THE IMPACT OF DIETARY DIVERSIFICATION ON THE NUTRITIONAL STATUS OF PREGNANT WOMEN IN THE VAAL REGION

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Doctorate Technologiae
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Thesis submitted in fulfilment of the requirements for the DTech (Food Service Management) degree in the Department of Hospitality, Tourism and PR Management, Faculty of Human Sciences, Vaal University of Technology

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DEDICATION

This thesis is dedicated to my loving husband Hitesh for his constant encouragement and endless support and most of all for being the wind beneath my wings.

ABSTRACT

The main objective of this study was to develop a cost-effective, culturally acceptable, nutrient-dense food multimix (FMM) based on local food staples for pregnant women in the Vaal region. The impact of the consumption of the multimix on the nutritional status of the women, dietary diversity and outcomes of pregnancy was assessed in an intervention study by measuring the same variables as for a pilot study where the nutritional status of pregnant women was determined. Compliance was measured through monitoring of the FMM consumption and sensory evaluation tests. Quantitative food frequency questionnaires (QFFQs) and 24-hour recall questionnaires were completed in interviews. Anthropometric and biochemical measurements were recorded.

The pilot study indicated that the mean total iron intake was 9,74 mg/day, below the estimated average requirement (EAR) of 22 mg/day for pregnant women. Therefore, 41,7 per cent of the women were found to be iron deficient and 50 per cent suffered from iron deficiency anaemia. Food consumed supplied little iron. Eighty per cent of the women were overweight before falling pregnant. Based on the pilot study, the FMM was developed and subjected to the following processes: chemical analysis, shelf life tests, recipe development and sensory evaluation. The product was then implemented in an intervention programme. A control group of pregnant women received soup powder. The respondents were relatively healthy and did not suffer from any chronic diseases.

According to the nutrient intakes measured by the QFFQ, indicating usual dietary intakes, the iron intake of 87,5 per cent of the experimental group and 94 per cent of the control group fell below the EAR before intervention. After the intervention it improved in that the iron intake of 35,2 per cent of the experimental group and 33,3 per cent of the control group fell below the EAR. The top 10 items consumed by the experimental group during pre- and post-intervention were mainly rich in carbohydrates. Food containing iron absorption inhibitors such as tannin in tea and phytates in maize meal and bread were among the top 10 foods listed.

The highest number of individual food items consumed by an individual in seven days was 39 before the intervention and 52 after the intervention, among the experimental group. The individual food variety improved after the intervention. The reason for this could be the inclusion of the FMM in their diets. The majority of the respondents consumed eight to nine of the nutritious food groups before and after the intervention. The mean food variety score (FVS) for the control group was 38,9 (±10,5) before the intervention, which decreased to 35,8 (±8,39) after the intervention. No improvement in FVS was observed after the intervention in the control group and the FVS indicated medium dietary diversity (30-60 food items).

The post-intervention results show that there was an improvement in most of the iron variables. The experimental group showed statistically significant differences between pre- and post-intervention measurements in transferrin and haematocrit levels and the control group in haematocrit levels.

All the babies born to the mothers of both the experimental and control groups were healthy with measurements in the normal range. The reason for this could be that the inclusion of the FMM and soup powder in the diets of the experimental and control group, respectively, made the women more aware of the importance of pregnancy monitoring. Furthermore, the attention given to the women by the clinic sisters and the researchers could have contributed to all the improvements mentioned.

