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PREGNANCY WEIGHT GAIN AND OUTCOMES

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Preface and acknowledgements

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To my family and friends, thank you for your continued support and interest.

To our dear Lord, thank You for the intellectual ability and opportunity to do this study. It is my wish that You will be proud of us and that this work will be continued in a positive way so that Your name will be honoured.

2 Chronicles 16:9

"For the eyes of the LORD move to and fro throughout the earth that He may strongly support those whose heart is completely His."

Psalms 144:3

"LORD, what is man, that thou takest knowledge of him! Or the son of man, that thou makest account of him!"

Proverbs 3:6

"In all thy ways acknowledge him, and he shall direct thy paths."

Opsomming (Uittreksel)

Effek van gewigstoename tydens swangerskap op swangerskap uitkomst

Doel

Om die verband tussen liggaams massa indeks (LMI) voor swangerskap, en massa toename tydens swangerskap teenoor swangerskap uitkomst te evalueer.

Metode

Nie-blanke, swanger vrywilligers ($n = 94$) van die Potchefstroomse kliniek is tydens swangerskap opgevolg. 'n Regressie analise is gebruik om die moeder se gewig voor swangerskap te bereken indien hul eerste besoek aan die kliniek in die tweede trimester van swangerskap was. Massatoename tussen kliniekbeseke is gebruik om hul weeklikse gewigstoename te bereken. Om die assosiasie tussen LMI voor swangerskap, sowel as weeklikse massatoename en geboorte massa, lengte en kopomtrek van die baba, met in agneming van rookgewoontes en MIV status, is partiële korrelasie koëffisiënte bereken.

Resultate en bespreking

Proefpersone is verdeel in drie kategorieë volgens hul LMI voor swangerskap: LMI < 19.8 , LMI $19.8 - 26$ en LMI > 26 . In verwysing na die "Institute of Medicine" se riglyne vir massatoename, is gevind dat in al die kategorieë, vroue neig om te veel gewig tydens swangerskap op te tel. Hoë bloeddruk kom ook meer algemeen voor by vroue wat oorgewig is. Betekenisvolle positiewe korrelasies is gevind tussen ouderdom en pariteit, ouderdom en LMI voor swangerskap en huishoudelike inkomste en die baba se geboortemassa. Vir vroue met 'n LMI < 26 , is positiewe korrelasies tussen weeklikse massatoename en kopomtrek en weeklikse gewigstoename en geboortemassa gevind.

Vir die met 'n LMI >26 , is positiewe korrelasies gevind tussen huishoudelike inkomste en die baba se kopomtrek en weeklikse massatoename en ouderdom. In die totale groep is geen betekenisvolle korrelasies gevind tussen weeklikse massatoename of die moeder se LMI voor swangerskap en die baba se gewig, lengte of kopomtrek nie.

Gevolgtrekking

Meeste vroue neig om te veel gewig op te tel tydens swangerskap. Oorgewig vroue is meer geneig tot hoë bloeddruk en ander gesondheidsprobleme, dus moet die belangrikheid van gewigsmoitoring van swanger vrouens beklemtoon word.

*Abstract**Pregnancy weight gain and outcomes**Objective*

To evaluate the association between prepregnancy body mass index (BMI), as well as maternal weight gain during pregnancy and pregnancy outcomes.

Methods

Black pregnant volunteers (n = 94) visiting the Potchefstroom Clinic were followed-up during pregnancy. A regression analysis was used to estimate the mother's prepregnancy weight for those whose first visit was during the second trimester of pregnancy. Weight gain between visits was used to calculate weekly weight gain. Partial correlation coefficients were calculated for the association between prepregnancy BMI, as well as weekly weight gain and birth weight, length and head circumference of the baby, with adjustment for smoking and HIV status.

Results and discussion

Participants were categorized into three groups: Prepregnancy BMI <19.8, BMI 19.8–26 and BMI >26. In reference to the Institute of Medicine's recommendations for weight gain, it was found that most of the women tended to gain too much weight. Overweight women tended to have a higher blood pressure during pregnancy. Significant positive correlations were found between age and parity, age and prepregnancy BMI and household income and baby's birth weight. For women with a BMI $\leq$ 26, positive correlations between weekly weight gain and head circumference and weekly weight gain and birth weight were found. For those with a BMI >26 positive correlations between household income and baby's head circumference and weekly weight gain and age were found. In the total group no significant correlations

were found between weekly weight gain or mother's prepregnancy BMI and the baby's weight, height or head circumference.

Conclusion

Pregnant women tended to gain too much weight. Overweight women are more prone to a higher blood pressure and other health risks, therefore the importance of weight monitoring of pregnant women must be emphasized.

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List of abbreviations

ADA: American Dietetic Association
AFA: arm-fat area
AI: adequate intake
AIDS: Acquired Immunodeficiency Syndrome
AMA: arm-muscle area
BMI: body mass index
BMR: basal metabolic rate
CDC: Centers for Disease Control and Prevention
CT: computed tomography
DFE: Dietary folate equivalents
DXA: dual-energy x-ray absorptiometry
FAO: Food and Agricultural Organization
FFM: fat-free mass
FFQ: food frequency questionnaire
FNB: Food and Nutrition Board
HIV: human immunodeficiency virus
ICMR: Indian Council of Medical Research
IOM: Institute of Medicine
IU: international units
IUGR: intra-uterine growth retardation
LBW: low birth weight
MRI: Magnetic resonance imaging
MUAC: mid-upper arm circumference
NCHS: National Center for Health Statistics
NE: niacin equivalents
PEM: protein energy malnutrition
RAE: retinol activity equivalents
RE: retinol equivalents
RDA: recommended dietary allowance

RMR: resting metabolic rate
SF: Symphyseal Fundal
STD: sexually transmitted diseases
TSF: triceps skin fold
UNU: United Nations University
US: United States
WHO: World Health Organization

Chapter 1: Introduction and aim of the study

1.1 Introduction

1.2 Problem statement

1.3 Aims of the study

1.4 Structure of the dissertation

1.1 Introduction

Pregnancy, a physiologically demanding process and its outcome are strongly influenced by the nutritional status of the mother both before pregnancy and during gestation. Maternal health and nutrition in turn are dependent on age, genetic, socio-economic as well as cultural and educational factors (Udipi *et al.*, 2000).

1.2 Problem statement

Maternal weight gain during pregnancy is an important determinant of fetal growth (Hickey *et al.*, 1995). Inadequate prenatal weight gain is a significant risk factor for intrauterine growth retardation and low birth weight in infants. Inadequate maternal weight gain during the third trimester of pregnancy is associated with increased risk of spontaneous preterm delivery (Hickey *et al.*, 1995). Maternal weight gain above the Institute of Medicine's (IOM) guidelines is associated with excessive postpartum weight retention. Weight retention is of concern, given the trend toward increasing obesity among United States (US) women and the associated risks for cardiovascular disease, diabetes, and certain types of cancer. Therefore, interventions aimed at achieving adequate weight gain during pregnancy will have an impact on preventing both poor birth outcomes and improving the future health of the mother (Wells & Murray, 2003). Women need to attain good nutritional status before, during, and after pregnancy to optimize maternal health and reduce the risk of birth defects and chronic disease in their children in later adulthood. Bringing maternal weight into a healthy

range before pregnancy makes conception easier, improves pregnancy outcomes and may enhance lactational performance (ADA, 2002).

The anthropometric status of women before and during gestation is a strong predictor of the outcome of pregnancy (Villamor *et al.*, 2002). Good maternal nutrition is important for the health and reproductive performance of women and the health, survival, and development of their children. Pregnancy-related health and nutritional problems affect a woman's quality of life, that of her newborn infant well beyond delivery, and that of her family and community (Mora & Nestel, 2000). This is especially true with respect to the birth weight of her infant, a factor closely related to infant mortality, and the infant's risk of long-term adverse health outcomes, such as hypertension, obesity, glucose intolerance, and cardiovascular disease (Mahan & Escott-Stump, 2000).

1.3 Aims of the study

The aim of the Thusa Mama Study was to evaluate the association between prepregnancy body mass index (BMI) as well as maternal weight gain during pregnancy and pregnancy outcomes. This includes a number of factors that have an impact on appropriate weight gain. Factors that were investigated in this study, were maternal health problems (blood pressure, haemoglobin levels, smoking and parity), socio-demographic background, dietary intake (especially energy, protein, iron and calcium) and pregnancy-related dietary problems. Outcomes that were investigated were mainly infant outcomes and included the baby's birth weight, birth length and head circumference.

1.4 Structure of the dissertation

This mini-dissertation begins with a preface and acknowledgement, to thank all the people involved in this study and acknowledge their contribution. An abstract in English and Afrikaans is given, followed by a list of tables, figures and abbreviations.

This chapter acts as an introduction and explains the aims of the Thusa Mama study. Chapter 2 gives a review of literature in relation to nutrition during pregnancy, pregnancy weight gain and outcomes. The importance of the subject, factors that might

Chapter 2: Literature study

- 2.1 *Determinants of maternal weight gain*
- 2.2 *Undernutrition and pregnancy*
- 2.3 *Obesity and pregnancy*
- 2.4 *Factors associated with pregnancy outcome.*
 - 2.4.1 *Postpartum weight retention*
- 2.5 *Methods for measuring body composition*
 - 2.5.1 *Standard methods*
 - 2.5.2 *Total body water*
 - 2.5.3 *Underwater weighing*
 - 2.5.4 *BOD POD (Air Displacement Plethysmography) and DXA (Dual-energy x-ray absorptiometry)*
 - 2.5.5 *Body mass index*
 - 2.5.6 *Total body potassium*
 - 2.5.7 *Skin fold thickness*
- 2.6 *Energy and macronutrient requirements during pregnancy*
 - 2.6.1 *Energy*
 - 2.6.2 *Protein*
 - 2.6.3 *Carbohydrates and Fat*
- 2.7 *Metabolism during pregnancy*
- 2.8 *Exercise*
- 2.9 *Pregnancy weight gain*

2.1 *Determinants of maternal weight gain*

Maternal weight gain and dietary behaviours can be influenced by prenatal nutrition intervention to promote more favourable pregnancy outcomes. Nutrition counselling is associated with improvements in dietary fat intake and increased maternal weight gain and with a decrease in the rate of low birth weight. The most valuable single outcome measure of prenatal nutrition intervention is a decrease in the rate of low-birth-weight infants. Nutrition counselling that focuses on a healthful diet to promote adequate weight gain during pregnancy should be an integral and essential part of all prenatal care (Widga & Lewis, 1999).

2.2 *Undernutrition and pregnancy*

The effects of undernutrition in pregnancy depend on the stage as well as the severity. Chronic undernutrition throughout pregnancy has clearly been shown to affect birth weight. The high prevalence of low birth weight babies (i.e. < 2.5 kg) is one consequence, which in turn increases the risk of high infant mortality. Poor maternal nutrition has been shown to be one of the major determinants of intra-uterine growth retardation (IUGR) in both developed and developing countries. Women are at a greater risk of having a low birth weight infant if low prepregnancy weight and low weight gain during pregnancy is combined (Udipi *et al.*, 2000).

Optimal fetal growth occurs only when the mother is able to accumulate a critical amount of extra body stores during pregnancy. The effect of maternal malnutrition on the development of the fetus is a matter of concern, not only with respect to the deliberate practice of restricting food intake to lose weight or prevent weight gain. A once popular concept held that the fetus could protect itself by parasitizing the mother when nutritional status is less than optimal. However, evidence from famines in Holland and Germany during World War II clearly contradict this assumption. The deprived mothers appeared to be proportionately less affected than their infants, an observation that is consistent with animal data. One recognized consequence of energy restriction is the increased production of ketone bodies and their ultimate spillage into the urine. Although it is known that the fetus can metabolise ketone bodies to some degree, the short- and long-term effects of maternal ketonemia are unclear. Both

animal and human data indicate that ketone bodies are probably normally presented to the fetal brain at various times during pregnancy. After an overnight fast, maternal ketone body concentrations in the blood are greater in pregnant than in non-pregnant women, and ketonuria sometimes is seen. Extreme levels of ketonemia, however, may be an indicator of maternal malnutrition, with maternal - fetal competition for nutrients and the associated increased fetal risk (Mahan & Escott-Stump, 2000).

2.3 Obesity and pregnancy

An excess of obesity determinants in black compared with white women have been reported frequently, e.g. lower physical activity, a more obesity tolerant body image, greater energy intake, greater weight gain during pregnancy, greater difficulty losing weight, shorter duration of weight loss attempts, less smoking, and lower alcohol intakes (Kumanyika, 1999).

The risk of maternal overweight due to excessive pregnancy weight gain needs to be balanced against the risk of poor fetal growth associated with low weight gain. Compared to recommended weight gains, excessive weight gain (above the upper limit of the IOM range) contributes more to postpartum weight retention and less to fetal growth in normal weight and overweight women (ADA, 2002).

2.4 Factors associated with pregnancy outcome

Short maternal stature (height below 150 cm, and wasting as mid-upper-arm circumference [MUAC] below 22 cm) and low prepregnancy weight are associated with increased risk of low birth weight (LBW), IUGR and preterm delivery. Short stature is also related to an increased risk of cephalopelvic disproportion, assisted delivery and increased perinatal and infant mortality. Some specific determinants of chronic energy and protein deficiency, as reflected in small maternal body size, have been identified. In populations where malnutrition is highly prevalent, poor socio-economic background is a strong predictor of short maternal stature and LBW (Villamor *et al.*, 2002).

Maternal infection, and especially malaria, is known to be associated with lower birth weight (Briend, 1985). The incidence of multiple births in the United States is rising. Infants of multiple births have a much greater risk of being born premature, or with LBW, than do singletons. Adequate maternal weight gain has been shown to be particularly important in these high-risk pregnancies (Mahan & Escott-Stump, 2000).

Villamor *et al.* (1998) studied maternal anthropometry, expressed in terms of height, prepregnancy weight and weight gain during pregnancy. Among the variables studied, social class was positively associated to mother's height. Height was positively associated to the rate of weight gain. Gestational age at delivery and gender was the strongest predictors of birth weight, followed by height and rate of weight gain. Similar results were found by Mora and Nestel (2000). Malnourished women (i.e. women who are short, are underweight, do not gain sufficient weight during pregnancy, or are anaemic) are more likely to have miscarriages or stillbirths or to deliver babies with IUGR or LBW, which are linked, in turn, to increased risk of perinatal and infant mortality.

In a study done by Winkvist *et al.* (2002) on Indonesia women, body weight, MUAC and height were measured monthly. The information collected included age, parity, family size, education, occupation, area of residence, housing conditions, and ownership of electricity, radio, television, bicycle, or motorcycle. A variable for socio-economic status was created; it combined information on housing conditions and ownership of electricity, radio, television, bicycle, or motorcycle. None of the women smoked. The results showed that prepregnancy weight was significantly higher among women with more than a secondary school education and women who owned a television. Area of residence, occupation, age, and parity were not significantly associated with prepregnancy weight. Many women in this population sample were undernourished when they began pregnancy. The total weight gain from prepregnancy to 9 months gestation was 8.3 kg, and pregnancy weight gain was inadequate in 79% of the women.

