs. and her REE measured 1949 kcals. Her weight was charted on the Weight Gain chart (Figure F, page 46). The 24-hour dietary

Prenatal Weight Gain Chart in Pounds

Prepregnancy BMI <19.8 (. . . 19.6 . . .), Prepregnancy BMI 19.8–26.0 (Normal Body Weight) (- - - - - -), Prepregnancy BMI >26.0 (— —)



Weight Record

TWINS

Date	Weeks of Gestation	Weight	Notes
	33.75	132	32
	34.5	134	34
	35.5	135	35
	36.5	136	36
	37	136	delivered

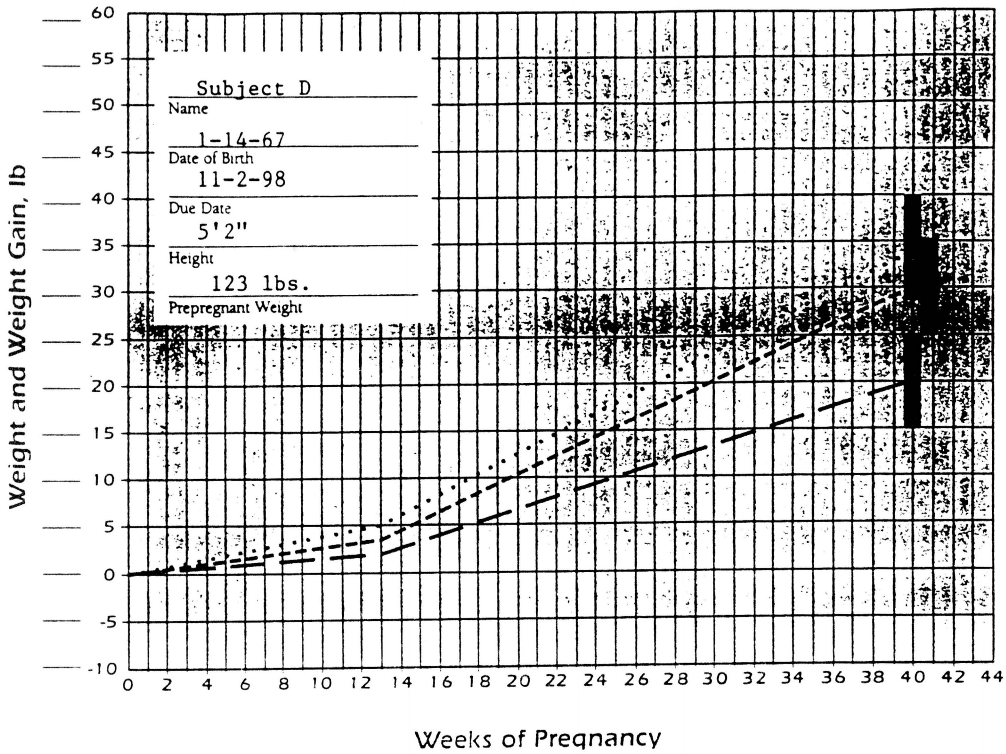
Please bring this chart with you to each prenatal visit.

Food and Nutrition Board, Institute of Medicine, 1992

Figure E. Prenatal Weight Gain for Subject C

Prenatal Weight Gain Chart in Pounds

Prepregnancy BMI <19.8 (· · · · · · ·), Prepregnancy BMI 19.8–26.0 (Normal Body Weight) (- - 22.5 - -), Prepregnancy BMI >26.0 (— —)



Weight Record — TRIPLETS

Date	Weeks of Gestation	Weight	Notes
	16	144	21
	18.5	150	27
	19.75	155	32
	21	154	31
	21.75	154	31
	22.75	155	32
	25	155	delivered

Please bring this chart with you to each prenatal visit.

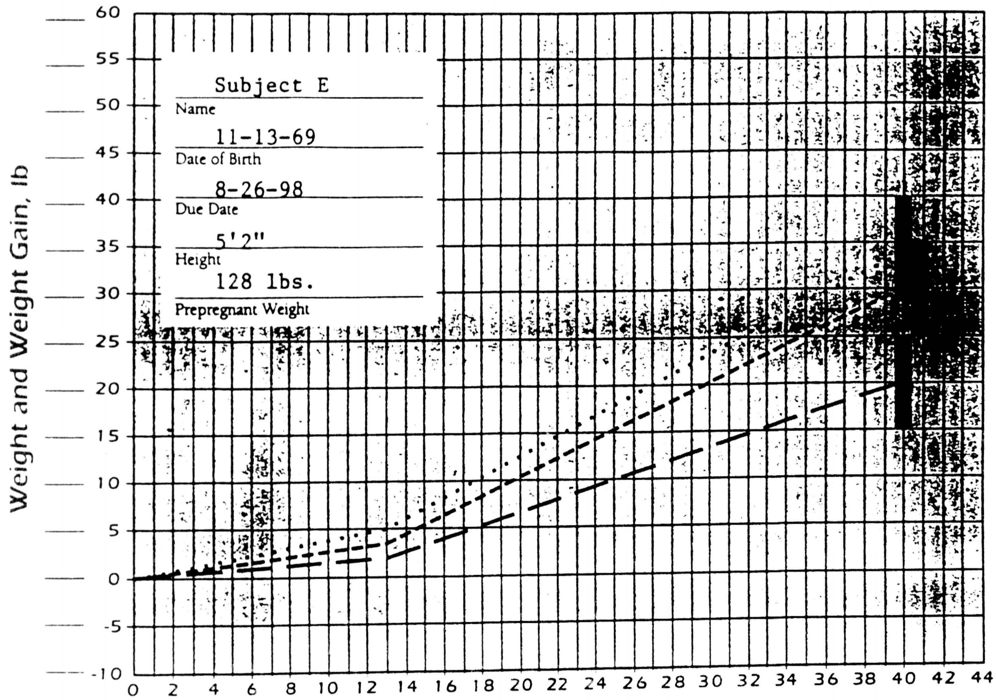
Food and Nutrition Board, Institute of Medicine, 1992

Figure F. Prenatal Weight Gain for Subject D recall showed 1992 kcals. She was hospitalized several times over the next few weeks for urinary tract complications. Patient D delivered 7-21-98 and weighed approximately 155 lbs. She was 25 weeks pregnant at delivery. Male Baby D1 weighed 1 lb. 8 ounces, female Baby D2 weighed 1 lb. 11 ounces, and male Baby D3 weighed 1 lb. 13 ounces. All babies were still in neonatal hospital care as of November. Subject D had a total pregnancy weight gain of 32 lbs.