THE IMPACT OF DIETARY DIVERSIFICATION ON THE NUTRITIONAL STATUS OF PREGNANT WOMEN IN THE VAAL REGION

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LIST OF ABBREVIATIONS

AAS	Atomic absorbance spectroscopy
ADA	American Dietetic Association
AIDS	Acquired immune deficiency syndrome
ARC	Agricultural Research Centre
BMI	Body mass index
BP	Blood pressure
DDPW	Dietary Diversification for Pregnant Women
DoH	Department of Health
EAR	Estimated average requirement
EDTA	Ethylene diamine tetra-acetic acid
FAO	Food and Agricultural Organization of the United Nations
FBDG	Food-based dietary guidelines
FGDS	Food group diversity score
FGR	Foetal growth retardation
FMM	Food multimix
FVS	Food variety score
GAIN	Global Alliance for Improved Nutrition
Hb	Haemoglobin
Hct	Haematocrit
HIV	Human immunodeficiency virus
HPLC	High performance liquid chromatography
ICP	Inductively coupled plasma
ICP-MS	Inductively coupled plasma mass spectroscopy
ID	Iron deficiency
IDA	Iron deficiency anaemia
INP	Integrated Nutrition Programme
IOM	Institute of Medicine
IQ	Intelligence quotient
IUGR	Intrauterine growth restriction
LBW	Low birthweight
LGA	Large-for-gestational-age

MCV	Mean cell volume
MI	Micronutrient Initiative
MRC	Medical Research Council
MUAC	Mid-upper arm circumference
NEP	Nutrition education programme
NHANES	National Health and Nutrition Examination Survey
NSP	Nutrition Supplementation Programme
NTD	Neural tube defect
NYC	New York City
QFFQ	Quantitative food frequency questionnaire
RCC	Red cell count
RDA	Recommended dietary allowance
RDP	Reconstruction and Development Programme
RE	Retinol equivalents
SA	South Africa
SD	Standard deviation
SIDS	Sudden infant death syndrome
SGA	Small-for-gestational-age
THUSA	Transition and Health during Urbanisation in SA
UN	United Nations
USA	United States of America
USAID	United States Aid Agency
VUT	Vaal University of Technology
WHO	World Health Organization
WTC	World Trade Center

Chapter 1

Introduction and background to the problem

1.1 Introduction

The major objective of any doctoral study is to contribute new knowledge to the scientific body of available evidence. The main focus of this thesis is to examine the impact of dietary diversification, by means of a food-based intervention, on the nutritional status of pregnant women. Aspects included in this study were a baseline survey to determine the nutritional status of pregnant women in the Vaal region. Based on a pilot study and preliminary literature survey, there was convincing evidence that this project might lead to new knowledge as this was the first attempt in South Africa to develop and test a food multimix (FMM) suitable for consumption for pregnant women. Therefore, in the first two chapters the factors associated with pregnancy outcomes and strategies used to improve folate and iron deficiency in pregnant women will be discussed and the context of this project will thus be highlighted.

1.2 Background and motivation

In South Africa the health of women follows closely on the socio-economic welfare of the family and the community. The demographic and health survey conduced in 1998 estimated the maternal mortality ratio to be 150 per 100 000 live births for South African women. This figure means that with about 1.1 million babies born, over 1 550 South African women will die annually from pregnancy related issues (Health Systems Trust 2006:114). Severe anaemia during pregnancy increases the risk of maternal mortality. During pregnancy iron deficient anaemia (IDA) during the first and second trimesters of gestation has been linked to an increase in the risk of low birthweight and preterm delivery, which are the strongest indicators of perinatal mortality (Seck & Jackson 2009:486).

Iron deficiency (ID) is highly prevalent in low-income countries as a result of various causes at different levels. Underlying most of these is poverty. Lack of purchasing power to afford foods containing haeme iron or to afford transport costs for pregnant women to access antenatal services all co-exist in poor households where anaemia rates are invariably the highest. The poor social status of women is another basic cause. At more immediate levels, low iron intake, poor bioavailability of dietary iron and infection combine to jeopardise an individual's iron levels, particularly at certain stages of the life cycle (Engmann, Adanu, Lu, Bose & Lozoff 2008:62). The cause of anaemia is multifactorial as it includes nutritional deficiencies of iron, folate and vitamin B12 (Abdelrahim, Adam, Mohammed, Salih, Ali, Elbashier & Adam 2009:494). Numerous pregnancies and lactations, especially at short intervals, are likely to deplete the mother of nutrients unless she has an exceptionally good diet. A woman whose diet is deficient during pregnancy, especially in terms of total food and energy, is likely to give birth to a baby that is smaller than it would have been if she were adequately nourished (Ramachandran 2002:26; Tomkins 2001:93). Inadequate intakes of certain micronutrients early in pregnancy have been related to other negative birth outcomes. For example, folate deficiency early in the first trimester is associated with neurological defects and stillbirths (Whitney & Rolfes 2010:497).