The growth of the fetus is influenced both by the genes as well as the availability of nutrients and oxygen. Factors that affect the supply of nutrients to the fetus are shown in Table 2.1 (Udipi *et al.*, 2000).

Table 2.1: Factors that affect the supply of nutrients to the fetus (Udipi *et al.*, 2000).

Maternal body composition and size
Maternal nutrient stores
Maternal food intake
Transport of nutrients to the placenta
Transfer of nutrients across the placenta
Other prerequisites for optimal maternal reproductive performance:
Protection from all preventable diseases (e.g. German measles)
Tight control of all chronic and metabolic disorders (e.g. diabetes mellitus)
Eradication of all habits harmful to the mother (e.g. tobacco, alcohol)
Early and frequent prenatal care

The size of the placenta determines the amount of nutrition available to the fetus, and eventually, the birth weight of the neonate. Mothers with low prepregnancy weights have much lighter-weight placentas than do heavier mothers (Mahan & Escott-Stump, 2000).

The fetus derives most of the energy it needs for its oxidative metabolism from glucose and amino acids. The portion derived from fat, if present, seems negligible. This makes unlikely the hypothesis that women who have low fat reserves after the delivery of a heavy baby utilised more fat to support fetal growth during pregnancy. A direct limitation of fetal growth by maternal energy reserves seems unlikely. Obese women may have some cardiovascular problems resulting in poor fetal growth. According to

Briend (1985), birth weight seems to be totally independent of maternal energy reserves.

According to Campbell-Brown and McFadyen (1985) for any given maternal weight, fatter women have lighter babies and at any maternal weight, taller women have heavier babies. This could reflect the observation that taller women are thinner than shorter ones. In this study, more of a variation in birth weight was explained by fat-free mass than by height and weight together. It seems to be an unknown factor associated with maternal lean body mass and not maternal energy reserves, which regulate infant birth weight. Sachdev and Bhargava (1985) suggest that this negative correlation of postpartum maternal fat with birthweight could mean that mothers losing more fat in pregnancy produce heavier babies. They took a series of triceps skin fold thickness measurements in pregnancy, which revealed an increase in the first two trimesters and a decrease in the third, presumably reflecting early pregnancy storage of fat and its release in late gestation to meet the increasing energy needs of the fetus. Inadequate energy intake limits the normal increase of maternal skin fold thickness during early pregnancy and decreases birthweight. The state of nutritional balance (i.e. intake minus expenditure) appears to exert a greater influence than dietary intake alone. Protein-energy supplements given during the third trimester enhanced birthweight in mothers who were nutritionally at risk, classified as mothers with no or only slight increase in triceps skin fold during the second trimester. Supplementation did not enhance fetal growth in mothers with satisfactory nutritional state.

Musculoskeletal components are more favourably associated with fetal growth than the contribution from adipose tissue. Triceps skin fold thickness norms established for white populations may not be appropriate for other racial groups, which may well have differences in distribution of fat between storage sites in the body (Newcombe, 1985). Adequate nutrition supports the growth of both maternal and fetal tissues. Major alterations affect every maternal organ system and metabolic pathway from the concerted action of several hormones. The two main physiological forces responsible for these changes are a 50% expansion of plasma volume with a 20% increase in hemoglobin mass (Udipi *et al.*, 2000).

Obstetricians have worried that pregnancy increases the risk of obesity in women. With increasing rates of obesity in the United States, postpartum weight retention is an important factor to consider when assessing maternal health and pregnancy outcome. Studies reviewed by the IOM's Committee on Maternal Nutrition in 1990 suggested an average weight retention of 1 kg per birth, although it should be remembered that the mean pregnancy weight gain in these studies was lower than is currently seen in the United States (Abrams *et al.*, 2000).

2.4.1. Postpartum weight retention

A sample of women with a normal prepregnancy BMI was divided into 3 groups according to pregnancy weight gain below, within, and above the IOM's recommended ranges. As shown in Figure 2.1, white women who gained within or below the IOM's recommended ranges had similar weight-retention distributions, but women who gained > 16 kg were much more likely to retain > 6 kg postpartum. Black women show a greater increase in postpartum weight retention with increasing pregnancy weight gain and in all categories of weight gain are more likely to retain ≥ 6 kg than are white women. Among women with weight gains within the IOM's recommended ranges, the median retained weight was 1 kg for white women and 3 kg for black women. Although weight retention was more likely in women with weight gains above the IOM's recommended ranges, even in this group, 45% of white women and 25% of black women had either lost weight or retained < 1.5 kg at 10-18 months postpartum. These data suggest that weight retention is more of a problem for women who gain excessive amounts of weight. Furthermore, although black women are known to be at greater risk of inadequate pregnancy weight gain and low birth weight, in this study they tended to retain more postpartum weight (Abrams *et al.*, 2000).

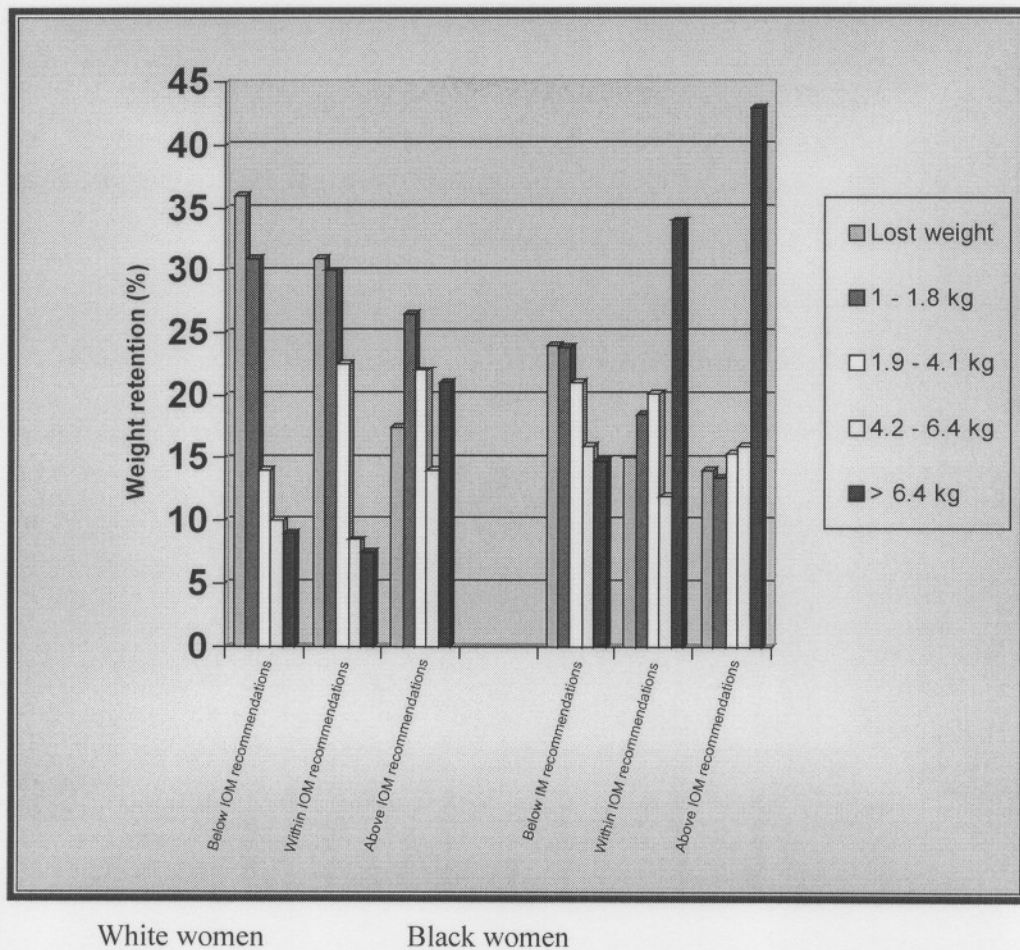


Figure 2.1: Weight retention 10-18 mo postpartum compared with prepregnancy weights of black (n = 133 000) and white (n = 859 000) women with normal prepregnancy weights and pregnancy weight gains below (< 12.4 kg), within (12.5 – 16 kg) and above (> 16 kg) the weight-gain recommendations of the Institute of Medicine (IOM, 1990).

Obligatory weight gain (i.e. of the fetus, placenta, amniotic fluid, uterine and breast tissue and blood volume) is about 7.5 kg in industrialized countries and only 6 kg in the developing ones. Table 2.2 shows the pattern of weight gain during pregnancy. Tissue stores tend to be even lower among mothers in developing countries. The average weight gain is about 11.5 kg, 25% of which is due to the fetus (Udipi *et al.*, 2000).

Table 2.2: Pattern of weight gain in pregnancy (Udipi *et al.*, 2000)

Period	Weight gain (kg/week)	Tissues
1 st trimester	0.1	-
2 nd trimester	0.34 – 0.5	Blood volume, breast and uterus tissue
3 rd trimester	0.34 – 0.5	Fetus, placenta and amniotic fluid

2.5 Methods for measuring body composition

Although measurement of weight gain can be a clinically useful screening method for identifying some pregnancies that are progressing abnormally, it provides very limited information regarding changes in body composition of an individual pregnant woman, even when weight gain is close to the average for normal pregnancies. Information on body composition would add substantially to understanding of the meaning of a given weight gain. Fetal growth may be influenced more by specific maternal tissue changes, for example, by accretion of lean tissue, fat, or body water, than by gestational weight gain (IOM, 1990).

2.5.1 Standard methods

In the most widely used model for examining body composition, the body is regarded as being composed of only two compartments – fat and lean. In this usage, lean body mass represents a mixture of all the nonfat tissues of the body. Most techniques currently used to estimate body composition are based on measuring the qualities of the lean body tissues. Of the commonly used methods, only density measurements are dependent on both fat and lean tissue, but the fat estimate is still highly influenced by the variability of the lean tissue density. In the two-compartment model, the weight of fat is the difference between two large masses – body weight and lean body mass. Therefore, small relative errors in the lean body mass estimation will produce a much larger relative error in calculated body fat. There are three standard methods for estimating lean body mass: measurement of total body water, determination of total body potassium content, and underwater weighing, which permits estimation of both fat and lean tissue (IOM, 1990).

2.5.2 *Total body water*

To calculate lean tissue from total body water, the water content of the lean tissue must be known. Although the average percentage of water in lean tissue is known with fair accuracy in adult women, the non-fat tissues added during pregnancy (edema fluid, fetus, amniotic fluid, and plasma) contain a high percentage of water. Thus, pregnancy may increase the water content of lean tissue from approximately 72.5% at 10 weeks of gestation to about 75.0% at 40 weeks in women with generalized edema (IOM, 1990).

2.5.3 *Underwater weighing*

Underwater weighing is based on the assumption that the weight of fat and lean tissue can be estimated from total body density by using standard values for the average densities of fat and lean tissues. Because of the increased hydration of lean tissue during pregnancy, and especially because added tissue includes little bone, which is dense, the density of the lean body mass is likely to decline during pregnancy. The true mean density of the lean body tissue differs among individuals because of differing proportions of the organs, muscle, and bone comprising the lean body and may also change to varying degrees over the course of pregnancy. This might occur because of the differential growth of various tissues, especially those with high water content and no bone (IOM, 1990).

2.5.4 *BOD POD (Air Displacement Plethysmography) and DXA (Dual-energy x-ray absorptiometry)*

Two particularly promising techniques are air displacement plethysmography (the BOD POD) and dual-energy x-ray absorptiometry (DXA). The literature suggests that because of practicality, the underwater hydrostatic method of assessing body composition is increasingly being displaced by the BOD POD technique, where the participant is immersed not in water, but rather in a closed air-filled system consisting of one chamber that holds the participant and a second chamber that serves as a reference volume. With the participant in one chamber, the door is closed and sealed, the pressure increased slightly, and a diaphragm separating the two chambers oscillates

to slightly alter the volumes. Another method for measuring body composition that is widely used in clinical research is DXA. However, because of expense, and in some cases state radiation regulatory law, DXA may not be practical or available to the public for body composition assessment (Maddalozzo *et al.*, 2002).

2.5.5 *Body mass index*

A growing literature supports the use of the BMI (defined as weight in kilograms divided by the square of height in meters) as a predictor of the impact of body weight on morbidity and mortality risks. As an index of healthy weight and as a predictor of morbidity and mortality risk, it has supplanted weight-for-height tables, which were derived primarily from white populations and relied on questionable estimates of frame size. BMI, although only an indirect indicator of body composition, is now used to classify underweight and overweight individuals. While sophisticated techniques are available to precisely measure fat-free mass (FFM) and fat mass of individuals, these techniques are used mainly in research protocols. For most clinical and epidemiological applications, body size is judged on the basis of the BMI, which is easy to determine, accurate, and reproducible. The main disadvantages of relying on the BMI are:

- That it does not reliably reflect body fat content, which is an independent predictor of health risk.
- That very muscular individuals may be misclassified as overweight (FNB, 2002).

2.5.6 *Total body potassium*

Measurement of total body potassium can be used to estimate lean body mass if a standard value for the concentration of potassium in the lean tissues is assumed. The vast majority of the body's potassium (approximately 98%) is intracellular; therefore, total body potassium is actually a reflection primarily of the intracellular compartment. Substantial changes in the extracellular compartment can go undetected. For this method to give a good estimate of the weight of total lean tissue, the ratio of intracellular to extracellular tissue must be either close to the norm or assessed

independently. This ratio of intra- to extra cellular water decreases during pregnancy, resulting in overestimation of fat if not corrected (IOM, 1990).

Despite their limitations total body water, underwater weighing, and total body potassium are the three best methods for studying body composition in pregnant women. However, measurement of total body potassium and underwater weighing require special, large equipment and considerable patient cooperation, and estimation of total body water requires special isotopes that are expensive to use and measure. These considerations have encouraged the use of simpler methods, such as measurement of skin fold thickness with calipers (IOM, 1990).

2.5.7 Skin fold thickness

Changes in skin fold thickness have been widely used to estimate changes in the fat content of pregnant women. Skin fold thickness measurements suggest that more maternal fat is accumulated centrally than peripherally. Skin fold thickness can be measured quickly with relatively inexpensive equipment. Proper use requires extensive training and monitoring to consistently achieve reproducible measurements. To convert skin fold thickness measurements to estimates of body fat, standard regression equations are used. The most widely used regression equations for interpreting skin fold thickness in pregnant women have been developed in studies of nonpregnant subjects. Longitudinal studies of skin fold thickness in late pregnant women suggest that skin fold thickness in late pregnancy may be increased by water retention. The magnitude of this hydration effect may also vary from one measurement site to another. Especially during late pregnancy, skin fold thickness measurements may be less indicative of body fat content. By combining skin fold thickness measurements with arm circumference measurements, it is possible to estimate arm muscle area, which reflects the amount of lean tissue (IOM, 1990).