Patient E was a 29 year old Caucasian female. She was 5'2" tall and her prepregnancy weight was 128. She was pregnant with twins from fertility treatments. She was relatively active, her BMI was 23.5, in the normal range, and no health issues. Her due date was 8-26-98 and she was 25 weeks pregnant when she was interviewed. The subject weighed 145 and her dietary recall showed 1672 kcals (Table 3, page 40). Her recommended dietary intake protocol was approximately 1350 plus 300 kcals per fetus (1950 kcals total). At 27.5 weeks of gestation, the subject was first measured using the metabolic cart. Her dietary recall showed 2152 kcals. The subject was only measured once before being confined to bed rest. She weighed 151 lbs. and the REE was 1821 kcals. Her weight was charted on the Weight Gain chart (Figure G, page 48). She delivered 7-15-98 at 33.5 weeks gestation and weighed approximately 155 lbs. Male Baby E1 weighed 4 lbs. 5.5 ounces; male Baby E2 weighed 5 lbs. 6.5 ounces. Baby E1 was delivered vaginally and Baby E2 was breech.

Prenatal Weight Gain Chart in Pounds

Prepregnancy BMI <19.8 (· · · · · · ·), Prepregnancy BMI 19.8–26.0 (Normal Body Weight) (- - 23.8 - -), Prepregnancy BMI >26.0 (—— ——)



Weight Record TWINS

Date	Weeks of Gestation	Weight	Notes
	22.5	140	12
	23	141	13
	24	147.5	19.5
	25	145	17
	27	151	23
	33	155	delivered

Please bring this chart with you to each prenatal visit.

Food and Nutrition Board, Institute of Medicine, 1992

Figure G. Prenatal Weight Gain for Subject E.

Both babies went home with the mother. Participant E had a total pregnancy weight gain of 27 lbs.

There were two participants (Subject A and Subject D) who were relatively similar in body size, due dates, and both were pregnant with triplets. The results of their tests and the end results of their pregnancies were very different. Participant A reported a high calorie, nutrient dense 24-hour dietary recall with substantial quantities of food eaten six times throughout the day. Participant D ate much lighter meals with the majority of her food intake coming in the morning and gradually reducing as the day went on. Both women were very conscious of trying to eat properly, but participant D did not have as much appetite as participant A. Subject A showed a REE of 1693 kcals at 17 weeks gestation and Subject D showed and REE of 1949 kcals at 16 weeks of gestation. Subject A had 22 lbs. of weight gain and subject D had 21 lbs. Their Weight Gain charts however, became very different as their pregnancy progressed. Subject A had a consistent weight gain that surpassed the ideal triplet weight gain recommendations at week 21. She delivered at week 29 and the three babies were able to go home after 5 weeks in neonatal care. Subject D showed a close to ideal triplet weight gain until week 21. She delivered at week 25 (Figure H, page 52). The three infants still remained in neonatal care 14 weeks after delivery.

Participants B and C were both measured two times using the metabolic cart. Each measurement was done at two-week intervals. Their caloric requirements were very different because of the mothers' size differences, gestational age, and the fact that one was a twin pregnancy and the other a triplet. Both women saw some increases in REE in their second test (Table 4, page 51). The twin pregnancy REE actually showed a greater increase (from 1283 to 1389) than did the triplet pregnancy (1859 to 1903). However, Subject B, the triplet pregnancy, went into preterm labor ten days after the second test and Subject C had to be induced for delivery.

The protocol for weight gain recommendations (300-500 kcals per fetus) during pregnancy is based on the concept that all women react the same to pregnancy, whether it be a single fetus or multiple fetuses. Consequently they should need the same nutrient requirements and caloric intake for optimum results. However, as this study has shown, women are very different (Table 3, page 40). Ideal weight gain for twins and triplets has been developed and Figure H and Figure I (pages 52 and 53) show the variances of the participants. The metabolic cart offered an option for testing individual needs in kilocalories, and the 24 hour dietary recall provided a guideline as to how and what the subject was eating. The Weight Gain chart provided a visual account of how a woman was progressing in her pregnancy compared to ideal, and the arm

Table 4

Results of Resting Energy Expenditure using Indirect Calorimetry

Subject	Test#	# of Fetuses	Prepreg. REE*	Actual REE	Wks. Gestation
A	1	3	1342 kcals	1693 kcals	17
B	1	3	1502 kcals	1859 kcals	26
	2		1502 kcals	1903 kcals	27.5
C	1	2	1210 kcals	1283 kcals	33
	2		1210 kcals	1389 kcals	33.5
D	1	3	1333 kcals	1949 kcals	16
E	1	2	1370 kcals	1821 kcals	27.5

* The metabolic cart automatically calculates a predicted REE based on prepregnancy weight.

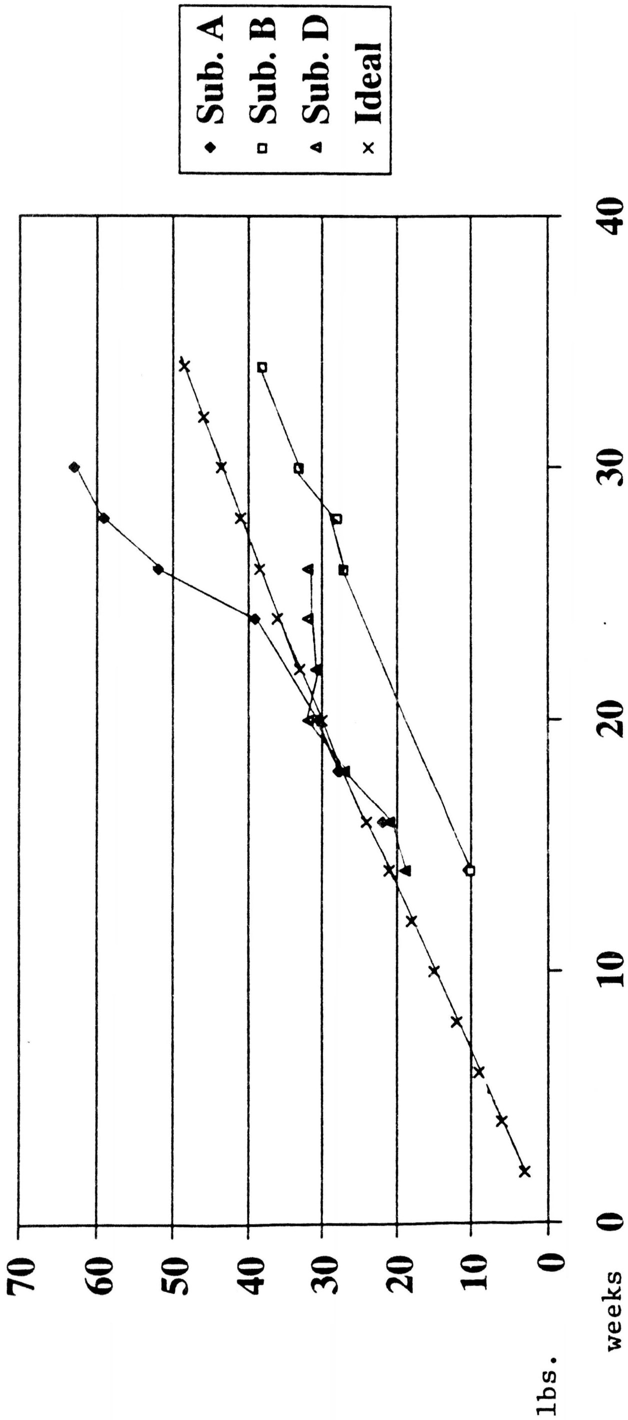


Figure H. Subjects A, B, and D compared to recommended triplet weight gain.