The global estimated prevalence of anaemia in pregnant women is 51 per cent, with a prevalence of 56 per cent in developing countries. Globally over 9 million deaths occur before or just after birth each year. An estimate of 56 out of every 1 000 babies born die in the prenatal period and about 34 of every 1 000 live born babies suffer neonatal death (Anthony, Costello, Mwansambo & David 2007:553).

Studies in African countries have shown that 60 per cent of iron-deficient women suffer from other nutrient deficiencies as well as infections (Van den Broek & Letsky 2000:249). A study was conducted in Eastern Sudan which found that infections associated with malarial infection lead to the release of free iron and an increase in serum ferritin. In malaria-stricken areas serum concentrations of ferritin in iron-deficient individuals are elevated by malarial

infections (Abdelrahim *et al.* 2009:495). A study conducted in Dakar, Senegal, showed that the prevalence of anaemia was higher than 50 per cent (Seck & Jackson 2009:485). Engmann *et al.* (2008) conducted a study in Accra, Ghana, and found a lower prevalence of malaria parasitaemia and anaemia, but in late pregnancy, a higher incidence of iron deficiency (Engmann *et al.* 2008:65).

In South Africa, according to a study done in Phoenix, Durban, 40 per cent of Indian women who participated in a series of absorption studies had IDA and all were at a low socio-economic level (MacFarlane, Baynes, Bothwell, MacPhail, Lamparelli, Siegenberg, Schmidt & Mayet 1989:134). A study done on coloured women in Tygerberg Hospital, Western Cape, showed that pregnant women with the highest risk for anaemia were unemployed, single and without their own income or the same claim to household resources as family members (Kruger, Dhansay, Van Staden, Faber, Badenhorst, Mansvelt, Theron, Abers & Benade 1994:134).

Although there may be other basic and underlying causes of malnutrition and anaemia in pregnant women, the most immediate are related to poor hygiene leading to infection and incorrect dietary intake of nutritious foods. For this reason a research project was completed by Kesa (2001), which focused on the iron status of pregnant and lactating women in the Vaal region. The specific aims were to determine food consumption patterns, anthropometrical status and iron status as well as the association between the nutrient intake and iron status of pregnant and lactating women. The study found that most of the pregnant and lactating women suffered from iron deficiency.

The nutritional status of a pregnant woman affects the outcome of her pregnancy. This is especially true with regard to the birthweight of the infant which is closely related to infant mortality and the infant's risk of long-term adverse health outcomes such as hypertension, obesity, glucose intolerance and cardiovascular diseases (Mahan & Escott-Stump 2008:167). Low birthweight (LBW: less than 2 500 g) is a major factor not only in infant

deaths but also in certain health problems, such as developmental disabilities and learning disorders.

Obesity is increasing worldwide and this trend affects women of reproductive age. The World Health Organization (WHO) estimated in 2005 that at least 400 million were obese with a projected rise to more than 700 million by 2015 (WHO 2009). In developed countries maternal obesity is the most common risk associated with adverse pregnancy outcomes (Rowlands, Graves, De Jersey, McIntyre & Callaway 2010:95). Maternal obesity is associated with diabetes and gestational diabetes, pre-eclampsia and urinary incontinence (Fitzsimons & Modder 2010:102). Babies of obese mothers are at great risk of stillbirth, congenital abnormalities, prematurity, macrosomia and neonatal death (Fitzsimons & Modder 2010:104). Obese mothers are less likely to initiate or maintain breastfeeding (Amir & Donath 2007:9).