➤ ISSUES TO CONSIDER WHEN EXAMINING RESULTS OF PREGNANCY BODY COMPOSITION STUDIES:

- Each body composition method is based on underlying assumptions, and correction factors are needed to adjust for changes in the lean body during pregnancy. Without these corrections, total body water tends to underestimate total body fat and both underwater weighing and total body potassium tend to overestimate it.
- In the future, multi-compartment models of body composition need to be used in studies of larger numbers of pregnant women. Attention must also be given to differences in the gestational period studied, weight gain, initial weight, maternal age, ethnic background, and parity.
- Skin fold thickness may be useful for research purposes, but the currently used reference equations may not permit calculation of actual total body fat changes. Because of its potential for clinical as well as research use, measurement of skin fold thickness needs to be standardized against reference methods in a large number of pregnant women.
- For the development of dietary and weight gain recommendations, more information is needed on the relationship of weight gain to body fat gain in individual women. Studies of the effects of composition changes on other outcomes are also needed (IOM, 1990).

Maternal insulin resistance is one factor that affects the relationship between fetal and maternal weight gain. Two techniques used to measure body fat distribution are computed tomography (CT) and magnetic resonance imaging (MRI). However, they use radiation and strong magnetic fields, which are prohibited during pregnancy. Ultrasound is safe and is highly correlated to computed tomography CT– derived measures of visceral adiposity. The skin fold calliper measurement of subcutaneous fat at the subscapular site is the best predictor of insulin resistance, better than BMI. It seems if most of the adipose tissue retained during pregnancy is stored subcutaneously on the trunk and that maternal visceral adiposity increases minimally during gestation (Stevens-Simon *et al.*, 2002).

Of the anthropometric variables, only maternal weight and triceps skin fold were significantly related to birth weight. Triceps skin fold correlated negatively with birth

weight. In other words, for a given maternal weight, the fattest mothers had the smallest newborns (Briend, 1985).

2.6 *Energy and macronutrient requirements during pregnancy*

2.6.1 *Energy*

Pregnancy and lactation are both conditions where the average requirements for energy of a woman might be expected to increase considerably. It is possible to calculate, with substantial theoretical accuracy, the extra energy required by the mother to increase her own tissues and fluids appropriately, and to produce a normal healthy baby, and after the baby is born, to breastfeed it for six months or longer. It is recommended that pregnant women who remain on “full activity” – which presumably means that there is no change in the way of life, nor a change of biological nature – need an *extra* 285 kcal (1 197 kJ) per day. Lactating women (either in the first 6 months, or after 6 months) need an *extra* 500 kcal (2 100 kJ) per day (Durnin, 2002).

These represent quite considerable additions to the average diet of a non-pregnant, non-lactating woman. Thus, in areas where chronic energy deficiency exists, and where food availability is therefore restricted, the implication is that either physical activity needs to be quite markedly reduced, or supplementation needs to be provided on an extensive scale. In fact, not only would physical activity need to be diminished proportionately to the energy-saving required, but the diminution would be disproportionate, since the heavier body mass of the pregnant woman means that everything she does – from sleeping to housework, walking, working in the fields – would use up more energy than in the pre-pregnant state when body mass is less. Such a decrease in activity places a burden not only on the woman, but also on the members of the family who receive less help and attention. If the extra requirements of energy need to be met in full, they become quantitatively probably by far the most important demand on any allocation of food supplements available for a community. It is therefore a matter of some significance to know whether or not pregnancy and lactation really require these considerable extra quantities of energy, particularly in the light of the comparative dearth of well-controlled experimental studies, together with the conflicting nature of some of the data (Durnin, 2002).

In the use of weight gain to identify suboptimal pregnancies, the variability in the components of weight gain must be recognized. These include the products of conception (fetus, placenta, and amniotic fluid), uterine and breast tissue, extracellular fluid, and maternal fat. These components change over the course of pregnancy and to different extents in different individuals, markedly affecting the interpretation of weight gain (Durnin, 2002).

In developed countries, it seems like only small extra intakes of energy are necessary to satisfy requirements. The extra energy requirement seems to be much less than 100 kcal (420 kJ) per day, and a recommendation of this quantity should be more than adequate for their needs (Durnin, 2002). Various data suggest that for undernourished women an additional 100 kcal (420 kJ) ingested daily throughout pregnancy would increase the birth weight by about 100 g, as compared to a 35 g increase in birth weight of infants born to non-malnourished mothers (Udipi *et al.*, 2000).

The total energy cost of pregnancy can be divided into 3 parts: the obligatory need for energy deposited in the products of conception, maternal fat storage, and the extra energy need for basal metabolism to maintain newly synthesised tissues (Kopp-Hoolihan *et al.*, 1999). Studies in well-nourished women indicate that the resting metabolic rate (RMR) increases gradually throughout pregnancy, reaching 1213-2430 kJ/d higher than prepregnant values by the end of pregnancy (Kopp-Hoolihan *et al.*, 1999).

The overall conclusions from the present studies have shown, *by actual measurement* that the energy costs of pregnancy are about 70,000 kcal (294,000 kJ). This ought to imply that pregnant women, on average, need 70,000 extra kcal in their diet. Adaptations appear to occur in normal pregnancy, which result in considerable savings of energy, probably in subtle ways by which physical activity is almost unnoticeably reduced. Whether this reduction has social or/and economic consequences seems unlikely, although this is still something for speculation. If it has no serious drawbacks, perhaps this may have weighty implications for supplementation programs (Durnin, 2002).

If energy supplies are limited, adaptations spare energy for fetal growth; if energy is abundant, energy balance may be achieved in different ways depending on individual behavioural changes in food intake or activity patterns and on adjustments in basal metabolism or fat deposition (King *et al.*, 1994). Thyroid volume and thyroid function adapt in a physiological way to meet the increased demands for iodine and energy (Berghout & Wiersinga, 1998).

Leptin levels correlate with gestational weight gain. The leptin concentration during pregnancy is higher than the postpartum level. There are no relationships between leptin and insulin or glucose. During pregnancy, there is augmented energy expenditure and maternal metabolism is altered to increase fat stores. The present observation that leptin levels were elevated in pregnant women suggests an additional role for leptin in the accumulation of body fat (Stock & Bremme, 1998).

The most recent Recommended Dietary Allowances (RDAs) and Adequate Intakes (AIs) are shown in Table 2.3. Table 2.4 shows the recommended daily food guide for women to meet the increased requirements of pregnancy.

Table 2.3: Dietary Reference Intakes: RDAs and AIs for women (FNB & IOM, 2002 and Mahan & Escott-Stump, 2000).

	15-18 yr of age	19-30 yr of age	31-50 yr of age	Pregnant			Lactating		
				≤18yr	19-30yr	31-50yr	≤18yr	19-30yr	31-50yr
Energy (kJ)	9240	9240	9240	9240	9240	9240	9240 + 2100	9240 + 2100	9240 + 2100
- 1 st trimester				+ 0	+ 0	+ 0			
- 2 nd trimester				+ 1260	+ 1260	+ 1260			
- 3 rd trimester				+ 1260	+ 1260	+ 1260			
Protein (g)	44	46	50	60	60	60	65	65	65
Vitamin A (µg RE) ¹	700	700	700	750	770	770	1200	1300	1300
Vitamin D (µg) ²	5*	5*	5*	5*	5*	5*	5*	5*	5*
Vitamin E (mg) ³	15	15	15	15	15	15	19	19	19
Vitamin K (µg)	75*	90*	90*	75*	90*	90*	75*	90*	90*
Vitamin C (mg)	65	75	75	80	85	85	115	120	120
Thiamin (mg)	1.0	1.1	1.1	1.4	1.4	1.4	1.4	1.4	1.4
Riboflavin (mg)	1.0	1.1	1.1	1.4	1.4	1.4	1.6	1.6	1.6
Niacin (mg) ⁴	14	14	14	18	18	18	17	17	17
Vitamin B ₆ (µg)	1.2	1.3	1.3	1.9	1.9	1.9	2.0	2.0	2.0
Folate (µg) ⁵	400	400	400	600	600	600	500	500	500
Vitamin B ₁₂ (µg)	2.4	2.4	2.4	2.6	2.6	2.6	2.8	2.8	2.8
Biotin (µg)	25*	30*	30*	30*	30*	30*	35*	35*	35*
Pantothenic acid (mg)	5*	5*	5*	6*	6*	6*	7*	7*	7*
Choline (mg) ⁶	400*	425*	425*	450*	450*	450*	550*	550*	550*
Calcium (mg)	1300*	1000*	1000*	1300*	1000*	1000*	1300*	1000*	1000*
Phosphorus (mg)	1250	700	700	1250	700	700	1250	700	700
Magnesium (mg)	360	310	320	400	350	360	360	310	320
Fluoride (mg)	3*	3*	3*	3*	3*	3*	3*	3*	3*
Iron (mg)	15	18	18	27	27	27	10	9	9
Zinc (mg)	9	8	8	12	11	11	13	12	12
Iodine (µg)	150	150	150	220	220	220	290	290	290
Selenium (µg)	55	55	55	60	60	60	70	70	70
Chromium (µg)	24*	25*	25*	29*	30*	30*	44*	45*	45*
Copper (µg)	890	900	900	1000	1000	1000	1300	1300	1300
Manganese (mg)	1.6*	1.8*	1.8*	2.0*	2.0*	2.0*	2.6*	2.6*	2.6*

- This table presents RDAs and AIs. The AIs are followed by asterisk (*), while the others represent the RDAs
- Footnotes are shown on page 21

¹ 1 RE = 1 µg retinal, 12 µg β-carotene, 24 µg α-carotene, or 24 µg cryptoxanthin. To calculate RAEs from RES of provitamin A carotenoids in foods, divide the RE's by 2. For preformed vitamin A in foods or supplements and for provitamin A carotenoids in supplements, 1 RE = 1 RAE (Retinol activity equivalents).

² calciferol. 1 µg calciferol = 40 IU vitamin D

In the absence of adequate exposure to sunlight

³ As α-tocopherol. α-Tocopherol includes RRR-α-tocopherol, the only form of α-tocopherol that occurs naturally in foods, and the 2R-stereoisomeric forms of α-tocopherol (RRR-, RSR-, RRS-, and RSS-α-tocopherol) that occur in fortified foods and supplements. It does not include the 2S-stereoisomeric forms of α-tocopherol (SRR-, SSR-, SRS-, and SSS-α-tocopherol), also found in fortified foods and supplements.

⁴ As niacin equivalents (NE). 1 mg of niacin = 60 mg of tryptophan; 0 – 6 months = preformed niacin (not NE).

⁵ As dietary folate equivalents (DFE). 1 DFE = 1 µg food folate = 0.6 µg of folic acid from fortified food or as a supplement consumed with food = 0.5 µg of a supplement taken on an empty stomach.

In view of evidence linking folate intake with neural tube defects in the fetus, it is recommended that all women capable of becoming pregnant consume 400 µg from supplements or fortified foods in addition to intake of food folate from a varied diet.

⁶ Although AIs have been set for choline, there are few data to assess whether a dietary supply of choline is needed at all stages of the life cycle, and it may be that the choline requirement can be met by endogenous synthesis at some of these stages.

Energy is the major nutrient determinant of gestational weight gain, although specific nutrient deficiencies may restrict that gain. Extra energy is required during pregnancy for the growth and maintenance of the fetus, placenta, and maternal tissues. Basal metabolism increases because of the increased mass of metabolically active tissues; maternal cardiovascular, renal, and respiratory work; and tissue synthesis. Energy requirements are greatest between 10 and 30 weeks of gestation, when relatively large quantities of maternal fat normally are deposited (IOM, 1990).

Table 2.4: Daily food guide for women (Mahan & Escott-Stump, 2000)

FOOD GROUP	MINIMUM NUMBER OF SERVINGS		
	Non-pregnant 11-24 yr old	Non-pregnant 25-50 yr old	Pregnant/Lactating 11-50 yr old
Protein foods	5 ¹	5 ¹	7 ²
Milk products	3	2	3
Breads, grains	7	6	7
Whole-grain	4	4	4
Enriched	3	2	3
Fruits, vegetables	5	5	5
Vitamin C-rich	1	1	1
Beta-carotene-rich	1	1	1
Folate-rich	1	1	1
Other	2	2	2
Unsaturated fats	3	3	3

¹ At least three servings per week should be from vegetable proteins

² At least one of these servings per day should be from vegetable proteins

2.6.2 Protein

Although the need for additional protein to support the synthesis of maternal and fetal tissues is well recognized, the required magnitude of the increase is uncertain. Efficiency of protein utilization in pregnant women appears to be about 70%, the same as that observed in infants. Needs are also variable, increasing as pregnancy proceeds, with greater demands occurring during the second and third trimesters. The current RDA of 60 g of protein for pregnant women represents an additional 10 to 16 g per day over non-pregnant protein requirements (Mahan & Escott-Stump, 2000). The maximum daily accretion of protein occurs in the final weeks of pregnancy. The requirements during pregnancy have been computed on the basis of N accretion for fetal growth and expansion of maternal tissue. It has been estimated that in the three trimesters of pregnancy, in a well nourished pregnant woman who gains 12 kg of body weight, daily the amount of nitrogen deposited are 0.1, 0.5 and 0.9 g respectively. The Expert Committee of the Indian Council of Medical Research (ICMR) has

recommended that the additional protein intake should be 15 g per day (Udipi *et al.*, 2000).

Protein deficiency during pregnancy has adverse consequences, but limited intakes of protein and energy usually occur together, making it hard to separate the effects of energy deficiency from those of protein deficiency. Studies have shown that providing extra energy to mothers influences pregnancy outcome as much as providing energy and protein together. Thus, it appears that it is usually the energy deficit and not the protein deficit that determines unfavourable pregnancy outcomes (Mahan & Escott-Stump, 2000).

2.6.3 *Carbohydrates and Fat*

There are no particular requirements for extra carbohydrate and fat which would be met by a normal diet. The linolenic acid requirement during pregnancy is 4.5% of energy (Udipi *et al.*, 2000).

2.7 *Metabolism during pregnancy*

Metabolic costs of pregnancy are extremely flexible and are influenced by maternal prepregnancy energy status, energy intake during pregnancy, or fetal size, or some combination of these. If the energy supply is limited, as among women with low fat stores at conception, metabolic adaptations may occur to spare energy for fetal growth. These women do not lose metabolically active lean tissue, and the decline in basal metabolic rate (BMR) results from a reduction in expenditure per kg FFM. The opposite appears to occur among overweight pregnant women. The mass-specific change in metabolism seems to be enhanced in women with ample fat reserves at conception. Possibly, further deposition of fat is unnecessary in this population, and basal energy expenditure is elevated to offset the propensity to deposit fat during gestation. Although energy intake and fetal size also influence the metabolic response, the amount of maternal fat reserves at conception is probably a more important determinant among all pregnant women worldwide (King *et al.*, 1994).

FFM is the major determinant of the RMR and accounts for a fairly large part of the remaining variation, suggesting genetic determination. Indirect evidence suggests that the gluteal-femoral depot of women is reserved for the need of the growing fetus and for lactation, because it seems to be mobilizable effectively only during late pregnancy and lactation (Björntorp, 1989).