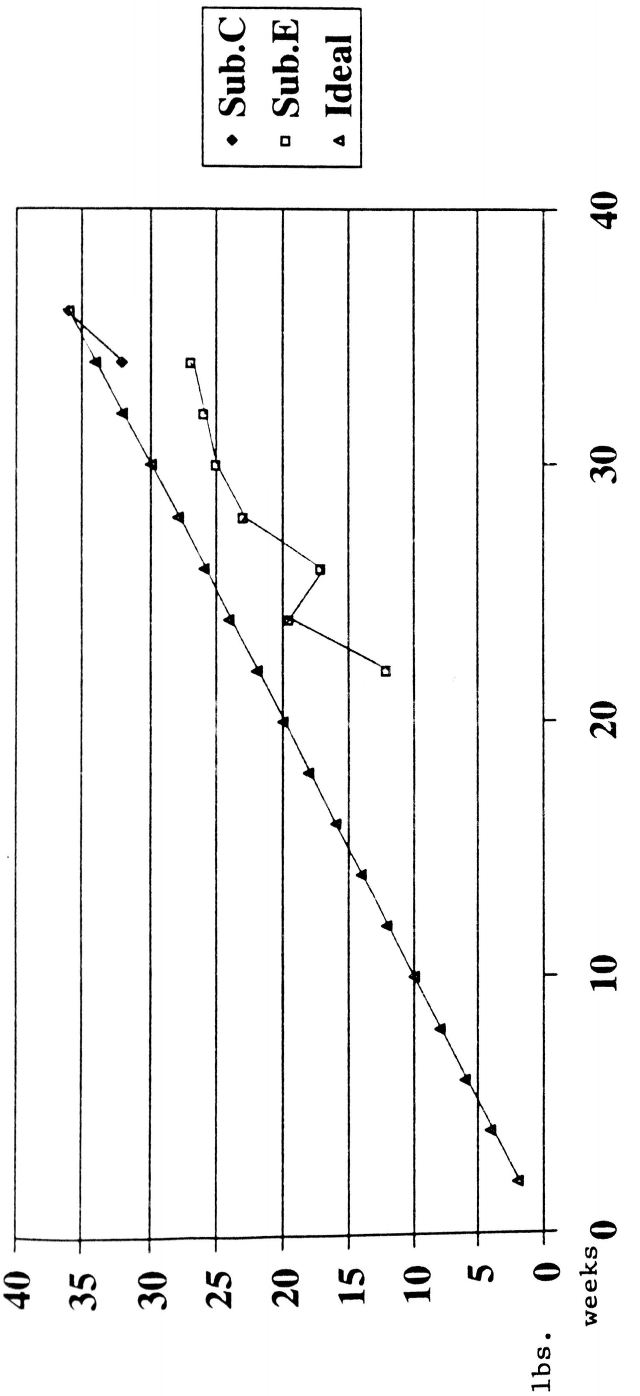


Figure I. Subjects C and E compared to recommended twin weight gain.

measurement provided an easy way to determine if the weight gained was for the support of the pregnancy or excess body fat.

The usual benchmarks for the successful course of a pregnancy with multiples are the sonogram measurements of the fetuses. There is very little emphasis on how the mother is growing the developing fetuses. The use of a metabolic cart to determine REE kilocalorie needs is a viable tool. Unfortunately, as was seen in this study, it is very difficult to measure a high-risk pregnant female with any consistency. It seems from this study that the tracking of weight gain with ideal or recommended weight gains for optimum fetal outcome, measuring REE, monitoring dietary intakes and upper arm measurements, can be used as a good comparison to determine the mother's progress (Table 5, page 55). However, each patient must be looked at individually.

Table 5

Comparison of Subjects' Pregnancy Data

Subject	Ht. Inches	Prepregnancy Weight (lbs.)	BMI	# of Fetuses	Total Weight Gain (lbs.)	Birth Weeks
A	6	132	25	3	63	29.5
B	74	153	20.5	3	38	33.5
C	60	100	19.5	2	36	37
D	62	123	22.5	3	32	25
E	62	128	23.5	2	27	33.5

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to compare the resting energy needs of women who were pregnant with multiple fetuses with protocol recommended caloric intake (2). Participants' resting energy needs were measured using the Metabolic Cart. A 24-hour dietary recall, an upper arm circumference, a pre-pregnancy BMI, and a Weight Gain chart were done as well. This data was compared to the outcomes of the twin and triplet pregnancies of the participants. The use of these measuring tools illustrated the need for following the weight gain of the pregnant woman more closely as a valid protocol for pregnancy outcomes.

Results of this study seem to indicate that further study is warranted. This study should incorporate the use of a booklet to assist in monitoring the pregnant woman's weight progress on a bi-weekly basis. The booklet would include an initial questionnaire similar to the one used in this study, a 24-hour dietary recall, a pre-pregnancy BMI determination, a weight gain chart and an upper arm circumference measurement. This information would be tracked at each office visit, which is usually every two weeks, or a maximum of twice monthly. In addition, the booklet would contain the summary of RDA's for women pregnant with twins or triplets and some healthy eating recommendations for multiple fetus pregnancies (Appendix D). This study showed an increase of kilocalories after the initial interview of most participants. Healthy eating habits, eating every 3-4 hours and general nutrition questions were addressed during that interview.

If funding were available, the use of a metabolic cart to measure REE would also be beneficial. It has not been determined if women who conceive using fertility drugs or treatments have different metabolic needs from natural pregnancies. However, this study showed lesser increments of metabolic increases in the natural pregnancy versus the fertility driven pregnancies.

The study should be done on a larger population group of at least 10-20 twins and the same number of triplet pregnancies. It would probably need to last for at least two years so all participants could be at the first trimester of their pregnancy and be measured through the first month postpartum. The purpose of this study would be to determine if the use of the booklet information and tracking would be a valid precursor for pregnancy outcomes. This study showed that the metabolic cart was an expensive tool for measuring REE. It did however provide a great deal of energy data that might prove to be valuable. If funding for the metabolic cart were available, it would be interesting to measure the pregnant subject for metabolic growth rates during the course of her pregnancy. The comparison of twin versus triplet metabolic rates might assist in the determination of whether the 300-500 kcals/fetus/day is a valid protocol. In addition, measuring post pregnancy women to see when their metabolic levels change and whether or not they remain elevated if breastfeeding might prove useful.