The most sensitive measure of acute nutritional stresses during pregnancy is maternal weight gain. There is strong epidemiological evidence of an association between maternal weight gain during pregnancy and LBW, especially in undernourished women, i.e. those who begin pregnancy in a nutritionally poor state (Seck & Jackson 2009:487). If these women are provided with adequate antenatal care, there is substantial reduction in the LBW, perinatal and infant mortality rates. Combining adequate antenatal care with effective food supplementation programmes results in marked improvement in pregnancy outcomes in undernourished communities (Ramachandran 2002:30).

It has been computed that foetal wastages – abortion, intrauterine deaths and stillbirths - occur in about 20 per cent of conceptions in poorer segments of the population in developing countries. It has become obvious that women from this portion of the population suffer from several pregnancy related problems such as anaemia and pregnancy induced hypertension (Ramachandran 2002:28).

In urban areas, the lowest income groups are those most at risk of food insecurity and chronic malnutrition. Many of these household income levels

are often so low that they can afford only to purchase the cheapest and most basic foods (FAO 1997). Current strategies to address household food insecurity and malnutrition include food fortification, supplementation and diversification.

The Global Alliance for Improved Nutrition (GAIN), through fortification, attempted to reduce micronutrient deficiencies in order to decrease child and maternal morbidity and mortality (GAIN 2005:7). Fortification of foods with iron is a strategy of choice that has been used in many developed countries to help meet dietary iron needs. But fortification comes at a potentially heavy cost for developing countries because some fortified items tend to be more costly than non-fortified ones. A main disadvantage of iron fortification in developing countries is its potentially low efficacy because of the often very low bioavailability of dietary iron (Nantel & Tontisirin 2002:839s).

Supplements for the prevention of deficiencies are usually given on a time-limited basis during immunisation days and family planning contacts. They are a good curative solution which deals with acute situations. However, although supplementation programmes have already been proven to be efficacious in carefully controlled circumstances, few have been proven to be effective. Reasons for this could be unpleasant side effects (constipation), low compliance and lack of adequate supply systems (USAID 1993:8; Whitney & Rolfes 2010:498). On the basis of these limitations iron supplementation should always be accompanied by a food-based approach that can be implemented once the "curative" phase of the intervention has been completed (Nantel & Tontisirin 2002:839s).

A strategy used to improve either the amount of food in the diet or its bioavailability is dietary diversification (Mannar 1999:24). Producing or purchasing a greater variety of affordable foods than those usually consumed is considered to be the safest and most sustainable long-term measure in the control of most micronutrient deficiencies (USAID 1993:8). Producing a greater variety can be achieved through agricultural projects. In order to purchase a greater variety of foods, higher household income is needed.

Studies on dietary diversification to meet needs for infant and adult nutrition in developing countries have recently been completed (Amuna, Zotor, Chinyanga & Sumar 2000:116). The introduction of a more cost-effective, culturally acceptable, high protein, nutrient-dense FMM for household consumption is also possible, though food fortification and supplementation with certain key nutrients continues to be applied. Based on the results of the pilot study study, it is clear that food insecurity and malnutrition are evident in pregnant and lactating women in the Vaal region. A reason for this could be poverty (Kesa 2001:188).

A survey conducted by Oldewage-Theron and co-workers in Eatonside indicated that in 340 households, 94 per cent of the women were unemployed and the majority of households (68,8 per cent) had a monthly income of less than R500 (Oldewage-Theron, Dicks, Napier & Rutengwe 2005:13). The Vaal region poverty report found that 67,7 per cent of all households in the Vaal region live in poverty (Oldewage-Theron & Slabbert 2010). It is thus unlikely that a greater variety of foods can be bought for consumption. This study also found that 56 per cent of the households were female headed. Eighty-seven per cent had only one person contributing to the income for the household and the average monthly income was R612,50 per month (Oldewage-Theron & Slabbert 2010).

Thus the present study reported on here attempted to examine the development of an FMM as part of an intervention study as a cost-effective and medium- and long-term sustainable food-based solution to improve the food and nutrition security of low-income, pregnant women in the Vaal region in order to prevent malnutrition during pregnancy. The main focus of this study was on women who were pregnant in their first trimester, to improve their nutritional status during pregnancy in order to have healthier pregnancy outcomes. Each of the women were followed to term and up to the end of the puerperium, i.e. the first six weeks following delivery during which time both mother and baby were monitored.