There are higher rates of energy expenditure and preferred use of carbohydrate during pregnancy and lactation. Certain hormones, including epinephrine and dopamine are positively associated with total energy expenditure and metabolic rate measurements. Energy expenditure is also influenced by body composition and hormone status (Butte *et al.*, 1998).

2.8 Exercise

Energy expended in voluntary physical activity is the largest variable in overall energy expenditure. Activities involving body movement require an increase in energy expenditure proportional to the increase in body weight. Most pregnant women compensate, however, by slowing their work pace as weight gain proceeds, so that total energy expenditure during a day may not be substantially greater than before. For those women who become pregnant while maintaining an exercise program, it appears that continuing with the exercise does not affect the rate of weight gain or fat deposition during the first trimester. However, after the 15th week of gestation, regular exercise does reduce fat deposition and weight gain. The overall pregnancy weight gain, however, usually still remains appropriate. Because individuals vary considerably in level and intensity of activity, it is best to advise women to eat enough to satisfy their physiological appetite and support an appropriate rate of weight gain. Excessive exercise, combined with inadequate energy intake, may lead to sub-optimal maternal weight gain and poor fetal growth (Mahan & Escott-Stump, 2000).

Some studies have shown job related physical “activity” to be related to unfavourable birth outcomes, including premature delivery and low birth weight. However, most studies have not controlled for socio-economic status, nor has actual physical activity been well quantified throughout gestation. Similarly, results of the relationship between leisure time physical activity and birth weight are mixed. Current evidence appears to indicate that participation in moderate to vigorous activity throughout pregnancy may

enhance birth weight, while more severe regimens may result in lighter offspring. Careful quantification of caloric balance during pregnancy in chronic exercisers is needed before further conclusions can be drawn. The interaction between energy expenditure (whether job related or leisure time) and energy consumptions must be addressed to determine whether physical activity per se may affect birth outcome, or if it is merely a confounder (Pivarnik, 1998).

According to the American Dietetic Association (ADA, 2002), depending on its type, frequency, duration, and intensity, exercise may confer health benefits to both mother and fetus. Thus, healthy women with uncomplicated pregnancies may continue moderate exercise on a regular basis, but they should be advised about appropriate activities and contraindications. A woman who has not been exercising before pregnancy should talk to her doctor first before starting an exercise program because pregnancy loosens ligaments, and excessive exercise can increase core temperatures (ADA, 2002 and Mahan & Escott-Stump, 2000). Activities at a low to moderate intensity level are generally safe and may include walking, swimming, running, aerobic dancing, and riding on a stationary bicycle. Activities that may not be safe include ball games that increase risk of abdominal trauma, weight lifting, scuba diving, marital arts, anaerobic exercise (sprinting), exercise above 2,500 meters of altitude and any exercise with a high risk of falling or requiring balance, especially in late pregnancy. Exercise is contraindicated for women with pregnancy-induced hypertension, toxemia, preeclampsia, preterm rupture of membranes, history of preterm labor, persistent second or third trimester bleeding, incompetent cervix, or any sign of intrauterine growth retardation. Pregnant women who exercise should be especially careful to maintain an adequate intake of calories, nutrients, and fluid and to avoid strenuous exercise (ADA, 2002).

2.9 Pregnancy weight gain

The normal weight distribution is illustrated in Figure 2.2. Less than half of the total weight gain resides in the fetus, placenta, and amniotic fluid; the remainder is found in maternal reproductive tissues, fluid, blood and “maternal stores”, a component composed largely of body fat. Gradually increasing subcutaneous fat in the abdomen, back, and upper thigh serves as an energy reserve for pregnancy and lactation (Mahan & Escott-Stump, 2000).

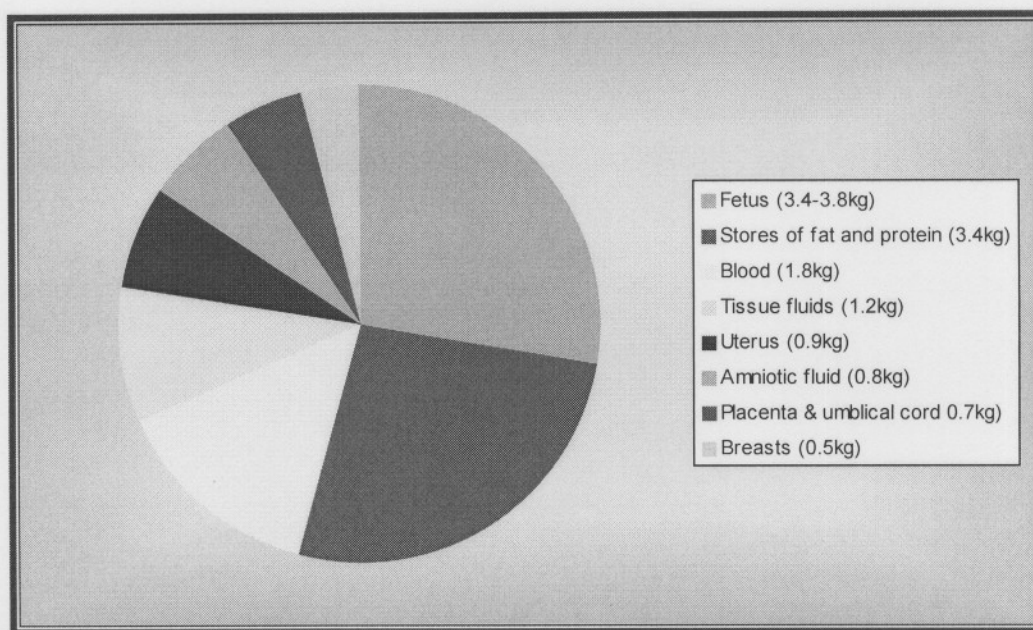


Figure 2.2: Distribution of weight gain during pregnancy; total weight gain given as 12.6-13.05 kg (Adapted from Mahan & Escott-Stump, 2000)

Pregnancy weight gain within the IOM's recommended ranges are associated with the best outcome for both mothers and infants (Table 2.5). However, weight gain in most pregnant women is not within the IOM's ranges. Weight gains outside the IOM recommended ranges are associated with twice as many poor pregnancy outcomes than are weight gains within the ranges. Women with low weight gains are more likely to be young, short, thin, less educated, smokers, and black. Women with excessive weight gains are more likely to be tall, heavy, primiparous, hypertensive, and white. An increased risk of low weight gain was also reported in white women who had poor scores on psychosocial scales measuring trait anxiety, depression, mastery, and self-

esteem, although they found no such effect in black women. Physical abuse, poor financial support, alcohol consumption, smoking, poor diet and poor compliance with prenatal care are associated with low or high weight gain in pregnancy (Abrams *et al.*, 2000).

Table 2.5: Recommended weight gains for pregnant women based on body mass index (BMI) (Mahan & Escott-Stump, 2000).

Weight category based on BMI ¹	Total weight gain	1 st trimester gain	2 nd & 3 rd trimester weekly gain
	kg	kg	kg
Underweight (BMI < 19.8)	12.5 – 18	2.3	0.49
Normal weight (BMI = 19.8- 26)	11.5 – 16	1.6	0.44
Overweight (BMI > 26 – 29)	7 – 11.5	0.9	0.3
Obese (BMI > 29)	6		

¹BMI: Body Mass Index → weight (kg)/height (m)²

Figure 2.3 presents curves of desirable weight gain during pregnancy, as recommended by the Subcommittee on Nutritional Status and Weight Gain During Pregnancy. Women who are of normal weight prior to pregnancy should aim for a weight gain in the B-D (11.3 – 15.9 kg) range during pregnancy. Underweight women should gain in the C-E (12.7 – 18.1 kg). Women who are overweight prior to pregnancy should gain in the A-B (6.8 – 11.3 kg) range (Mahan & Escott-Stump, 2000).

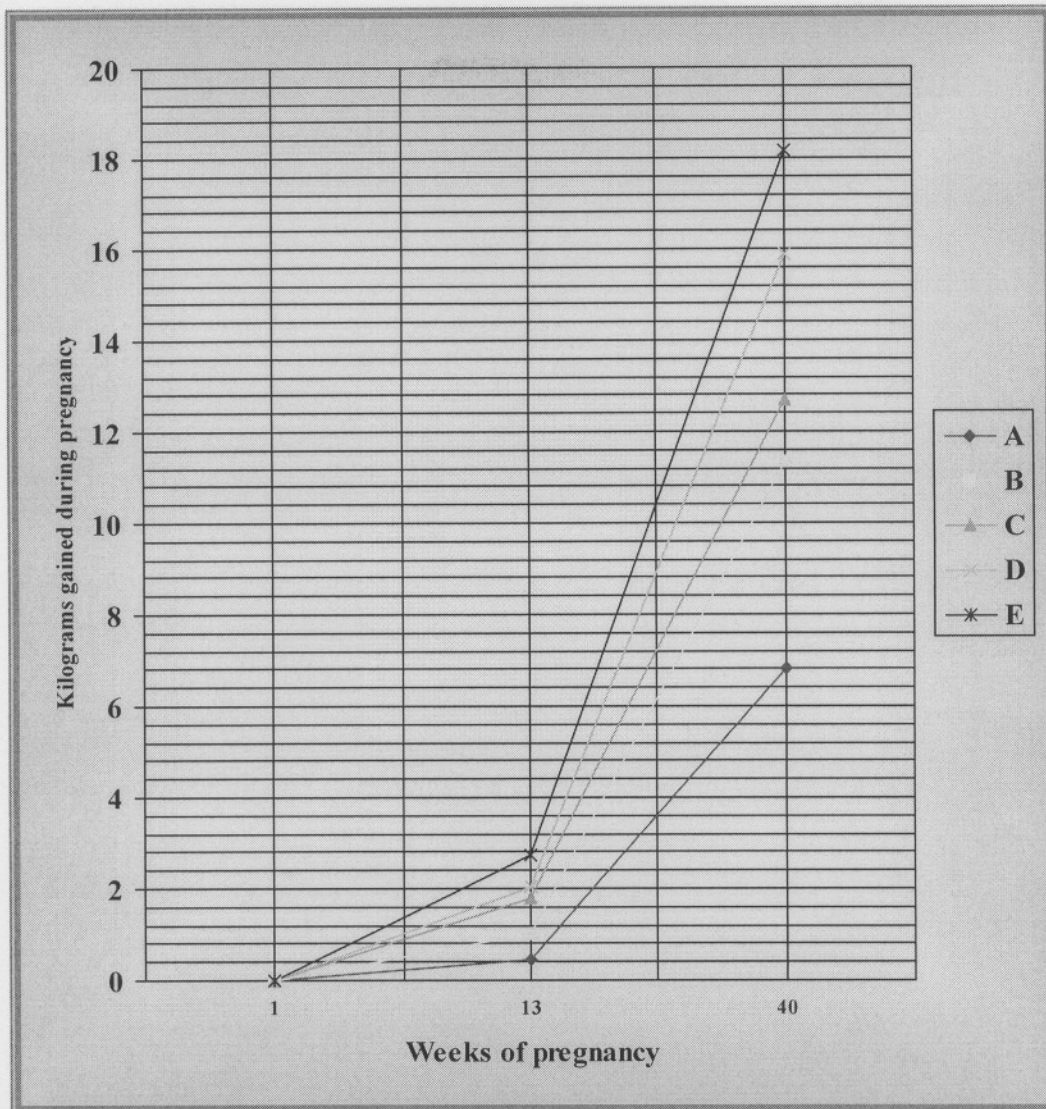


Figure 2.3: Ranges of weight gain during pregnancy. Women who are of normal weight prior to pregnancy should aim for a weight gain in the B-D (11.3 – 15.9 kg) range during pregnancy. Underweight women should gain in the C-E (12.7 – 18.1 kg). Women who are overweight prior to pregnancy should gain in the A-B (6.8 – 11.3 kg) range (Adapted from Mahan & Escott-Stump, 2000).

Recommendations for weight gain during pregnancy should be individualized according to prepregnancy BMI to improve pregnancy outcome, avoid excessive maternal postpartum weight retention, and reduce risk of adult chronic disease in the child. Prenatal weight gain within the IOM recommended ranges is associated with better pregnancy outcomes, but many women do not gain within these ranges. Women with a BMI <19.8 are at high risk of delivering a low birth weight infant if their prenatal weight gain is inadequate. However, even women with a BMI >29.0 should gain at

least 7.0 kg; those who lose weight or gain less than 6 kg are more likely to deliver an infant that is small for gestational age infant. Women with a BMI >29.0 should be advised to gain at a rate that does not exceed 11.4 kg throughout total pregnancy to reduce risk of postpartum weight retention. Excessive weight gain in women with a BMI >26 should also place the child at risk of being large-for-gestational-age which, in turn, has been associated with excess body fat during childhood (ADA, 2002).

If the prepregnancy weight is not available to determine the prepregnancy BMI or total weight gain, a linear and logistic regression with adjustment for timing of measurements and length of gestation can be statistically performed (Olson & Strawderman, 2003).

The timing of prenatal weight gain is also important. Regardless of the mother's pregravid weight, low weight gain in either the second or third trimester increases the risk of intrauterine growth retardation. Low weight gain in the third trimester is also associated with a higher risk of preterm delivery (ADA, 2002).

Chapter 3: The association between pregnancy weight gain and outcomes: the Thusa Mama study

- 3.1 Introduction
 - 3.2 Methodology
 - 3.3 Results
 - 3.4 Discussion
 - 3.5 Conclusion and recommendations
-

3.1 Introduction

Weight gains within the IOM recommendations are associated with healthy fetal and maternal outcomes; weight gains below these goals are associated with low infant birthweight and higher weight gains are associated with macrosomia in the infant (Lederman, 1993 and Parker & Abrams, 1992). Moreover, women who gain more than recommended retain twice as much weight after pregnancy as women who gain within the recommendations (Keppel & Taffel, 1993 and Scholl *et al.*, 1995). Weight gain during pregnancy may thus contribute to the development of obesity in young women (Polley *et al.*, 2002). In their position statement, the ADA (2002) states that: “*It is the position of the American Dietetic Association that women of childbearing potential should maintain good nutritional status through a lifestyle that optimises maternal health and reduces the risk of birth defects, suboptimal fetal development, and chronic health problems in their children. The key components of a health-promoting lifestyle during pregnancy include appropriate weight gain; consumption of a variety of foods in accordance with the Food Guide Pyramid; appropriate and timely vitamin and mineral supplementation; avoidance of alcohol, tobacco, and other harmful substances; and safe food-handling. In particular for medical nutrition therapy, pregnant women with*

inappropriate weight gain, hyperemesis, poor dietary patterns, phenylketonuria (PKU), certain chronic health problems, or a history of substance abuse should be referred to a qualified dietetics professional." The aim of the Thusa Mama Study was to evaluate the association between prepregnancy BMI as well as maternal weight gain during pregnancy and pregnancy outcomes. This includes a number of factors that have an impact on appropriate weight gain. Factors that were investigated in this study, were maternal health problems through the measurements of blood pressure, haemoglobin levels, smoking, parity and urine tests as well as socio-demographic background, dietary intake (especially energy, protein, iron and calcium) and pregnancy-related dietary problems. Outcomes that were investigated were mainly infant outcomes and included the baby's birth weight, birth length and head circumference.