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APPENDICES

APPENDIX A

TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

HUMAN SUBJECTS
REVIEW COMMITTEE
P.O. Box 425619
Denton, TX 76204-5619
Phone: 940/898-3377
Fax: 940/898-3416

November 5, 1998

Ms. Jyl DeHaven
508 Fox Glenn
Southlake, TX 76092

Dear Ms. DeHaven: Social Security # 465-04-2266

This is to inform you that, as of this date, the Human Subjects Review Committee has received the agency approval letters and signatures of the subjects who participated in your research project "The Measurement of Energy Needs in Women with Multiple Fetus Pregnancies Using the Metabolic Cart." These signatures constitute evidence of informed consent of each subject.

Sincerely,

Jerry D. Wilkerson

Chair
Human Subjects Review Committee

cc. Graduate School
Dr. Betty Alford, Department of Nutrition & Food Sciences
Dr. Carolyn Bednar, Department of Nutrition & Food Sciences

A Comprehensive Public University Primarily for Women

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University and may be published in professional journals. During the study, the information will be stored in a locked file cabinet at the investigator's home office. After the study is complete, the information will be stored for 3 years and then destroyed by shreading.

The medical community is not sure what the actual energy needs of a woman are during pregnancy. This is further complicated when there are multiple fetuses. This study hopes to gather information that might assist the patient and her medical team to determine what her individual energy requirements are in the resting state during this very physically demanding time. The procedures performed by the investigator for this study will be provided to you free of charge. After the study is complete, you will be debriefed.

We will try to prevent any problem that could happen because of this research. Please let us know at once if there is a problem and we will help you. You should understand, however, that TWU does not provide medical services or financial assistance for injuries that might happen because you are taking part in this research.

If I have any questions about the research or about my rights as a subject, I should ask the researchers: their phone numbers are at the top of this form. If I have questions later, or wish to report a problem, I may call the researchers or the Office of Research and Grants Administration at (817) 898-3377.

My participation in this study is completely voluntary. I may withdraw from the study at any time, and that refusal to participate will involve no penalty or loss of benefits to which I am otherwise entitled.

An offer has been made to answer all of the my questions and concerns and a copy of the dated and signed consent form has been given to me to keep.

______________________________ _______________________

Signature of Participant Date

The above consent form was read, discussed, and signed in my presence. In my opinion, the person signing said consent form did so freely and with full knowledge and understanding of its contents.

______________________________ _______________________

Representative of Texas Woman's University Date

APPENDIX B

Texas Woman's University
Subject Consent to Participate in Research

Title: The measurement of energy needs in pregnant women with multiple fetuses using the Metabolic Cart.

Principal Investigator: Jyl DeHaven Office Phone: (817) 431-8792.
Advisor: Dr. Betty Alford Office Phone: (817) 898-2647.

This is a study to measure energy needs of women pregnant with multiple fetuses . The Metabolic Cart will be used to measure your energy needs by collecting oxygen consumption and carbon dioxide production for approximately 10 minutes. This procedure is done by sitting comfortably with a mask placed over your nose and mouth. You will be asked to sit still and relax so as to breath normally. Every effort will be made to try to make you as comfortable as possible. You will also be asked to complete a 24 hour diet history at each visit. The entire process takes about 20 minutes. In addition, a simple questionaire will be completed by you during the first visit. The testing will be done once a month during the course of the study (approximately 6 months). The test will be done in Dr. Tabor's office and will coincide with your regular office visit. After the study is complete, you will be debriefed.

You may experience some discomfort in completing the questionaire. It is not a test. The reason that it is necessary for you to complete the questionaire is to provide the investigator with a baseline of information as to what your general current health status is. The questionaire should take approximately ten minutes to complete. The reason for collecting information regarding activity level and diet history is to give some basic information as to your current physical condition so this information can be compared with the data that will be collected throughout the study. There are no right or wrong answers.

There is a risk of discomfort while the testing is being done. It can sometimes be difficult to find a comfortable position during advanced stages of pregnancy for any extended period of time. Every effort will be made to make the testing time as comfortable as possible. No names or other identifying information will be used by the investigator in this study. Names will be coded on the questionaire in order for the information collected to be kept in the patient's medical file. The study will be published at the investigator's

University and may be published in professional journals. During the study, the information will be stored in a locked file cabinet at the investigator's home office. After the study is complete, the information will be stored for 3 years and then destroyed by shreading.

The medical community is not sure what the actual energy needs of a woman are during pregnancy. This is further complicated when there are multiple fetuses. This study hopes to gather information that might assist the patient and her medical team to determine what her individual energy requirements are in the resting state during this very physically demanding time. The procedures performed by the investigator for this study will be provided to you free of charge. After the study is complete, you will be debriefed.

We will try to prevent any problem that could happen because of this research. Please let us know at once if there is a problem and we will help you. You should understand, however, that TWU does not provide medical services or financial assistance for injuries that might happen because you are taking part in this research.

If I have any questions about the research or about my rights as a subject, I should ask the researchers: their phone numbers are at the top of this form. If I have questions later, or wish to report a problem, I may call the researchers or the Office of Research and Grants Administration at (817) 898-3377.

My participation in this study is completely voluntary. I may withdraw from the study at any time, and that refusal to participate will involve no penalty or loss of benefits to which I am otherwise entitled.

An offer has been made to answer all of the my questions and concerns and a copy of the dated and signed consent form has been given to me to keep.

______________________________ ______________________

Signature of Participant Date

The above consent form was read, discussed, and signed in my presence. In my opinion, the person signing said consent form did so freely and with full knowledge and understanding of its contents.