1.3 Project objectives

The main objective of this project was to develop a cost-effective, culturally acceptable, nutrient-dense FMM based on local food staples for household consumption for pregnant women in the Vaal region. With recent successes obtained by dietary diversification in Ghana, the same principles were employed in this study (Amuna *et al.* 2000:118). In Ghana, the results included a product acceptable to the subjects, as well as being cost-effective, as no extra purchases needed to be made. Sustainability was thus possible when the women were taught to prepare multimixes themselves. The study reported on in this thesis was the first study in South Africa where available staples in the majority of households in the Vaal region were used as a basis for the development of a multimix in which nutrients were optimised. Supplementation by means of natural ingredients in the households formed the basis of an optimal multimix. In this study, the specific objectives were:

a. To determine the food consumption patterns and dietary intake of pregnant women in the Vaal region by:

   - Verifying the QFFQ by administering a 24-hour recall questionnaire and comparing results.
   - Analysing the dietary intake by using the FoodFinder software program. Correlations were drawn between the 24-hour recall questionnaire and the QFFQ.
   - Using the QFFQ to collect information on usual dietary intake and food consumption patterns.

b. To undertake a pilot study determining the nutritional status of pregnant women in the Vaal region by:

   - Using anthropometric measurements, namely the weight, height, body mass index (BMI), waist and hip circumference and mid-upper arm circumference (MUAC) of the pregnant women. These measurements were recorded and compared with the weight-for-height tables to

determine overweight and underweight pregnant women (Scotland 2005:633).

- Using biochemical and haematological measurements, namely serum retinol, serum retinol binding protein, haematocrit (Hct), haemoglobin (Hb), mean cell volume (MCV), full blood cell count, serum ferritin and transferrin levels as a measure of the status iron and serum folate and vitamin B12 to determine micronutrient deficiencies.

c. To formulate a FMM which would address micronutrient deficiencies and to develop recipes including the mix in the diet of the women

d. To assess the impact of consumption of the multimix on the nutritional status of pregnant women and the outcomes of their pregnancy in an intervention study by measuring the same variables as for the pilot study where the nutritional status of the pregnant women was determined. Compliance was also measured through the monitoring of the FMM consumption and post-sensory evaluation tests.

e. To assess the impact of the consumption of the multimix on the dietary diversity of the pregnant women participating in this study by:

- Comparing the pre- and post-intervention measurements with regard to anthropometric and biochemical variables.
- Determining dietary diversity scores and comparing the pre- and post-food variety score (FVS) and food group diversity score (FGDS). The FVS was measured by quantifying the number of individual foods consumed and the number of food groups used by the pregnant women measured the FGDS.

1.4 Hypothesis

Dietary diversification by means of the introduction of a cost-effective, culturally acceptable, nutrient-dense FMM, based on locally available food resources, significantly improves the micronutrient status and pregnancy outcomes of low-income pregnant women in the Vaal region.

1.5 Scope of this study

According to Barasi (1997:239), the most common ages for women to fall pregnant are between the ages of 16 and 35 years. Therefore this study included low-income pregnant women between the ages of 16 and 35 years in the first trimester and early second trimester in the Vaal municipal regions of Vanderbijlpark and Vereeniging.

1.6 Relevance of this study

Maternal and child health is a global priority. There have been numerous initiatives and programmes (fortification and supplementation) formulated to try and improve the health status of pregnant women. The aim of one of the Millennium Development Goals is to inspire countries to significantly reduce maternal mortality and to address related challenges by 2015 (Health Systems Trust 2006:107).

According to the WHO (2003), pregnant women in the developed world face maternal mortality ratios of less than 20 deaths per 100 000 live births. Women in Africa and Asia have ratios in excess of 1 000 per 100 000 live births. Anaemia during pregnancy is a global problem and it includes nutritional deficiencies of iron, folate and vitamin B12 (Abdelrahim *et al.* 2009:494).