3.2 Methodology

A letter was written to the District Manager, Department of Health to gain permission to conduct the study in the Potchefstroom Primary Health Care Clinic. Permission was granted and women visiting the Ante Natal Clinic (ANC) at the Potchefstroom Clinic in Potchefstroom were asked to volunteer as participants for the study. The inclusion criteria are listed in Table 3.1. All participants ($n = 96$) signed an informed consent form (Appendix A). The project has been approved by the Ethics committee of the North-West University. Background information (including age, educational status, occupational status, average household income, marital status and pregnancy history) of the participants were gathered by Dietitians and final year Dietetic students from the Potchefstroom University using a demographic questionnaire (Appendix B). Information regarding their nutritional intake and factors influencing their intake were gathered using a questionnaire with common problems experienced during pregnancy (nausea, vomiting, constipation and pica), which is attached as Appendix C and a Food Frequency Questionnaire (FFQ), attached as Appendix D. Food portion photo books were used to estimate portion weights. Dietitians and trained fieldworkers did the interviews with the patients. A Maternal Health questionnaire (Appendix E) was used to fill in other details measured by a qualified nurse in the Clinic, such as blood pressure, Symphyseal Fundal (SF)-measurement, smoking status, allergies, parity and hemoglobin levels (Haemoglobin meter). Urine samples were also tested for the presence of ketones, glucose, blood, nitrites or protein. The Clinic nurses did blood

tests for Human Immunodeficiency Virus (HIV) only for subjects who gave their consent. A blood test for Sexually Transmitted Diseases (STD) was done for all subjects.

Table 3.1: Inclusion criteria for the Thusa Mama Study

Inclusion Criteria:

- Pregnant women
- Black or coloured ethnic group
- On their first visit to the clinic
- Still within the first 28 weeks of pregnancy
- Living (sleeping) in the Potchefstroom municipal area (town, Ikageng, with the exclusion of the most remote extension and those living on farms) for follow-up
- Planning to give birth in the Potchefstroom Hospital
- Expecting one baby only (not twins and triplets)

To determine the weight gain during pregnancy and bodily changes during pregnancy, each participant's weight, height, triceps and subscapular skin fold, as well as their MUAC were measured and recorded on a form similar to the one in Appendix F. It was decided to use only the above-mentioned measurements for this study and not all those measurements shown on the form, as they are not applicable and easily interpreted. The weight was measured using a Precision electronic scale (A & D Company, Tokyo, Japan), the height by using the clinic's own equipment (stadiometer) and the skin folds with a caliper (John Bull, British Indicators, London, UK). Each skin fold was taken three times and the averages of the three folds were used. The MUAC was measured using a Lufkin steel tape (Cooper Tools, Apex, NC). The anthropometry measurements were done by Dieticians, final year Dietetic students and post-graduate Sport Science students. Pregnancy weight gain was categorized as optimal weight gain; insufficient weight gain and excessive weight gain according to the IOM guidelines. For statistical analysis a regression analysis to estimate the mother's prepregnancy weight in order to

calculate the prepregnancy BMI, as described by Olson and Strawderman (2003) was used. The regression was done back to week 14 (gestational age), as the weight gain is more linear from there on and thus to give a more realistic regression analysis. Weight gain between visits was used to calculate weekly weight gain. Partial correlation coefficients were calculated using *Statistica*[®] for the association between prepregnancy BMI, as well as weekly weight gain and birth weight, length and head circumference of the baby, with adjustment for smoking and HIV status. The correlation coefficient for the association between mean MUAC of the mother and birth weight of the baby was also calculated.

Each participant was followed-up for a minimum of three visits. Where possible, the first visit was done within 20 to 28 weeks of gestation, the second within 30 to 32 weeks and the third within 36 to 38 weeks. Most participants were followed up for more than three visits. Taxi fees were reimbursed at each visit (R10/visit).

At birth, a hospital visit was done to record the infant's birth weight, which was measured by the hospital with a spring scale (Salter model 40A, Japan); length and head circumference, measured with a unstretchable tailoring tape made of linen (Butterfly brand, China), gestational age and apgar score were recorded. The form used for data collection is attached as Appendix G. To determine the gestational age of the baby, the hospital used the following criteria: Sonar dates (for most of the babies), palpations and for premature babies, the *Farr system* (Harrison *et al.*, 1999).

Mothers at risk for poor pregnancy outcomes (underweight, positive HIV status and those not gaining enough weight during pregnancy) received all possible help, such as advice from the dietitians, medical care and standard clinic nutritional supplements (Folic acid, Iron and vitamin C tablets and a ready-mix meal if the mother qualified for the Protein Energy Malnutrition (PEM) scheme).

3.3 Results

Of the ninety-four women included in the study, data of eighty ($n = 80$) women could be analysed. Two pregnancies ended in miscarriage and 12 were lost to follow-up. Numbers may vary due to incomplete data.

Table 3.2 shows the demographic data of the group ($n = 94$) collected through a demographic questionnaire on the first visit to the clinic. Figure 3.1 shows the participants who have experienced these problems during the first, second and third trimester of pregnancy. Figure 3.2 shows the women who gained adequate, inadequate and excessive weight according to the IOM's recommendation (IOM, 1990).

Table 3.2: Demographic data of the participants (n=96, numbers may vary due to incomplete data)*

Demographic data	N
First language:	
Tswana	66
Sotho	17
Xhosa	9
Zulu	1
English	1
Afrikaans	1
Second language:	
Tswana	2
Sotho	2
Xhosa	1
Zulu	0
English	51
Afrikaans	28
Marital status:	
Live with husband	16
Live with partner, baby's father (not married)	29
Live with partner, not baby's father (not married)	2
Widow, live alone with other relatives	1
Divorced, live alone with other relatives	-
Never married, live alone	1
Never married, live with relatives/ friends	45
Other children:	
Yes	51
No	44
Highest qualification:	
None	7
< Grade 8	17
Grade 8 – 10	9
Grade 8 – 10 + trade	7
Grade 11 – 12	36
Grade 11 – 12 + trade	11
Grade 12 + Technikon, University, College	8
Employment:	
Employed	43
Unemployed	53
Occupation:	
Professional (teacher/nurse/other with tertiary education)	4
Self-employed, formal	3
Office work/ sales assistant	13
Domestic service/ cleaner	21
Informal sector (hawker, car-minder)	2
Source of income:	
Own work	37
Parents/ Grandparents	29
Relative's pension	2
Partner	19
Child	-
Other: brother or sister	5

Table 3.2 (continued)

Demographic data	N
Total household income per month:	
<R500 per month	28
R500 – R1 000 per month	32
R1 000 – R2 000 per month	21
R2 001 – R5 000 per month	8
>R5 000 per month	1
Type of housing:	
Brick house	70
Zinc house	21
Other: prefabricated/ zinc	5
Flooring in the house:	
Mud/ ground/ animal source	9
Cement	41
Tiles/ Bricks	26
Carpet	20
Type of toilet:	
Outside, long-drop	21
Outside, chemical	1
Outside, water-flush	50
Outside, pit	1
Inside, water-flush	23
Source of drinking water:	
Collect from fountain, river, etc.	8
Communal tap	54
Outside tap	32
Inside tap	1
Transport:	
Family's own car	5
Neighbour/ relative/ friend's car	5
Taxi	82
Bicycle	4
Access to electricity:	
Yes	86
No	10
Appliances in the home:	
Electric stove	68
Refrigerator	67
Television	69
Radio	81
Telephone	46
Education received from a qualified Health Professional:	
Healthy eating during pregnancy	27
Oral rehydration therapy	35
Breastfeeding practices	33

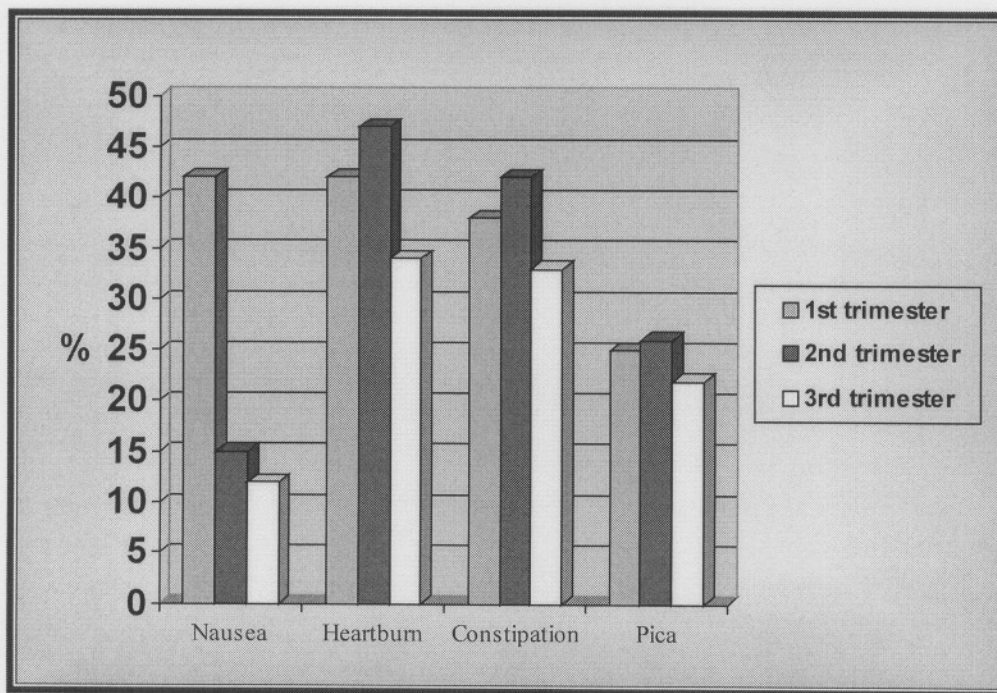


Figure 3.1: Participants experiencing common nutritional problems during pregnancy during the 1st, 2nd and 3rd trimester

Table 3.3: Weight gain below, within or above the IOM's ranges (n=87, sufficient data for 87 subjects only)*

Underweight (BMI < 19.8)		
< 0.45 kg/ week (inadequate)	0.45 – 0.49 kg/ week (lower end of range)	> 0.49 kg/ week (upper end of range)
14.3% (n = 2)	7.1% (n = 1)	78.6% (n = 11)
Normal weight (BMI 19.8 – 26)		
< 0.31 kg/ week (inadequate)	0.31 – 0.44 kg/ week (lower end of range)	> 0.44 kg/ week (upper end of range)
31.1% (n = 14)	20% (n = 9)	48.9% (n = 22)
Overweight (BMI > 26)		
< 0.1 kg/ week (inadequate)	0.1 – 0.3 kg/ week (lower end of range)	> 0.3 kg/ week (upper end of range)
-	42.9% (n = 12)	57.1% (n = 16)

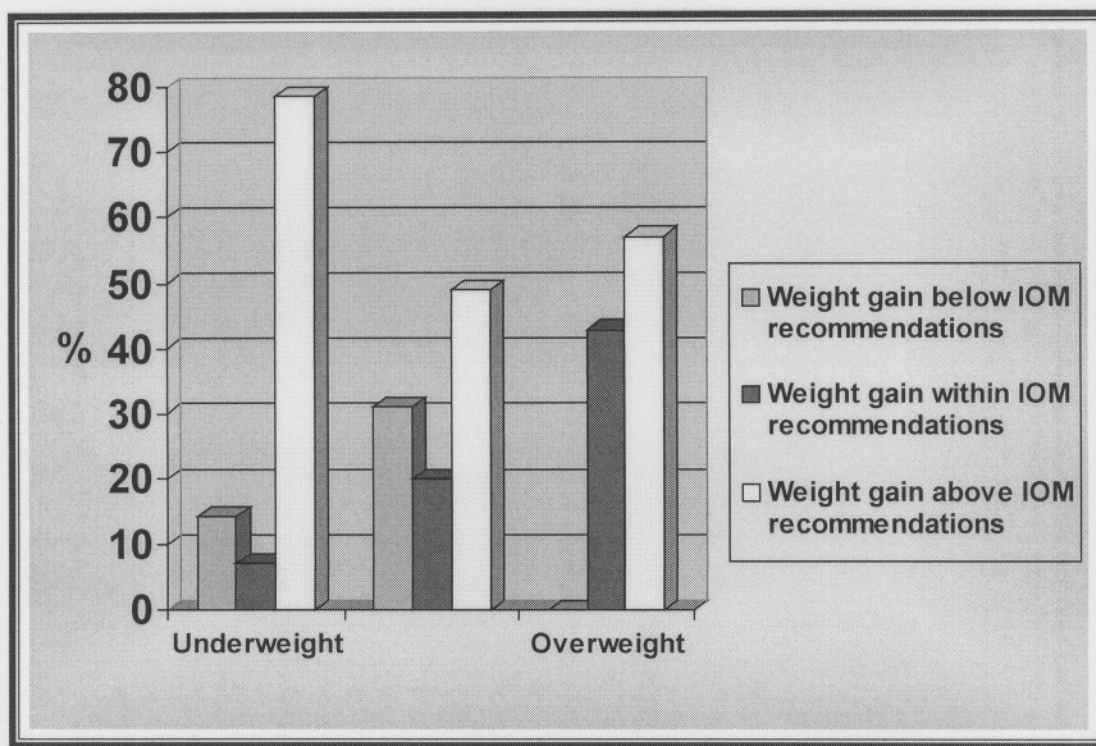


Figure 3.2: Weight gain below, within and above the IOM's recommendations according to prepregnancy BMI classifications.

Table 3.4 shows the data for age, weekly weight gain, dietary intake, and birth data for women according to their prepregnancy BMI categories. The dietary intake of the group is shown in Table 3.5. The birth data of the boys and girls in this group is shown in Table 3.6.

Table 3.4: Data regarding age, weight gain, dietary intake and birth data for mothers with regard to their prepregnancy BMI (Numbers may vary due to incomplete data).