______________________________ ______________________

Representative of Texas Woman's University Date

APPENDIX C

Subject A

Description	Amount	Portion	FAT	KCAL	PROT	SATF	SOD	V-A	V-C
Day 1 (14 foods, 1428 Cals)									
Breakfast (4 foods, 400.7 Cals)									
CEREAL-BRAN FLAKES-KELLOGG'S	1.000	CUP	0.000	158.000	5.280	0.000	387.000	396.000	26.40
MILK-NONFAT/SKIM-FLUID	1.000	CUP	0.440	86.000	8.350	0.287	126.000	150.000	2.400
STRAWBERRIES-RAW-WHOLE	1.000	CUP	0.551	44.700	0.909	0.030	1.490	4.100	84.50
JUICE-ORANGE-FROZEN CONCENTRATE-DILUTED	1.000	CUP	0.140	112.000	1.680	0.017	2.000	19.400	96.90
Morning (1 foods, 81 Cals)									
APPLES-RAW-WITH SKIN-2 3/4 INCH DIAMETER	1.000	ITEM	0.490	81.000	0.270	0.080	1.000	7.400	7.800
Lunch (3 foods, 360.4 Cals)									
SANDWICH-TURKEY/HAM-6 INCH-WHEAT-SUBWAY	1.000	ITEM	4.000	275.000	17.000	1.000	1287.000	87.200	13.00
SOUP-TOMATO-CANNED-PREPARED WITH WATER	1.000	CUP	1.920	85.400	2.050	0.366	871.000	69.000	66.40
WATER-MUNICIPAL TAP	1.500	CUP	0.000	0.000	0.000	0.000	10.500	0.000	0.000
Afternoon (2 foods, 80 Cals)									
YOGURT-FRUIT FLAVORS-LIGHT-YOPLAIT	1.000	SERVING	0.000	80.000	7.000	0.000	80.000	0.000	0.000
WATER-MUNICIPAL TAP	1.500	CUP	0.000	0.000	0.000	0.000	10.500	0.000	0.000
Dinner (4 foods, 506.1 Cals)									
CHICKEN-BREAST-ROAST/BROIL	1.000	ITEM	15.300	386.000	58.400	4.300	138.000	54.700	0.000
RICE-WHITE-LONG GRAIN-ENR-COOKED	0.500	CUP	0.225	102.500	2.125	0.061	0.500	-	0.000
BEANS-GREEN-FROZEN-BOILED-FRENCH STYLE	0.500	CUP	0.095	17.550	0.920	0.021	8.800	35.800	5.550
WATER-MUNICIPAL TAP	1.500	CUP	0.000	0.000	0.000	0.000	10.500	0.000	0.000
Day 2 (21 foods, 2705 Cals)									
Breakfast (4 foods, 380 Cals)									
CEREAL-BRAN FLAKES-KELLOGG'S	1.000	CUP	0.000	158.000	5.280	0.000	387.000	396.000	26.40
MILK-NONFAT/SKIM-FLUID	1.000	CUP	0.440	86.000	8.350	0.287	126.000	150.000	2.400
MELONS-CANTALOUPE-RAW-CUBED PIECES	1.000	CUP	0.448	56.000	1.410	0.000	14.400	516.000	67.50
YOGURT-FRUIT FLAVORS-LIGHT-YOPLAIT	1.000	SERVING	0.000	80.000	7.000	0.000	80.000	0.000	0.000
Morning (2 foods, 237.9 Cals)									
YOGURT-FRUIT FLAVORS-LOWFAT-ADDED SOLIDS	1.000	CUP	2.450	231.000	9.920	1.580	133.000	31.200	1.500
JUICE-ORANGE-PLUS CALCIUM-PURE-TROPICANA	0.500	FL OZ	0.000	6.900	0.031	0.000	0.000	0.625	3.375
Lunch (4 foods, 596.6 Cals)									
SALMON-VEGETABLE SALAD	1.000	SERVING	12.800	208.000	12.600	1.920	284.000	31.000	7.130
LETTUCE-ICEBERG-RAW-LEAVES	1.000	PIECE	0.038	2.610	0.201	0.005	1.810	6.610	0.781
ICE CREAM-VANILLA BEAN-EDY'S/DREYER'S	1.000	CUP	18.000	300.000	4.000	12.000	60.000	120.000	0.000
MILK-NONFAT/SKIM-FLUID	1.000	CUP	0.440	86.000	8.350	0.287	126.000	150.000	2.400
Afternoon (2 foods, 150 Cals)									
BAR-APPLE-NUTRI-GRAIN	1.000	ITEM	5.000	150.000	2.000	1.000	65.000	150.000	-
WATER-MUNICIPAL TAP	1.500	CUP	0.000	0.000	0.000	0.000	10.500	0.000	0.000
Dinner (4 foods, 652.5 Cals)									
BEEF BURRITO	1.000	ITEM	27.200	460.000	29.300	13.300	606.000	189.000	7.290
RICE-WHITE-LONG GRAIN-ENR-COOKED	0.500	CUP	0.225	102.500	2.125	0.061	0.500	-	0.000
SOUP-SEAFOOD GUMBO-SOUP SUPREME	1.000	CUP	1.500	90.000	5.000	0.000	900.000	134.000	13.00
WATER-MUNICIPAL TAP	1.500	CUP	0.000	0.000	0.000	0.000	10.500	0.000	0.000
Evening (5 foods, 688.8 Cals)									
ROLL-HAMBURGER-PLAIN	1.000	ITEM	2.200	123.000	3.600	0.514	241.000	-	-
TOMATO-RED-RIPE-RAW	1.000	ITEM	0.406	25.800	1.050	0.056	11.100	76.300	23.50
MCDONALDS-FRENCH FRIES-REGULAR ORDER	1.000	SERVING	12.000	220.000	3.000	8.000	110.000	0.000	8.160
MCDONALDS-MILKSHAKE-CHOCOLATE-LOWFAT	1.000	SERVING	1.700	320.000	11.600	0.900	240.000	91.900	0.000
WATER-MUNICIPAL TAP	1.000	CUP	0.000	0.000	0.000	0.000	7.000	0.000	0.000