According to Kesa (2001), the underlying cause of malnutrition among pregnant women in the Vaal region is incorrect dietary intake of nutritious food as well as lack of nutrition education. Dietary diversity has been positively linked to adjust maternal mortality and lower obesity, diabetes and cardiovascular diseases (Temple 2006:29).

Dietary diversification with effective nutrition intervention programmes should result in an improved nutritional status in pregnant women in the Vaal region. The improvement of the nutritional status of the mother could lead to healthier pregnancy outcomes and thus healthier babies. The women should learn to make healthier food choices and in the process teach their children to eat healthier in order to perform better and thus become healthy adults.

1.7 Conceptual framework

Figure 1 below is the conceptual framework of the process of developing, implementing and evaluating the FMM to improve the micronutrient status and pregnancy outcomes of women.

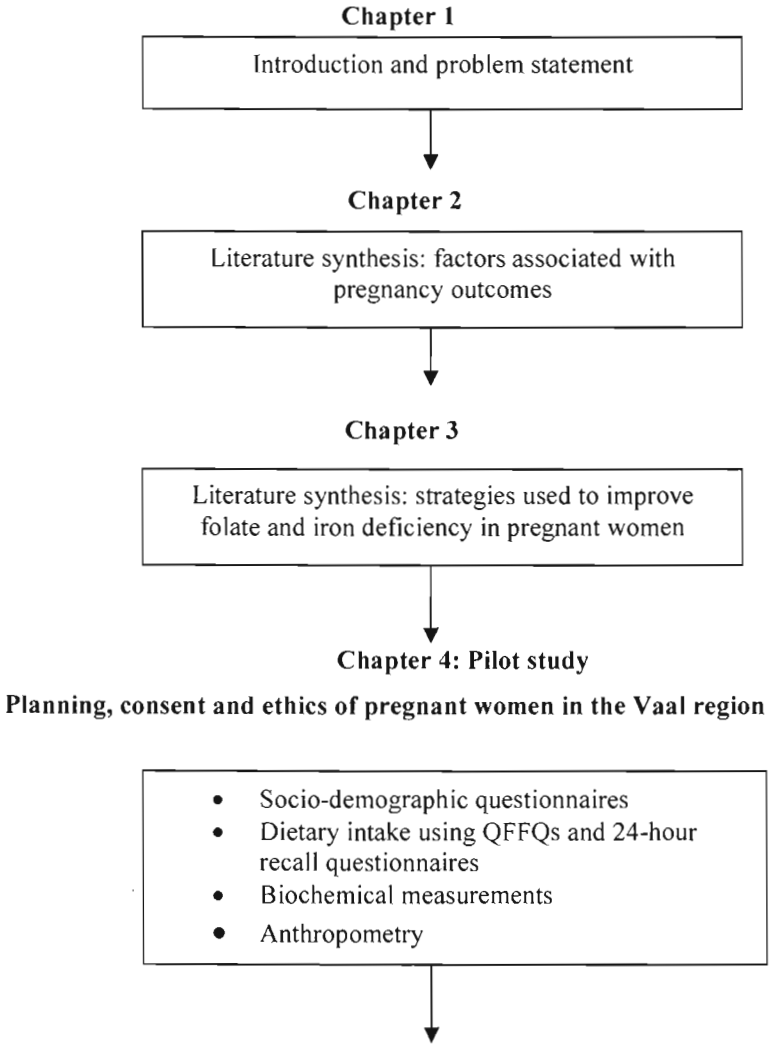

Figure 1: Conceptual framework of project implementation phases

Chapter 5

Development of multimix

- Criteria for FMM
- Formulation, development and testing of FMM
- Recipe development
- Sensory evaluation
- Shelf life testing
- Training sessions on food preparation

Chapter 6

Implementation and evaluation of multimix

Intervention study

Baseline measurements (pre-intervention)