Women with a prepregnancy BMI < 19.8					
	n	Mean ¹	Min ²	Max ³	SD ⁴
Age (years)	14	24.71*	18.00	40.00	6.32
Weekly weight gain (kg)	14	0.64	0.340	0.94	0.17
Energy intake (kJ)	14	12497.86	6467.00	17988.00	3568.03
Protein intake (g)	14	92.89	35.30	183.10	38.70
Iron intake (mg)	14	11.61	4.30	15.50	3.72
Calcium intake(mg)	14	756.29	337.00	1219.00	274.08
Birth weight (kg)	13	3.18	2.60	3.70	0.33
Birth length (cm)	13	50.31	46.00	57.00	3.07
Head circumference (cm)	13	34.46	33.00	38.00	1.56
Women with a prepregnancy BMI 19.8 - 26					
	n	Mean ¹	Min ²	Max ³	SD ⁴
Age (years)	47	26.38	14.00	37.00	5.69
Weekly weight gain (kg)	45	0.49	0.12	1.08	0.24
Energy (kJ)	45	11678.13	5014.00	20149.00	3809.04
Protein (g)	45	79.56	23.80	178.70	29.08
Iron (mg)	45	10.98	4.90	19.60	3.83
Calcium (mg)	45	802.93	177.00	2182.00	406.51
Birth weight (kg)	42	3.08	1.90	4.12	0.45
Birth length (cm)	39	49.67	44.00	57.00	2.81
Head circumference (cm)	39	34.82	31.00	40.00	1.89
Women with a prepregnancy BMI > 26					
	n	Mean ¹	Min ²	Max ³	SD ⁴
Age (years)	31	29.55*	19.00	47.00	7.10
Weekly weight gain (kg)	28	0.44	0.13	1.13	0.27
Energy (kJ)	29	12248.28	4069.00	21799.00	4085.69
Protein (g)	29	86.22	22.60	175.60	29.99
Iron (mg)	29	13.32	3.70	30.00	5.48
Calcium (mg)	29	838.31	240.00	2088.00	429.09
Birth weight (kg)	26	3.20	2.490	4.20	0.50
Birth length (cm)	26	50.92	45.00	58.00	3.33
Head circumference (cm)	26	34.54	32.00	37.00	1.53

¹Mean

²Min: minimum

³Max: maximum

⁴SD: standard deviation

* significant difference (P<0.05)

Table 3.5: Dietary intake of the group (n = 93)

	n	Mean ¹	Min ²	Max ³	SD ⁴
Energy (kJ)	93	11968.39	4069.00	21799.00	3755.99
Protein (g)	93	84.33	22.60	183.10	30.44
Iron (mg)	93	11.81	3.70	30.00	4.40
Calcium (mg)	93	789.51	144.00	2182.00	393.02

¹Mean²Min: minimum³Max: maximum⁴SD: standard deviation

Table 3.6: Birth data of boys and girls (n = 80)

Boys (n = 37)*				
	Mean ¹	Min ²	Max ³	SD ⁴
Birth weight (kg)	3.2	2.5	4.0	0.4
Birth length (cm)	50.1	45.0	58.0	3.0
Head circumference (cm)	35.1	32.0	40.0	1.9
Girls (n = 43)*				
	Mean ¹	Min ²	Max ³	SD ⁴
Birth weight (kg)	3.1	1.9	4.2	0.5
Birth length (cm)	50.1	44.0	57.0	3.2
Head circumference (cm)	34.3	31.0	37.0	1.6

Health information, which includes the participants' haemoglobin, number of children they have had, gestational age, blood pressure and anthropometric measurements (triceps skin fold, subscapular skin fold and mid-upper arm circumference) are shown in Table 3.7.

Table 3.7: Health information of the participants

	n	Mean ¹	Min ²	Max ³	SD ⁴
Haemoglobin (g/dl)	47	10.91	0.00	17.00	3.45
Number of children					
Women with prepregnancy BMI ≤ 26	27	0.78	0.00	4.00	0.97
Women with prepregnancy BMI > 26	19	1.56	0.00	4.00	1.26
Gestational age (weeks)					
Women with prepregnancy BMI ≤ 26	45	38.91	36.00	42.00	1.46
Women with prepregnancy BMI > 26	35	39.40	37.00	42.00	1.12
Triceps skin fold (mm)					
Women with prepregnancy BMI ≤ 26	50	17.31	6.40	36.80	6.56
Women with prepregnancy BMI > 26	37	28.84	12.40	59.80	9.83
Subscapular skin fold (mm)					
Women with prepregnancy BMI ≤ 26	50	15.72	6.90	35.70	6.86
Women with prepregnancy BMI > 26	37	30.56	13.80	60.00	11.81
Mid-upper arm circumference (mm)					
First measurement	97	28.87	20.90	43.80	4.65
Second measurement	73	29.27	20.80	44.30	4.40
Third measurement	49	29.38	21.10	43.30	4.60
WOMEN WITH BMI ≤ 26					
Blood pressure (mm Hg)					
First measurement:					
Systolic	42	110.83	90.00	160.00	15.46
Diastolic	42	67.55	50.00	90.00	8.75
Second measurement:					
Systolic	42	108.90	80.00	150.00	13.60
Diastolic	42	65.60	40.00	90.00	9.12
Third measurement:					
Systolic	35	110.86	90.00	150.00	15.43
Diastolic	35	68.00	60.00	90.00	8.33
Fourth measurement:					
Systolic	23	108.26	80.00	140.00	14.03
Diastolic	23	65.65	40.00	90.00	12.73
WOMEN WITH BMI > 26					
Blood pressure (mm Hg)					
First measurement:					
Systolic	23	117.52	90.00	145.00	11.98
Diastolic	23	73.48	50.00	95.00	10.38
Second measurement:					
Systolic	22	118.41	100.00	145.00	11.48
Diastolic	22	*	60.00	90.00	7.67
Third measurement:		72.73*			
Systolic	19		100.00	140.00	10.81
Diastolic	19	113.42	50.00	85.00	8.74
Fourth measurement:		69.74			
Systolic	15		90.00	130.00	11.87
Diastolic	15	115.33	60.00	80.00	7.04

¹Mean²Min: minimum³Max: maximum⁴SD: standard deviation* significant difference between women with BMI <26 and women with BMI >26

3.4 Discussion

In Table 3.2 it can be seen that Tswana (n = 66) was the most common first language spoken by the participants, with English (n = 51) as the second language. Most of the women (n = 45) has not been married, and lived with relatives. Whether or not they have already had children and was employed or unemployed, is very much divided evenly within the group (n = 51 vs. n = 44 and 51 vs. 54), although 58% (n = 55) had an education level higher than grade 11. Their type of employment is listed in the table, with most of them being domestic workers (49%, n = 21) and being responsible for their own income (40%, n = 37). Their total household income per month was divided into five categories, and most of them (n = 32) had a household income of R500 – R1 000 per month. The type of housing is mostly brick (n = 70) with the type of flooring cement (n = 41). Most of them reported having an outside, water-flushable toilet (n = 50) and collected their drinking water from a communal tap (n = 54). For transport, eighty-two (n = 82) used a taxi. Most of them (n = 86) had electricity in their homes and owned an electric stove (n = 68), refrigerator (n = 67), television (n = 69), radio (n = 81) and some a telephone (n = 46). The participants of this study consisted thus mainly of Tswana speaking, single women living with relatives. Those with a job had a low income. It can thus be said that the participants in this study had a low socio-economic class.

In order to determine if they have a sound nutritional knowledge, they were asked if they have ever received education by a health professional regarding healthy eating during pregnancy, oral rehydration therapy (which was explained to them) and breastfeeding practices (Table 3.2). Only 28% (n = 27) received education regarding healthy eating during pregnancy. In a study done in a New York clinic, Olson and Strawderman (2003) found that nearly 60% of women reported getting no advice from their health care provider on how much weight to gain in pregnancy. Our study suggests that it might be even less in South Africa. Education regarding oral rehydration therapy were received by 37% (n = 35) and 35% (n = 33) received education regarding breastfeeding practices.

The problems experienced during pregnancy are shown in Table 3.3 and Figure 3.1 and show the participants' experience of these problems during the first, second and third

trimester. Nausea and heartburn was the most common problems experienced during the first trimester ($n = 36$ each). The experience of nausea seems to fall quite dramatically from the first to the third trimester ($n = 36$ to $n = 10$), while the occurrence of heartburn, constipation and pica did not seem to differ too much between the different trimesters. Mahan and Escott-Stump (2000) confirms this as they state that morning sickness or nausea is common during the early months of pregnancy, but the condition usually disappears as spontaneously as it appears. According to Lacroix *et al.* (2000) nausea and vomiting or "morning sickness" is one of the most common complaints among pregnant women. Heartburn, which is also quite common during pregnancy, may occur as a result of the hormonal changes that slow the movement of food through the digestive tract (ADA, 1998). Infrequent or hard, dry stools may also occur either as a side effect of high doses of supplemental iron or as part of the normal digestive changes during pregnancy (ADA, 1998). All the participants in this study did receive iron supplementation. Mahan and Escott-Stump (2000) explains pica as a compulsion for persistent ingestion of unsuitable substances that have little or no nutritional value. Pica of pregnancy most often involves consumption of dirt or clay (geophagia) or starch (amylophagia), such as laundry starch. However, nonfood substances subject to compulsive consumption include a bizarre variety of nonfoods, such as ice, paper, burnt matches, stones or gravel, charcoal, soot, cigarette ashes, antacid tablets, milk of magnesia, baking soda, and coffee grounds. The incidence of pica is not limited to any one geographic area, race, sex, culture, or social status, nor is it limited to pregnancy. Malnutrition is among the medical consequences of pica, as nonfood substances displace essential nutrients in the diet. Starch in excessive amounts can contribute to obesity. Some substances contain toxic compounds, such as heavy metals; others can interfere with the absorption of minerals, such as iron. Starch and clay in gross amounts can lead to intestinal obstruction. The etiology of pica is poorly understood. One theory suggests that the ingestion of nonfood substances relieves nausea and vomiting. It has also been hypothesized that a deficiency of an essential nutrient, such as calcium or iron, results in the eating of nonfood substances that contain these nutrients. Pica in this study was found to consist mostly of ice and dirt.

Table 3.4 and Figure 3.2 show the women divided into categories of prepregnancy BMI's and their weight gain during pregnancy. Women who gained inadequate weight, around the lower range and upper range according to the IOM's recommendations are

shown. Of those women with a prepregnancy BMI <19.8 , classified as underweight ($n = 14$), 14.3% ($n = 2$) gained weight below the IOM's recommendations, 7.1% ($n = 1$) within and 78.6% ($n = 11$) above the recommendations. Of those with a normal prepregnancy BMI ($19.8 - 26$) ($n = 45$), 31.1% ($n = 14$) had a weight gain below, 20% ($n = 9$) weight gain within and 48.9% ($n = 22$) weight gain above the IOM recommendations. The mothers classified as overweight ($n = 28$) based on a prepregnancy BMI > 26 mostly gained weight above the recommended ranges (57.1%, $n = 16$) while 42.9% ($n = 12$) gained weight within the IOM's recommended ranges. Figure 3.2 clearly demonstrates the tendency to gain weight above the recommendation for all women, not only those who are overweight prior to pregnancy. This finding is in correlation with the findings of Carmichael *et al.* (1997), Caulfield *et al.* (1996) and Keppel and Taffel (1993). Wells and Murray (2003) also found that nearly 40% of women in Colorado gained an excessive amount of weight during pregnancy. In the Thusa Mama study the numbers were even higher (56%).

Data regarding age, weight gain, dietary intake and birth data for mothers with regard to their prepregnancy BMI are shown in Table 3.4. Women with a BMI > 26 were significantly older ($P < 0.05$) with a mean age of 29.55 than the other women with mean ages 24.71 and 26.38 respectively, although the age seems to differ also within the groups (SD 6.32, 5.69 and 7.10 respectively). No correlations were found between dietary intake and any of the outcomes measured (baby weight, length, head circumference or mother's weekly weight gain). Dietary intakes did not differ much between the different categories. This is unlikely and may be because of under- or over-reporting of dietary intake. The dietary intake of the group is shown in Table 3.5. The mean energy intake was 11968.38 kJ (SD 3755.99), while the mean protein intake was 84.33 g (SD 30.44). Iron intake had a mean of 11.81 mg (SD 4.40) and calcium 789.51 mg (SD 393.02). The mean energy and protein intakes were adequate in reference to the Dietary Reference Intake (FNB & IOM, 2002 and Mahan and Escott-Stump, 2000). The mean iron intake is just below the DRI, while the mean calcium intake is inadequate (Adequate Intake = 1300 mg). According to the FNB (2002) it is now widely recognised that reported energy intakes in dietary surveys underestimate usual energy intake. Underreporting tend to increase, as children grow older, is worse among women than in men, and is more pronounced among overweight and obese than among lean individuals. Low socio-economic status, characterised by low income, low

educational attainment, and low literacy levels increase the tendency to underreport to a greater degree than those who experience frequent hunger. As this group of women are from a low socio-economic status, this may also apply to them.

The average birth weight of the three groups (Table 3.4) did not differ much (3.18kg, 3.08kg and 3.20kg). The same seems to be true for the length (50.31cm, 49.67cm and 50.92cm) and head circumference (34.46cm, 34.82cm and 34.54cm). None of these differences were statistically significant. Edwards *et al.* (1996) found that women with a BMI <19.8 are at high risk of delivering a low birth weight infant if their prenatal weight gain is inadequate. They state that even women with a BMI >29.0 should gain at least 7.0kg; those who lose weight or gain less than 6kg are more likely to deliver an infant that is small for gestational age. Excessive weight gain in women with a BMI >26 also place the child at risk of being large for gestational age (Galtier-Dereure *et al.*, 2000). Johnston and Kandel (1992) and Abrams *et al.* (1995) have described positive relations between second trimester or third trimester weight gains and birthweight: Increased rates of gain were associated with larger fetal size, and lower rates of gain with smaller size. In this study no significant correlation between rate of weight gain and birthweight were found, because all the participants received timely, good medical and nutritional care.

Other investigators (Siega-Riz *et al.*, 1996 and Hickey *et al.*, 1995) have noted that risk of preterm birth is approximately doubled when third trimester rate of gain is low or inadequate. Abrams *et al.* (2000) found that weight gain in the second trimester was more strongly associated with fetal growth than was weight gain in the first or third trimester. The Thusa Mama study focused on an average weekly weight gain and not weight gain within the first, second or third trimester. This was done because close monitoring of each woman during each of the three trimesters was not possible. Most women could be followed up for only four to five visits over the total pregnancy period. Abrams *et al.* (2000) found that the best birth weight outcomes were found in women whose weight gains were within the IOM's ranges. In their report, the IOM (1990) also stated that fetal growth might be influenced more by specific maternal tissue changes, for example, by accretion of lean tissue, fat, or body water, than by gestational weight gain. Campbell-Brown and McFadyen (1985) also found more of a variation in birth weight explained by fat-free mass than by height and weight together. According to

them, it seems to be an unknown factor associated with maternal lean body mass and not maternal energy reserves, which regulate infant birth weight. In this study it was not possible to measure maternal lean body mass separately, but the MUAC was measured as an indication of lean body mass (WHO, 1995). The mean MUAC showed a slight increase from the first to the third measurement (28.87 - 29.38 mm). There was a tendency of an association between MUAC of the mother and birth weight of the baby ($r = 0.206$, $P = 0.083$). The arm-muscle area (AMA) and arm-fat area (AFA) were also calculated using the triceps skinfold (TSF) and MUAC measurements. No significant correlations were found between the AMA or AFA and the birth outcomes of the baby.

The birth data of the boys and girls, as shown in Table 3.6 also showed no significant differences between the mean birth weight, length and head circumference of the boys and girls. This is in contrast with a study done by Villamor *et al.* (1998) where they found that gender, together with gestational age at delivery, were one of the strongest predictors of birth weight.