Subject B

Description	Amount	Portion	FAT	KCAL	PROT	SATF	SOD	V-A	V-C
Day 1 (12 foods, 1677 Cals)									
Breakfast (4 foods, 339.6 Cals)									
SAUSAGE-PORK-PATTY-COOKED	1.000	ITEM	8.410	100.000	5.310	2.920	349.000	-	0.500
BISCUIT-BUTTERMILK	1.000	ITEM	5.800	127.000	2.200	0.872	368.000	-	0.000
JUICE-ORANGE-FROZEN CONCENTRATE-DILUTED	1.000	CUP	0.140	112.000	1.680	0.017	2.000	19.400	96.900
COFFEE-BREWED-DECAF	1.000	FL OZ	0.000	0.592	0.030	0.000	0.592	0.000	0.000
Lunch (3 foods, 600 Cals)									
SALAD-GREEN SALAD-TOSSED	1.000	SERVING	0.160	32.000	2.600	0.021	53.000	235.000	48.000
SALAD DRESSING-RANCH STYLE	2.000	TBSP	11.400	108.000	0.800	1.470	194.000	25.200	0.000
BEEF BURRITO	1.000	ITEM	27.200	460.000	29.300	13.300	606.000	189.000	7.290
Dinner (5 foods, 738.1 Cals)									
BEEF CUTS-LEAN AND FAT-SIMMERED/ROASTED	1.000	SLICE	22.900	297.000	21.200	9.450	50.000	0.000	0.000
POTATOES-WHOLE NEW-CANNED-S & W	1.000	CUP	0.000	120.000	2.000	0.000	520.000	0.000	0.000
CARROTS-BOILED-DRAINED-SLICED	0.500	CUP	0.140	35.100	0.850	0.027	51.500	1915.000	1.795
ICE CREAM-CHOCOLATE	1.000	CUP	14.600	286.000	5.000	8.980	100.000	156.000	1.000
WATER-MUNICIPAL TAP	1.500	CUP	0.000	0.000	0.000	0.000	10.500	0.000	0.000
Day 2 (17 foods, 2423 Cals)									
Breakfast (4 foods, 483.3 Cals)									
CEREAL-CORN FLAKES-KELLOGGS-USDA	1.000	CUP	0.068	88.300	1.840	0.000	281.000	300.000	12.000
MILK-WHOLE-REGULAR-3.3% FAT-FLUID	1.000	CUP	8.150	150.000	8.030	5.070	120.000	92.200	2.290
BANANA-RAW-PEELED	1.000	ITEM	0.550	105.000	1.180	0.211	1.000	9.200	10.300
JUICE-PINEAPPLE-CANNED	1.000	CUP	0.200	140.000	0.800	0.013	2.500	0.000	26.800
Lunch (6 foods, 792.4 Cals)									
BEEF CUTS-LEAN AND FAT-SIMMERED/ROASTED	1.000	SLICE	22.900	297.000	21.200	9.450	50.000	0.000	0.000
SPINACH-FROZEN-BOILED-CHOPPED	1.000	CUP	0.431	57.400	6.440	0.068	176.000	1596.000	25.200
MASHED POTATOES	1.000	SERVING	3.770	116.000	2.140	0.620	184.000	55.600	6.870
HOLIDAY SWEET POTATOES	0.500	SERVING	4.415	195.000	1.785	0.680	40.950	1129.500	21.450
CORNBREAD	1.000	PIECE	3.620	127.000	3.140	0.556	62.300	24.200	0.192
WATER-MUNICIPAL TAP	1.500	CUP	0.000	0.000	0.000	0.000	10.500	0.000	0.000
Afternoon (4 foods, 344.1 Cals)									
POPSICLE	1.000	ITEM	0.000	70.000	0.000	0.000	0.000	0.000	0.000
CRACKER-GRAHAM-PLAIN	1.000	ITEM	0.700	30.000	0.500	0.177	42.000	0.000	0.000
PEANUT BUTTER-SMOOTH TYPE	1.000	TBSP	8.000	94.100	3.940	1.530	76.500	-	0.000
MILK-WHOLE-REGULAR-3.3% FAT-FLUID	1.000	CUP	8.150	150.000	8.030	5.070	120.000	92.200	2.290
Dinner (3 foods, 804.2 Cals)									
SLOPPY JOE ON ROLL	1.000	ITEM	13.500	331.000	20.100	4.830	590.000	62.000	9.290
POTATO CHIPS-FROM DRIED POTATOES	3.000	OUNCE	32.642	473.166	5.091	8.026	557.018	0.000	6.888
WATER-MUNICIPAL TAP	1.500	CUP	0.000	0.000	0.000	0.000	10.500	0.000	0.000

Subject C

Description	Amount	Portion	FAT	KCAL	PROT	SATF	SOD	V-A	V-C
Day 1 (12 foods, 2032 Cals)									
Breakfast (2 foods, 244 Cals)									
CEREAL-BRAN FLAKES-KELLOGG'S	1.000	CUP	0.000	158.000	5.280	0.000	387.000	396.000	26.400
MILK-NONFAT/SKIM-FLUID	1.000	CUP	0.440	86.000	8.350	0.287	126.000	150.000	2.400
Lunch (3 foods, 455.7 Cals)									
SANDWICH-TURKEY-6 INCH-WHITE-SUBWAY	1.000	ITEM	4.000	273.000	16.000	1.000	1303.000	87.000	13.000
POTATO CHIPS-SALT ADDED	3.000	ITEM	2.124	31.500	0.384	0.543	28.200	0.000	2.490
SODA-COLA TYPE-CARBONATED	12.000	FL OZ	0.000	151.200	0.000	0.000	14.760	0.000	0.000
Afternoon (1 foods, 130 Cals)									
CARNATION INSTANT BREAKFAST-CHOCOLATE	1.000	ITEM	1.000	130.000	7.000	-	136.000	525.000	27.000
Dinner (6 foods, 1202 Cals)									
QUICHE LORRAINE-FROZEN DINNER-MRS SMITHS	1.000	ITEM	41.000	720.000	34.000	-	1965.000	67.000	0.000
SALAD-GREEN SALAD-TOSSED	1.000	SERVING	0.146	33.300	2.600	0.021	54.100	237.000	48.300
SALAD DRESSING-BLUE CHEESE	2.000	TBSP	16.000	154.200	1.400	3.000	334.000	19.000	0.600
TOMATO-RED-RIPE-RAW	0.500	ITEM	0.203	12.900	0.525	0.028	5.550	38.150	11.750
TEA-ICED-SWEETENED-NESTEA	12.000	FL OZ	0.000	97.440	0.000	0.000	0.000	0.000	-
ICE CREAM-FRENCH VANILLA	1.000	CUP	11.200	185.000	3.500	6.430	52.000	133.000	0.600
Day 2 (9 foods, 1952 Cals)									
Breakfast (2 foods, 244 Cals)									
CEREAL-BRAN FLAKES-KELLOGG'S	1.000	CUP	0.000	158.000	5.280	0.000	387.000	396.000	26.400
MILK-NONFAT/SKIM-FLUID	1.000	CUP	0.440	86.000	8.350	0.287	126.000	150.000	2.400
Lunch (2 foods, 410 Cals)									
PASTA-FETTUCCINE-ROMANOFF-NOODLE RONI	1.000	CUP	19.000	410.000	13.000	5.500	1070.000	100.000	0.000
WATER-MUNICIPAL TAP	1.500	CUP	0.000	0.000	0.000	0.000	10.500	0.000	0.000
Afternoon (2 foods, 248.2 Cals)									
CRACKER-GRAHAM-PLAIN	2.000	ITEM	1.400	60.000	1.000	0.354	84.000	0.000	0.000
PEANUT BUTTER-SMOOTH TYPE	2.000	TBSP	16.000	188.200	7.880	3.060	153.000	-	0.000
Dinner (3 foods, 1050 Cals)									
TACO	2.000	ITEM	41.200	740.000	41.400	22.800	1604.000	294.000	4.400
RICE-SPANISH-COOKED FROM HOME RECIPE	1.000	CUP	4.160	213.000	4.410	0.000	774.000	485.000	36.700
TEA-ICED-SWEETENED-NESTEA	12.000	FL OZ	0.000	97.440	0.000	0.000	0.000	0.000	-