- Socio-demographic questionnaires
- Health and medical questionnaires
- Dietary intake
- Anthropometry
- Biochemical measurements

Compliance

Experimental group
(n=54)
received food multimix for 4 months

Control group
(n=33)
received soup powder for 4 months

Final measurements (post-intervention)

- Dietary intakes
- Anthropometry
- Biochemical measurements
- Pregnancy outcomes
- Dietary diversification

Analysis
Compliance

Chapter 7

Final discussion, conclusions and recommendations
Final evaluation of impact of FMM on the nutritional status of pregnant women

Figure 1 continued

1.8 Organisation of the research report

One primary and five secondary objectives were identified for this study. Each objective was treated as a separate entity and the results of each objective will thus be presented on their own in each of the chapters as can be seen in Figure 1. Following the introductory chapter on the background of the study and problem statement, the literature synthesis focusing on factors associated with pregnancy outcomes will follow in Chapter 2. Strategies used to improve folate and iron deficiency in pregnant women will be explained in Chapter 3. The pilot study which determined the anthropometric indications and nutritional intake will be discussed in Chapter 4. The development of the food multimix product is dealt with in Chapter 5. The implementation and evaluation of the intervention study, including dietary diversification, will be discussed in Chapter 6. The thesis concludes with Chapter 7 in which the overall results will be discussed, evaluated and summarised. Recommendations and conclusions will also be made in the final chapter.

Chapter 2

Factors associated with pregnancy outcomes

2.1 Introduction

This chapter focuses on the various factors that are associated with pregnancy outcomes, be they positive or negative. This chapter serves as an introduction to the problems experienced during pregnancy, and will lead to the chapters to follow on strategies and programmes to overcome adverse pregnancy outcomes.

Nutritional status of women during pregnancy is vital for the health of women and their newborn babies. The survival and health of the newborn are affected by the maternal pre-pregnancy nutritional status and pregnancy weight gain (Nohr, Bech, Davies, Frydenberg, Henriksen & Olsen 2005:253). Efforts to improve maternal health and pregnancy outcomes from the prenatal period to the preconceptional and interconceptional periods have been made by policy makers, researchers and clinicians (Moses 2004:12). To improve health and pregnancy outcomes, such as preterm birth and low birthweight (LBW) infants or birth defects, the prenatal period is the time to intervene even though the prenatal period is narrow (Weitzman, Gortmaker & Sobel 1992:216).

2.2 Behavioural factors influencing pregnancy outcomes

A woman's behaviour and bad habits during pregnancy play a big role on the pregnancy outcomes. Studies have shown that poor behaviour such as smoking, alcohol consumption, drugs and caffeine intake have been associated with negative birth outcomes.

2.2.1 Smoking

When a woman smokes during pregnancy, it has harmful effects on foetal and infant development. Such effects include a reduction in the weight at birth, the

risk increases associated with sudden infant death syndrome (SIDS) and the risk for perinatal mortality also increases. Children of smokers suffer from cognitive and achievement deficits. The effect of maternal smoking can also be linked to more serious intellectual disabilities such as mental retardation (Grazuleviciene, Danileviciute, Nadisauskiene & Vencloviene 2009:1283). Drews, Murphy, Yeargin-Allsopp and Decouflé (1996:548) state that the likelihood that a child will have mental retardation will increase if the mother has smoked during pregnancy. The more a woman smokes during pregnancy, the greater the chance that the child will have mental retardation. According to Ribas-Fito (2003:582), children of smokers have lower cognitive scores even when prenatal smoking is taken into account. Weitzman *et al.* (1992:48) discovered that smokers' offspring were more likely to display aggressive behaviours and were less attentive than children of non-smokers. Such behaviours could increase the likelihood that a child will not perform well on an intelligence quotient (IQ) test and should be referred for psychometric testing instead.