The health data shown in Table 3.7 shows the mean haemoglobin value to be 10.91g/dl (SD 3.45). This was the measurement taken at the first visit. All the pregnant women who visited the Potchefstroom Clinic received iron (ferrous sulphate, 30mg) supplementation, regardless of their haemoglobin value. The Centers for Disease Control and Prevention (CDC) also recommend a routine low-dose iron supplement (30mg/day) for all pregnant women, beginning at the first visit (CDC, 1998). Women with a BMI >26 had more children on average (mean = 1.56, SD 1.26) than those with a BMI <26 (mean = 0.78, SD 0.97). Brown *et al.* (1992) also found a direct association between parity and body weight. There were no significant differences in the gestational ages of the two groups of women. Kramer (1993) also found inconsistent data regarding the effect of maternal weight gain on gestational duration. If maternal weight gain does affect gestational duration, the effect is small. Taffel *et al.* (1993) describes no temporal decline in the incidence of preterm delivery, despite an impressive trend of higher weight gains over this interval. The skin folds taken (triceps and subscapular), showed a bigger standard deviation for mothers with a prepregnancy BMI >26 (SD 9.83 and 11.81 respectively). The mean triceps skinfold for women with a prepregnancy BMI ≤ 26 lies between the 25th and 50th percentile, while those with a prepregnancy BMI >26 has a mean measurement between the 50th and 75th percentile

(NCHS, 1974). The standard deviation of triceps skinfold in this study (SD 9.83), is very similar to the one referred to in the NCHS tables (SD 8.7 – 9.8), which might show a representative population.

The blood pressure did not differ significantly between the two groups. The mean blood pressure measurements were slightly higher in the group with a prepregnancy BMI >26, although the maximum measurement taken were higher in the group with a prepregnancy BMI $\leq$ 26. This might be due to one subject in the group with a high blood pressure, although of normal weight. Sodré (2002) explained the change in blood pressure during pregnancy as a slight decrease in systemic blood pressure. There is a small change in systolic blood pressure, but diastolic pressure is reduced (5 – 10 mmHg) from about 12 – 26 weeks. Diastolic pressure increases thereafter to prepregnancy levels by about 36 weeks.

Very few of the subjects gave their consent for HIV (Human Immunodeficiency Virus) /AIDS (Acquired Immunodeficiency Syndrome) testing. The HIV status and smoking were considered when the partial correlations were calculated, because these factors may confound the association between the variables studied.

This study has a number of limitations. Participants were included on the days the researchers visited the clinic, which was sometimes irregular. Different persons did the measurements. It was not possible for one person to do all the anthropometric measurements and questionnaires. Also, skin folds might be influenced by water retention in late pregnancy (IOM, 1990). Miss-communication between researchers and the participants may be common where there is a language difference, although trained field workers and clinic personnel were used as translators where possible. Also, the food frequency questionnaire is confusing for an uneducated person, even though it was explained to them as clearly as possible and a picture book used as an aid to estimate portions. As prepregnancy weight was unknown, and some women had their first visit in their second trimester, prepregnancy weight (to determine prepregnancy BMI) had to be calculated with a regression analysis. The analysis could not be done if less than three weights were available and was found to be the most accurately estimated up to week 14 and not prepregnancy. Prepregnancy weight and

BMI used in this study were in most cases calculated from a regression equation and not the actual measured weight and BMI.

3.5 Conclusion and recommendations

The results found in this study, emphasizes the importance of good, timely care of pregnant women, whether they are underweight, normal weight or overweight. All the women in this study visited the clinic on a regular basis. All of the women received nutritional counselling when there were reasons for concern and underweight, HIV positive mothers also received nutritional supplementation from the South African Government. The chances of pregnant women to have a positive pregnancy outcome through good, timely care is also confirmed and described by Hickey *et al.* (2000) and Wells and Murray(2003). No significant correlations were found for prepregnancy BMI, weight gain during pregnancy and pregnancy outcomes, which might be because of the good care taken of the mothers. A study done with participants who do not visit clinics regularly might produce different results, but such a study is almost impossible, since subjects would be very difficult to trace. The tendency of women to gain weight above the IOM's recommended guidelines is important and cannot be ignored. The reasons for this being that excessive prenatal weight gain in overweight and obese women increases the risk of maternal postpartum weight retention and macrosomia in the infant (Galtier-Dereure *et al.*, 2000). In this study excessive weight gain was not associated with macrosomia, as shown in Table 3.4.

Nutritional education and guidelines are of utmost value in favouring pregnancy outcomes. It would be ideal to develop a nutritional protocol for care in the Primary Health Care setting for pregnant women. Nutritional guidelines during pregnancy must consider the need to prevent low birth weight and, except in underweight women, avoid postpartum weight retention (ADA, 2002). As described in the report of an Expert Work Group (Suitor, 1997), there seems to be no need for a formal revision of the 1990 IOM weight gain recommendations. We will thus still promote weight gain within the IOM recommendations for the rate of weight gain as well as those for total weight gain. These recommendations are specific for the women's BMI category. Pregnancy provides a window of opportunity to educate women about the benefits of a good diet and a healthy lifestyle (Chomitz *et al.*, 1995).

Chapter 4: Summary, conclusion and recommendations

The aim of the Thusa Mama Study was to evaluate the association between prepregnancy body mass index (BMI) as well as maternal weight gain during pregnancy and pregnancy outcomes (incidence of health problems of the mother during pregnancy, infant birth weight and head circumference). The consequences of maternal underweight, maternal overweight, and weight gain below and above the IOM's recommendations were evaluated in this study.

For the study pregnant, black volunteers ($n = 80$) were used. Data capturing methods included demographic, nutritional problems, maternal health and food frequency questionnaires. Anthropometric measurements used to monitor their bodily changes consisted of weight, length, triceps skin fold, subscapular skin fold and mid-upper arm circumference. The demographic and food frequency questionnaires were filled in during their first visit only, as well as the length measurement. The rest of the data were captured at each visit. The babies' birth data was then collected from the hospital where they gave birth.

No correlations were found between prepregnancy BMI or weight gain during pregnancy and pregnancy outcomes. Most of the women, regardless of their prepregnancy BMI seemed to gain excess weight in relation to the IOM's recommendations. As described in the literature, this may lead to a number of complications and health risks. Proper nutritional and ante-natal care in a clinic setting is essential for good health of the mother and for a positive pregnancy outcome.

As pregnancy forms an integral part of women's health in general, this study is relevant to today's lifestyle and focus points. This study should give some insight in the Primary Health Care setting and care of pregnant women in the ante-natal clinic. There still is much room for further research regarding weight gain during pregnancy divided into different trimesters, or in a more rural area, where health care is less available.

Dieticians play an important role in the nutritional education of patients, clinic personnel, health workers and the general public, and their value should not be underestimated.

Annexure

Annexure A: Informed Consent Form

Annexure B: Demographic Questionnaire

Annexure C: Pregnancy-related Problems Questionnaire

Annexure D: Food Frequency Questionnaire

Annexure E: Maternal Health Questionnaire

Annexure F: Anthropometric Data Form

Annexure G: Birth Data Collection Form

Annexure A:
Informed Consent Form

MATERNAL AND INFANT HEALTH PROJECT: PU FOR CHE
INFORMED CONSENT FORM

Title of the project: THUSAMAMA

Name: _____ No: _____
Address: _____ Tel no: _____
Age: _____

INFORMED CONSENT

I, the undersigned.....(full name in print), have read the details of the project or, listened to the oral explanation thereof, and declare that I understand it. I have had the opportunity to discuss relevant aspects with the researcher and declare that I voluntarily participate in the project. I hereby give consent to participate in the project.

Signature of volunteer

Witnesses: _____
Signed at _____ on _____

For subjects under the age of 21, signed consent of a parent/guardian is necessary.
I, _____(full name in print) the parent/guardian of the person named above, hereby consent that he/she may participate in the THUSAMAMA project)

Signature _____ Date _____
Relationship _____

MATERNAL AND INFANT HEALTH PROJECT: PU FOR CHE
INFORMED CONSENT FORM

Title of the project: THUSAMAMA

Name: _____ No: _____
Address: _____ Tel no: _____
Age: _____

INFORMED CONSENT

I, the undersigned.....(full name in print), have read the details of the project or, listened to the oral explanation thereof, and declare that I understand it. I have had the opportunity to discuss relevant aspects with the researcher and declare that I voluntarily participate in the project. I hereby give consent to participate in the project.

Signature of volunteer

Witnesses: _____

Signed at _____ on _____

For subjects under the age of 21, signed consent of a parent/guardian is necessary.
I, _____(full names in print) the parent/guardian of the person named above, hereby consent that he/she may participate in the THUSAMAMA project)

Signature _____ Date _____
Relationship _____

Annexure B:
Demographic Questionnaire

PREGNANCY WEIGHT GAIN & OUTCOMES

Demographic Questionnaire (All the information on this questionnaire is confidential)

Date: _____

Interviewer: _____

1. Subject number: _____
2. File number: _____
Home address: _____

Telephone _____
3. Birth date - Year: _____ / Month: _____ / Date: _____
4. First language: ____ Tswana=1, Sotho=2, Xhosa=3, Zulu=4,
5. Second language: ____ English=5, Afrikaans=6, Other, specify.....
6. Marital status:
1=live with husband
2=live with partner, baby's father (not married)
3=live with partner, not baby's father (not married)
4=widow, live alone with other relatives
5=divorced, live alone with other relatives
6=never married, live alone
9=never married, live with relatives/ friends

7. Other children? Yes (1) ☐ No (2) ☐
Ages of other children: _____
8. What is your highest qualification? ☐
 1. None
 2. < St. 6 (Gr. 8)
 3. St. 6 – 8 (Gr. 8 – 10)
 4. St. 6 – 8 (Gr. 8 – 10) + trade
 5. St. 9 – 10 (Gr. 11 – 12)
 6. St. 9 – 10 (Gr. 11 – 12) + trade
 7. St. 10 (Gr. 12) + Technikon, University, College
9. Do you have a job at the moment? Yes (1) ☐ No (2) ☐
10. If yes, what kind? _____
 1. Professional (teacher/nurse/other with tertiary education)
 2. Self-employed formal
 3. Office work/ sales assistant
 4. Domestic service/ cleaner
 5. Informal sector (hawker, car-minder)

11. Do you work:

1. part-time (1 – 3d/ week),
2. full-time (5 – 6d/ week)

☐☐

12. What is the source of income? ☐

1. Own work
2. Parents/ Grandparents
3. Relative's pension
4. Partner
5. Child
6. Other, specify.....
7. Breadwinner's occupation (refer item 10)

13. What is your total household income per month? ☐

1. <R500/month
2. R501-1000/month
3. R1001-2000/month
4. R2001-5000/month
5. R5001+/month

☐☐

14. How many people eat/ sleep/ live in your house?

1. Children <12
2. Children 12 – 18
3. Adults

☐☐☐

15. Information regarding members of household

Member

Educational level

Present job

16. In what type of house do you live?

1. Brick house
2. Zinc house
3. Other _____

17. What type of floor is mainly in your house?

1. Mud/ ground/ animal source
2. Cement
3. Tiles/ Bricks
4. Carpet

18. What type of toilet do you have? ☐

1. Outside, long-drop
2. Outside, chemical
3. Outside, water-flush
4. Outside, pit
5. Inside, water-flush

19. Where do you get your drinking water? ☐

1. Collect from fountain, river, etc.
2. Communal tap
3. Outside tap
4. Inside tap
5. Other: _____

20. What do you use for transport? ☐

1. Family's own car
2. Neighbour/relative/friend's car
3. Taxi
4. Bicycle
5. Other: _____

21. Do you have access to electricity? Yes=1 No=2 ☐

22. Which of the following do you have in your house?:

1. Electric stove
2. Refrigerator
3. Television
4. Radio
5. Telephone

☐
☐
☐
☐
☐

23. Have you received any nutritional education from a qualified Health Professional?

1. Healthy eating during pregnancy? Yes (1) ☐ No (2)
2. Oral rehydration therapy? Yes (1) ☐ No (2)
3. Breastfeeding practices? Yes (1) ☐ No (2)

Annexure C:
Pregnancy-related Problems Questionnaire

THUSAMAMA

Maternal health questionnaire: nutrition-related problems experienced during pregnancy

1. Subject number: 2. Visit: 1 / 2 / 3

Circle the appropriate number:

3. Problems experienced during pregnancy:

3.1 **Nausea:** Yes = 1/ No = 2

3.2 When experienced: first **3** months/ **3-6** months/ **7-9m**

3.3 **Heartburn:** Yes = 1/ No = 2

3.4 When experienced: first **3** months/ **3-6** months/ **7-9m**

3.5 **Constipation:** Yes = 1/ No = 2

3.6 When experienced: first **3** months/ **3-6** months/ **7-9m**

3.7 **Pica** (eating non-food items): Yes = 1/ No = 2

3.8 When experienced: first **3** months/ **3-6** months/ **7-9m**

3.9 **Other**, specify: Yes = 1/ No = 2

3.10 When experienced: first **3** months/ **3-6** months/ **7-9m**

4. How did you manage these problems?

4.1 **Nausea:** By eating /drinking more of

4.2 By eating/ drinking less of

4.3 Medication taken:

4.4 **Heartburn:** By eating /drinking more of

4.5 By eating/ drinking less of

4.6 Medication taken:

4.7 **Constipation:** By eating /drinking more of

4.8 By eating/ drinking less of

4.9 Medication taken:

4.10 **Pica** (eating non-food items): By eating /drinking more of

4.11 By eating/ drinking less of

4.12 Medication taken:

4.13 Other, specify: By eating /drinking more of

4.14 By eating/ drinking less of

4.15 Medication taken:

.....

.....

Annexure D:
Food Frequency Questionnaire

PART II FOOD FREQUENCY QUESTIONNAIRE

INSTRUCTIONS: Circle the subject's answer. Fill in the amount and times eaten in the appropriate columns.

SUBJECT NO:

I shall now ask you about the type and the amount of food you have been eating in the last few months. Please tell if you eat the food, how much you eat and how often you eat it. We shall start with maize meal porridge.

Do you eat maize meal porridge? YES 1 NO 2
If YES, what type do you have at home now?

Brand name:

Don't know 2

Grind self 3

If brand name given, do you usually use this brand?