subject D

Description	Amount	Portion	FAT	KCAL	PROT	SATF	SOD	V-A	V-C
Day 1 (13 foods, 1743 Cals)									
Breakfast (5 foods, 709.7 Cals)									
EGG-SCRAMBLED/MILK/BUTTER	2.000	ITEM	14.900	202.000	13.540	4.480	342.000	238.000	0.240
CHEESE-CHEDDAR-CUT PIECES	2.000	OUNCE	18.767	227.599	14.095	11.939	351.380	179.883	0.000
BREAD-WHEAT-TOASTED	2.000	SLICE	2.000	130.000	4.600	0.448	264.000	0.000	0.000
PEANUT BUTTER-SMOOTH TYPE	1.000	TBSP	8.000	94.100	3.940	1.530	76.500	-	0.000
JUICE-ORANGE-FROZEN CONCENTRATE-DILUTED	0.500	CUP	0.070	56.000	0.840	0.009	1.000	9.700	48.450
Morning (1 foods, 37 Cals)									
GRAPEFRUIT-PINK & RED-RAW	0.500	ITEM	0.123	37.000	0.680	0.017	0.000	31.850	45.500
Lunch (3 foods, 656.8 Cals)									
SANDWICH-TUNA/SALAD/MAYONNAISE	3.000	OUNCE	7.934	192.640	14.395	1.127	280.395	33.960	0.427
CORN CHIPS	3.000	OUNCE	27.372	464.181	5.091	4.492	491.134	32.343	1.701
WATER-MUNICIPAL TAP	1.500	CUP	0.000	0.000	0.000	0.000	10.500	0.000	0.000
Afternoon (1 foods, 31.74 Cals)									
RAISIN-YOGURT COATED-FRUITSOURCE	6.000	ITEM	1.236	31.740	0.528	0.882	6.180	-	0.210
Dinner (3 foods, 308 Cals)									
SPAGHETTI-MEATBALLS-SAUCE-LEAN CUISINE	1.000	SERVING	7.000	290.000	20.000	2.000	550.000	80.000	-
BEANS-SNAP-GREEN-FROZEN-BOILED	0.500	CUP	0.090	18.000	0.920	0.021	8.500	35.500	5.550
WATER-MUNICIPAL TAP	1.500	CUP	0.000	0.000	0.000	0.000	10.500	0.000	0.000
Day 2 (13 foods, 1992 Cals)									
Breakfast (2 foods, 410 Cals)									
MCDONALDS-EGG MCMUFFIN	1.000	ITEM	11.000	280.000	18.000	6.000	710.000	150.000	1.380
MCDONALDS-HASH BROWNS	1.000	SERVING	8.000	130.000	1.000	1.500	330.000	10.000	2.400
Morning (1 foods, 86 Cals)									
MILK-NONFAT/SKIM-FLUID	1.000	CUP	0.440	86.000	8.350	0.287	126.000	150.000	2.400
Lunch (2 foods, 372 Cals)									
CHICKEN CACCIATORE CASSEROLE	1.000	SERVING	2.540	256.000	24.900	0.658	151.000	114.000	18.800
JUICE APPLE-CANNED OR BOTTLED	1.000	CUP	0.280	116.000	0.150	0.047	7.000	0.200	2.300
Afternoon (2 foods, 172 Cals)									
SALAD-GREEN SALAD-TOSSED	1.000	SERVING	0.160	32.000	2.600	0.021	53.000	235.000	48.000
SALAD DRESSING-OIL/VINEGAR-HOME RECIPE	2.000	TBSP	15.620	140.000	0.000	2.840	0.156	0.000	0.000
Dinner (4 foods, 848 Cals)									
DIP-BEAN-MADE WITH REFRIED BEANS	1.000	CUP	13.900	365.000	15.100	1.830	3058.000	141.000	35.600
CRACKER-TRISCUITS	8.000	ITEM	6.000	168.000	3.200	1.504	194.400	0.000	0.000
MILK-NONFAT/SKIM-FLUID	1.000	CUP	0.440	86.000	8.350	0.287	126.000	150.000	2.400
PIE-PUMPKIN-COMM PREP	1.000	SLICE	10.400	229.000	4.300	2.200	308.000	-	-
Evening (2 foods, 104 Cals)									
WATER-MUNICIPAL TAP	1.000	CUP	0.000	0.000	0.000	0.000	7.000	0.000	0.000
JUIÇE-ORANGE-CANNED	1.000	CUP	0.360	104.000	1.460	0.045	6.000	43.700	85.700

Subject E

Description	Amount	Portion	FAT	KCAL	PROT	SATF	SOD	V-A	V-C	I
Day 1 (10 foods, 1672 Cals)										
Breakfast (2 foods, 244 Cals)										
CEREAL-BRAN FLAKES-KELLOGG'S	1.000	CUP	0.000	158.000	5.280	0.000	387.000	396.000	26.400	:
MILK-NONFAT/SKIM-FLUID	1.000	CUP	0.440	86.000	8.350	0.287	126.000	150.000	2.400	(
Lunch (3 foods, 698.3 Cals)										
SANDWICH-TURKEY-6 INCH-WHITE-SUBWAY	1.000	ITEM	4.000	273.000	16.000	1.000	1303.000	87.000	13.000	:
TORTILLA CHIPS-PLAIN	3.000	OUNCE	22.161	425.250	5.989	4.253	449.208	17.968	0.000	:
WATER-MUNICIPAL TAP	1.500	CUP	0.000	0.000	0.000	0.000	10.500	0.000	0.000	(
Afternoon (1 foods, 61.6 Cals)										
ORANGE-RAW-ALL COMMON VARIETIES-WHOLE	1.000	ITEM	0.157	61.600	1.230	0.020	0.000	26.900	69.700	(
Dinner (3 foods, 349 Cals)										
SPAGHETTI AND MEAT SAUCE	1.000	SERVING	12.200	299.000	20.400	4.350	380.000	73.300	14.400	:
BREAD STICKS-PLAIN	2.000	ITEM	1.200	50.000	1.400	0.168	78.000	0.000	0.000	(
WATER-MUNICIPAL TAP	1.500	CUP	0.000	0.000	0.000	0.000	10.500	0.000	0.000	(
Evening (1 foods, 320 Cals)										
MCDONALDS-MILKSHAKE-CHOCOLATE-LOWFAT	1.000	SERVING	1.700	320.000	11.600	0.900	240.000	91.900	0.000	(
Day 2 (10 foods, 2152 Cals)										
Breakfast (2 foods, 386 Cals)										
ROLL-CINNAMON	3.000	ITEM	12.600	300.000	4.500	1.815	288.000	12.000	0.015	:
MILK-NONFAT/SKIM-FLUID	1.000	CUP	0.440	86.000	8.350	0.287	126.000	150.000	2.400	(
Lunch (2 foods, 669 Cals)										
SANDWICH-CHICKEN/SALAD/MAYONNAISE	3.000	OUNCE	14.065	243.730	19.354	1.770	226.600	31.556	0.255	(
TORTILLA CHIPS-PLAIN	3.000	OUNCE	22.161	425.250	5.989	4.253	449.208	17.968	0.000	:
Afternoon (1 foods, 51.2 Cals)										
WATERMELON-RAW	1.000	CUP	0.688	51.200	0.992	-	3.200	58.500	15.400	(
Dinner (4 foods, 723 Cals)										
PASTA-FETTUCCINE-STROGANOFF-NOODLE RONI	1.000	CUP	14.000	370.000	14.000	3.500	10.000	80.000	1.200	[illegible]
CHICKEN-BREAST-NO SKIN-ROAST/BROIL	1.000	ITEM	6.140	284.000	53.400	1.740	126.000	10.800	0.000	:
BREAD-FRENCH	1.000	SLICE	0.800	69.000	2.200	0.160	152.000	0.000	0.000	(
WATER-MUNICIPAL TAP	1.500	CUP	0.000	0.000	0.000	0.000	10.500	0.000	0.000	(
Evening (1 foods, 323 Cals)										
ICE CREAM SUNDAE-CARAMEL	1.000	ITEM	9.870	323.000	7.770	4.800	208.000	56.200	3.630	(