YES 1 NO 2 DON'T KNOW 3

Where do you get your maize meal from? (May answer more than one)

Shop 1

Employer 2

Harvest and grind self 3

Other – specify 4

Don't know 5

FOR OFFICE USE

FOOD	DESCRIPTION	Amount	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom Never		
Maize meal porridge	Stiff ('pap')						e4225 4250	
Maize meal porridge	Soft ('slap pap')						e4225 4250	
Do you pour milk on your soft porridge? YES 1 NO 2 If YES, what type of milk (whole fresh, sour, 2 %, fat free, milk blend)? INSTRUCTION: Show subject examples.								
If YES, how much milk?								
Do you pour sugar on your soft porridge? YES 1 NO 2								
If YES, how much sugar?							9012	
Maize meal porridge	Crumbly (phutu)						e4225 4250	
Ting								
Mabella Coarse Fine Rice	Stiff						4082	
Mabella Coarse Fine Rice	Soft						4082	

FOOD	DESCRIPTION	Amount	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom Never		
Do you pour milk on your mabella porridge? YES 1 NO 2 If YES, what type of milk (whole fresh, sour, 2 %, fat free, milk blend)? INSTRUCTION: Show subject examples.								
If YES, how much milk?								
Do you pour sugar on your mabella? YES 1 NO 2								
If YES, how much sugar?							9012	
Oats							4032	
Do you pour milk on your oats? YES 1 NO 2 If YES, what type of milk (whole fresh, sour, 2 %, fat free, milk blend)? INSTRUCTION: Show subject examples.								
If YES, how much milk?								
Do you pour sugar on your oats? YES 1 NO 2								
If YES, how much sugar?							9012	
Breakfast cereals	Brand names of cereals at home now: Don't know						4036	
Do you pour milk on your cereal? YES 1 NO 2 If YES, what type of milk (whole fresh, sour, 2 %, fat free, milk blend)? INSTRUCTION: Show subject examples.								
If YES, how much milk?								
Do you pour sugar on your cereal? YES 1 NO 2								
If YES, how much sugar?							9012	
Samp	Bought Self ground with fat without fat						4043	
Samp and beans							A014	
Are the amounts of samp and beans the same as in the picture? YES NO If NO, do you use more beans than in the picture or less? MORE LESS								
Samp and peanuts							A013	
Are the amount of samp and peanuts the same as in the picture? YES NO If NO, do you use more peanuts than in the picture or less? MORE LESS								
Rice	White Brown Maize rice						4040 4134 4043	
Pastas	Macaroni Spaghetti Other						4062	

FOOD	DESCRIPTION	Amount	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom Never		
You are being very helpful. Can I now ask you about meat? CHICKEN, MEAT, FISH Where do you get your chicken from? (May answer more than 1)								
	Shop, supermarket, spaza							1
	Employer							2
	Slaughter own							3
	Gift							4
	Other specify:							5
	Do not eat chicken							6
Chicken:	Boiled, nothing added						1521	
	Fried: in butter/crumbs						1634	
	Not coated						1520	
	Roasted, grilled						1520	
	Stewed						1520	
	What vegetables are in the stew?							
	Don't know							
Do you eat chicken skin? ALWAYS 1 SOMETIMES 2 NEVER 3								
Chicken bones stew							A003	
Chicken feet	How do you cook it?						A004	
							1609	
Chicken offal	How do you cook it?						1610	
Where do you get your MEAT from? (May answer more than 1)								
	Shop, supermarket, spaza							1
	Employer							2
	Slaughter own							3
	Gift							4
	Other specify:							5
	Do not eat red meat							6
Red meat:	How do you like meat?							
	With fat							
	Fat trimmed							
Beef	Fried – with bone							
	Fried – without bone							
	Stewed – with bone						A001	
	Stewed – without bone						A001	
	Grilled – with bone							
	Grilled – without bone							
	Minced						1585	
Mutton	Fried – with bone						1522	
	Fried – without bone						1571	
	Stewed – with bone						1511	
	Stewed – without bone						1511	
	Grilled – with bone							
	Grilled – without bone							
	Minced						1662	

FOOD	DESCRIPTION	Amount	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom Never		
Pork	Fried – with bone							
	Fried – without bone							
	Stewed – with bone							
	Stewed – without bone							
	Grilled – with bone							
	Grilled – without bone							
Beef Offal	Intestines: boiled, nothing added						161	
	Stewed with vegetables							
	Tripe						1546	
	Heart						1565	
	Lungs							
	Liver						1515	
	Kidneys						1518	
	Other specify:							
What vegetables are usually put into meat stews?								
Wors sausage	Fried						1526	
	Grilled							
Bacon							1501	
Cold meats	Polony						1514	
	Ham						1564	
	Viennas						1531	
	Other specify:							
Canned meat	Bully beef						1535	
	Other specify:							
Meat pie	Home made						1548	
	Bought							
Hamburger	Home made						A015	
	Bought							
Dried beans, peas, lentils (10)	How do you prepare them?							
Soya products e.g. Toppers	Brands at home now						3527	
	Don't know.....							
	Show examples							
Pilchards in tomato chilli brine	Whole						2557	
	Mashed with fried onion						A005	
Fried fish	With batter/ crumbs						2523	
	Without batter/crums						2509	
Other canned fish	Tuna							
	Pickled fish						2562	
	Other:							
Fish cakes	Home made (describe)						2531	
	Frozen							
	Bought							

FOOD	DESCRIPTION	Amount	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom Never		
Carrots	How do you cook carrots?							
	Boiled, sugar & fat						8129	
	With potato/ onion						A008	
	Raw, salad						8015	
	Chakalaka						A025	
	Other:							
	Don't know							
Mealies / Sweet corn	How do you eat mealies?						8033	
	On cob -with fat -without fat							
	Off cob -with fat -without fat						8261	
Beetroot salad	Home made						8005	
	Bought							
Potatoes	How do you cook potatoes?							
	Boiled/baked						8046	
	- with skin							
	- without skin						8045	
	Mashed						8187	
	Roasted						8189	
	French fries						8048	
	Salad						8236	
	Other:							
Sweet potatoes	How do you cook sweet potatoes?							
	Boiled/baked						8057	
	- with skin							
	- without skin						8214	
	Mashed						8058	
	Other:							
	Don't know							
Salad vegetables	Raw tomato						8059	
	Lettuce						8031	
	Cucumber						8025	
Other vegetables specify:								
FRUIT: Do you like fruit? YES NO Where do you get your fruit from? Own fruit trees Farm – employer Farm – own Supermarket/greengrocer Hawker Veld Gifts Other								1 2 3 4 5 6 7 8

FOOD	DESCRIPTION	Amount	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom Never		
Apples/Pears	Fresh						7001	
Pears	Fresh						7053	
	Canned						7054	
Bananas							7009	
Oranges / naartjies							7031	
Grapes							7020	
Peaches	Fresh						7036	
	Canned						7038	
Apricots	Fresh						7003	
	Canned						7004	
Mangoes	Fresh						7026	
Guavas	Fresh						7021	
	Canned						7023	
If subject eats canned fruit: Do you have custard with canned fruit? YES 1 NO 2								
Custard	Home made						0004	
	Ultramel							
Wild fruit / berries	Stamvrugte						7070	
	Noen-noem							
	Klappers							
	Maroelas							
	Nastergals							
	Other – specify							
Dried fruit:	Types:							
Other fruit:								
BREAD AND BREAD SPREADS								
Bread	White						4001	
Bread rolls								
	Brown						4002	
	Whole wheat						4003	
Do you spread anything on the bread? ALWAYS 1 SOMETIMES 2 NEVER 3								
If YES, what do you spread?								
Margarine	What brand do you have at home now?						6508	
							6521	
	Don't know							
	Show examples							
Butter	What brand do you have at home now?						6502	
								
	Home made							
	Don't know							

FOOD	DESCRIPTION	Amount	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom Never		
Peanut butter							6509	
Jam/syrup/honey							9008	
Marmite/Fray BENTOS etc.							9501	
Fish/meat paste							1512	
Cheese	Type:						0010	
Atchar							3004	
Polony							1514	
Other spreads: specify								
Dumpling							4001	
Vetkoek							4057	
Provita, crackers etc.								
FATS:								
What fats do you use and where do you use them?								
Margarine	Where used: on bread							
	with vegetables** Number of spoons /number in family							
Butter	on bread with vegetables** Number of spoons /number in family							
Holsum / vegetable fat	Where used: Number of spoons /number in family						6508	
Oil	Where used: Number of spoons /number in family						6510	
Dripping	Where used: Number of spoons /number in family							
Mixed fat (makhuru)	Where used: Number of spoons /number in family							

FOOD	DESCRIPTION	Amount	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom Never		
Lard	Where used: Number of spoons /number in family						6520	
Mayonnaise/ salad dressing	Number of spoons /number in family						6573	
Cream	Fresh/Long life /canned Orley whip						6503	
DRINKS:								
Tea							9514	
Sugar/cup tea							9012	
Milk / cup tea	What type of milk do you use in tea?							
	Fresh / long life whole						0006	
	Fresh / long life 2%							
	Fresh / long life fat free						0072	
	Whole milk powder Brand						0009	
	Skimmed milk powder Brand						0008	
	Milk blend Brand						0068	
	Whitener Brand						0039	
	Condensed milk						0002	
	Evaporated milk						0003	
	None							
Coffee								
Sugar / cup coffee							9012	
Milk / cup coffee	What type of milk do you use in coffee?							
	Fresh / long life whole						0006	
	Fresh / long life 2 %							
	Fresh / long life fat free						0072	
	Whole milk powder Brand						0009	
	Skimmed milk powder Brand						0008	
	Milk blend Brand						0068	
	Whitener Brand						0039	

FOOD	DESCRIPTION	Amount	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom Never		
	Condensed milk						0002	
	Evaporated milk						0003	
	None							
Milk as such	What type of milk do you drink as such?							
	Fresh / long life whole						0006	
	Fresh / long life 2 %							
	Fresh / long life fat free						0072	
	Sour / Maas						0006	
	Buttermilk						0001	
	Whole milk powder Brand						0006	
	Skimmed milk powder Brand						0072	
	Milk blend Brand						0068	
Milk drinks Brand	Nestle Milo Other						0023	
Yoghurt	Drinking yoghurt Thick yoghurt						0044 0020	
Squash	Sweeto SixO Oros/Lecol - with sugar - artificial sweetner Kool Aid Other						9013 9013 9002 9013 9002	
Fruit juice	Fresh/Liquifruit/Ceres Tropica Concentrates e.g. Halls Nectars Flavour							
Fizzy drinks Coke, Fanta	Sweetened Diet						9001 9013	
Mageu/Motogo							9562	
Home brew							9516	
Tlokwe							9516	
Beer							9506	
Spirits							9510	
Wine red							9508	
Wine white							9518	
Liqueur							9517	
Other: specify								

FOOD	DESCRIPTION	Amount	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom Never		
SNACKS AND SWEETS:								
Potato crisps							4275	
Cheese curls							4067	
Niknaks etc.								
Peanuts	Raw						6001	
	Roasted						6007	
Raisins							7022	
Peanuts and raisins								
Chocolates	Name						9024	
Candies	Sugars, gums, hard sweets						9009	
Sweets	Toffees, fudge, caramels						9014	
Biscuits	Type							
Cakes & tarts	Type							
Scones							4029	
Rusks							4160	
Savouries	Sausage rolls						1534	
	Samosas						4196	
	Biscuits e.g.							
	Bacon kips						4162	
	Other							
PUDDINGS:								
Canned fruit	Type							
Jelly							9004	
Custard	Homemade						0004	
	Ultramel							
Baked pudding							4181	
Instant pudding							4066	
Ice cream							6507	
Sorbet							6516	
Other: specify								
SAUCES / GRAVIES / CONDIMENTS:								
Atchar							3004	
Tomato sauce							3027	
Worcester sauce								
Chutney							9524	
Pickles							8176	
Packet soups							3046	
Others:								
INSECTS:								
Locusts								
Mopani worms								
Others:								

FOOD	DESCRIPTION	Amount	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom Never		
WILD BIRDS OR ANIMALS (hunted in rural areas or on farms)								
MISCELLANEOUS: Please mention any other foods used more than once/two weeks which we have not talked about:								

Annexure E:
Maternal Health Questionnaire

THUSAMAMA: Maternal health questionnaire

1. Subject number: 2. File number:
3. Allergies: 4. Patient notes (p15-24).....
-
-
5. Mental health notes (p 28):
6. Present medication (p 28):
7. HIV & STD (p 29 – 30): Date: Test: Result:
8. Chronic medication (p 31):
9. Problems with menstrual cycle (p 32):
10. Do you smoke? Yes..... No..... If yes, how many cigarettes/day?
For how many years?
If no, have you ever smoked?
If yes, number of years and cigarettes/day.....
11. Do you take snuff? Yes..... No.....
12. Do you drink alcohol (p 32)? Yes..... No If yes, amount per day/ week.....
13. Examination (p32): Blood pressure: date:..... systolic BP..... diastolic BP.....
date:..... systolic BP..... diastolic BP.....
date:..... systolic BP..... diastolic BP.....
- Haemoglobin: date:..... Hb:
date:..... Hb:
date:..... HB:
14. Other visits (p 33, 34).....
15. Midwifery history (p 37 – 52)
16. Type of delivery (normal/ Cesarean): 1..... 2..... 3..... 4..... 5.....
17. Complications during previous childbirth:.....
18. Investigation (p 37-52):
Urine: date:..... blood..... protein.....glucose.....other.....
date:..... blood..... protein.....glucose.....other.....
date:..... blood..... protein.....glucose.....other.....
date:..... blood..... protein.....glucose.....other.....
19. SF measure: date:.....SF: date:.....SF:
date:.....SF: date:.....SF:

Annexure F.
Anthropometric Data Form

Anthropometry DATASHEET

Subject number: _____ Date: _____

Body mass: _____ kg

Stature: _____ cm

Triceps: 1. _____ mm 2. _____ mm 3. _____ mm

Subscapular: 1. _____ mm 2. _____ mm 3. _____ mm

Thigh: 1. _____ mm 2. _____ mm 3. _____ mm

Calf: 1. _____ mm 2. _____ mm 3. _____ mm

Upper arm circumference: _____ cm

Hip circumference: _____ cm

Thigh circumference: _____ cm

Anthropometry DATASHEET

Subject number: _____ Date: _____

Body mass: _____ kg

Stature: _____ cm

Triceps: 1. _____ mm 2. _____ mm 3. _____ mm

Subscapular: 1. _____ mm 2. _____ mm 3. _____ mm

Thigh: 1. _____ mm 2. _____ mm 3. _____ mm

Calf: 1. _____ mm 2. _____ mm 3. _____ mm

Upper arm circumference: _____ cm

Hip circumference: _____ cm

Thigh circumference: _____ cm

Annexure G:
Birth Data Collection Form

THE THUSAMAMA PROJECT

Birth data

Subject number:

Date of birth:

Boy/Girl (underline)

Gestational age of baby:weeks

Delivery: normal/Caesarean

Baby: Weight:kg Length:cm

Head circumference:cm

Leg length:cm Arm length:cm

Trunk length:cm

Apgar score (1min):..... Apgar score (5min):.....

Placenta: Weight:g

Mother: Weight before birth:kg

Weight:kg (after birth)

Weight:kg (at dismissal)

Health status:

Date of dismissal:

THE THUSAMAMA PROJECT

Birth data

Subject number:

Date of birth:

Boy/Girl (underline)

Gestational age of baby:weeks

Baby: Weight:kg Length:cm

Head circumference:cm

Leg length:cm Arm length:cm

Trunk length:cm

Apgar score (1min):..... Apgar score (5min):.....

Placenta: Weight:g

Mother: Weight before birth:kg

Weight:kg (after birth)

Weight:kg (at dismissal)

Date of dismissal:

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