Healthy Eating Recommendations for Multiple Fetus Pregnancies

The goal of every pregnancy is to grow healthy babies. The recommendations for weight gain during the course of the pregnancy is as follows:
For Twins: Approximately 1 pound per week for the duration of the pregnancy
For Triplets: Approximately 1.5 lbs per week for the first 24 weeks and 1.24 lbs there after

In order to gain this kind of weight, it is suggested that the pregnant woman eat every 3-5 hours, not to exceed 5 hours between meals. It is also recommended that the woman eat a carton of yogurt or glass of milk an hour before going to bed at night. Because of the large blood volume increases, red meat is recommended as a daily food. Water is also an important component of pregnancy and it is recommended that 8-10 glasses of water be consumed daily (preferably filtered water).

Planning Menus for a Healthy Diet

The USDA's food guide pyramid recommends 6-11 servings from the bread group, 2-4 servings of fruit, 3-5 servings of vegetables, 2-3 servings of dairy, 2-3 servings of protein and sparingly use fats, oils, and sweets. When the woman is pregnant with twins or triplets, the higher serving recommendations from each group needs to be used.

For twins: 9 servings from bread
4 servings from vegetables
3 servings from fruit
3 servings from dairy
2 servings from protein for a total of 6 oz.

For triplets: 11 servings from bread
5 servings from vegetables
4 servings from fruit
3 servings from dairy
3 servings from protein for a total of 7 oz.

Protein sources should primarily be from meat and nuts
Red meat should be eaten frequently

To quickly estimate serving sizes, use the following equivalents:
A thumb = 1 oz of cheese
A thumb tip = 1 tsp
Palm of a hand = 3 oz
A fist = 1 cup

Healthy menus

Breakfast
1 peeled orange
1 1/2 cup Cheerios
with 1/2 cup 1% milk
1 slice whole wheat toast
with 1 tsp butter
Water or herb tea

Snack
1 banana
1 cup 1% milk

Lunch
Ham sandwich
  2 slices whole wheat bread
  2 oz ham
  2 tsp mustard
1 apple
2 oatmeal raisin cookies (small)
1 cup 1% milk

Snack
1 whole wheat bagel
1 tblsp peanut butter
1 cup 1% milk

Dinner
Spinach salad
  1 cup spinach
  1/2 sliced tomatoes
  1 tblsp low fat dressing
  1/2 grated carrot or chopped mushrooms
3 oz broiled salmon
1/2 cup rice
3/4 cup green beans
1 whole wheat roll
1 tsp butter
water or herb tea

Snack
1 cup low fat fruit yogurt

Breakfast
1 poached egg
1 slice whole wheat toast
1 tsp butter
1/2 cup orange juice
1 cup 1% milk

Snack
2 tblsp peanut butter
1 slice whole wheat bread
1/2 cup low fat fruit yogurt
Water

Lunch

Spinach chef salad

1 cups spinach leaves

1/2 sliced tomatoes

1/2 cup sliced turkey

1/2 cup sliced provolone cheese

2 tblsp low fat dressing

5 low fat crackers

1 apple

1 cup 1% milk

Snack

1 scoop frozen yogurt

2 ginger snaps

Dinner

3 oz lean hamburger, broiled

1 slice tomato

1 slice onion

2 tsp mustard

1 whole wheat or enriched bun

3/4 cup steamed broccoli

1 tsp butter

Water or herb tea

Snack

1 cup 1% milk

1 nutrigrain bar

In addition, 8-10 cups of water should be consumed daily.

Patient Profile

Appointment Date ___________
Name _____________________
# of Fetuses _____ Due Date ________ Weeks Gestation _________
Prepregnancy Weight ______ Current Weight _______ Height ________
Birthdate ___________ Activity Level _____ Arm Circumfer. ________
Health Issues ____________ Vitamin Supplements ______________

24 hour diet recall
Meal Quantities Preparation Meal Quantities
Preparation

Breakfast AM Snack

Lunch PM Snack

Dinner Bed Snack

RDA's for Multiple Gestation Pregnancies

Summary of RDA's for women aged 25 and older, pregnant with twins/triplets. Adapted from the pregnancy RDA's in National Academy of Sciences: Recommended Dietary Allowances, 10th edition, Washington D.C: National Academy Press, 1989.

Nutrient	RDA	Dietary Sources
Folic Acid	800μg	leafy vegetables, liver
Vit. D	15μg	fortified dairy products
Iron	50mg	meats, eggs, grains
Calcium	1800mg	dairy products
Phosphorus	1800mg	meats
Pyroxidine	4.0mg	meats, liver, grains
Thiamin	3.0mg	enriched grains, pork
Zinc	30mg	meats, seafood, eggs
Riboflavin	3.0mg	meats, liver, grains
Protein	120mg	meats, fish, poultry, diary
Iodine	300μg	iodized salt, seafood
Vit. C	150mg	citrus fruits, tomatoes
Energy	3000kcal	protein, fat, carbohydrates
Magnesium	450mg	seafood, legumes, grains
Niacin	25mg	meats, nuts, legumes
Vit. B12	3.0μg	animal proteins
Vit. A	1000μg	dark green, yellow, or orange fruits and vegetables, liver

Prenatal Weight Gain Chart in Pounds

Name ______________________DOB___________ Due Date ____________
Height __________ Prepregnant Weight __________

Weight Record

Date	Weeks Gestation	Weight	Total Weight Gained