Among studies done, the two most consistent predictors of foetal growth retardation were found to be small maternal size and cigarette smoking. According to Martin (2008:800), in the United States (US), an estimated 10 per cent of women smoke during pregnancy. When a woman smokes during pregnancy, the supply of blood to the growing foetus is restricted, thus limiting nutrient and oxygen supply to the foetus. LBW and intrauterine growth restriction (IUGR, <2,5 kg and gestation < 37 weeks) are related to smoking (Grazuleviciene *et al.* 2009:1286). A study in Jefferson County, Alabama, of the relationships between measures of psychosocial well-being was done on predicting infant size at birth as well as maternal size and parents' smoking habits. This study found that in thinner women, poor psychosocial profile and smoking increased the rate of foetal growth retardation and were associated with a substantial increase. In contrast, though, a poor psychosocial profile in a population of poor, primarily black women, a greater pre-pregnancy weight and height appeared to protect against the adverse effects (Cliver, Goldenburg, Cutter, Hoffman, Copper, Gotlieb & Davies 1992:262; Reichman, Teitler & Hamilton 2009:786).

Poor lung function, respiratory infections and childhood asthma are all related to smoking. Women who chew tobacco during pregnancy have babies with LBW and high rate of foetal deaths (Moshammer, Hoek, Luttmann-Gibson, Neuberger, Antova, Gehring, Hruba, Pattenden, Rudnai, Slachtova, Zlotkowska & Fletcher 2006:1260). A study conducted in Kaunas (Lithuania) found that foetal growth retardation is associated with tobacco smoke exposure to pregnant women, even at low levels (Stillerman, Mattison, Giudice & Woodruff 2008:640).

Shaw, Pickett and Wilkinson (2010:707) conducted an interesting study which investigated if pregnancy outcomes (relating to smoking) improved when mothers from the same ethnic minority groups lived in areas with a higher density of people from the same ethnic group who were socio-economically deprived. This study was conducted among black and Hispanic mothers in the United States. The results showed that infant mortality and smoking levels decreased among the Hispanic group and no changes were observed among the black women.

Smoking decreases a woman's appetite and therefore she might not consume the appropriate amount of food and has lower nutrient intakes than non-smokers. Young pregnant smokers are thus at risk of low micronutrient intakes (Mathews, Yudkin, Smith & Neil 2000:20).

2.2.2 Alcohol intake

Maternal alcohol consumption is associated with teratogenicity and foetal alcohol syndrome with features such as growth failure prenatally and postnatally, developmental delays, microencephaly, eye changes, abnormalities of face and abnormalities of skeletal joints. Other associations are brain and central nervous system impairment, poor motor skills and coordination and hyperactivity (Ervalahti 2007:2920).

The Australian National Health and Medical Research Council (NHMRC) has run studies and found a detrimental effect of alcohol during pregnancy (more

than two standard drinks per day), increasing the risk of spontaneous abortion, IUGR, infants born prematurely and an increased reduction in birthweight (Holman, English, Bower & Kurinczuk 1996:699). Mukherjee (2005:375) states that although an occasional glass of wine with food does not yield maternal foetal consequences, pregnant women should avoid binge drinking. Health care professionals urge women to stop drinking as soon as they realise that they are pregnant. The first month or two of being pregnant is the most critical period of foetal development. If alcohol is consumed by a woman during early pregnancy, developing organs such as the heart, brain and kidneys may be malformed during the first trimester. The risk of spontaneous abortion increases during the second trimester and during the third trimester retardation of the body and brain growth may occur (Jirikowic, Kartin & Olsen 2008:240). Aliyu, Wilson, Zoorob, Brown, Alio, Clayton and Salihu (2009) suggest significant interaction between smoking and prenatal alcohol consumption on the risk of giving birth to a small-for-gestational-age (SGA) baby. They also found that the risk of preterm delivery and spontaneous preterm birth are both associated with alcohol intake during pregnancy. Risk for spontaneous preterm birth linked to alcohol consumption increased with the increase in the number of drinks consumed per week by pregnant women.

A pregnant woman can cause harm to her unborn child not only by consuming alcohol, but also not eating nutritious food during pregnancy. This combination results in malnutrition and a poorly developed baby (Carter 2007:562).

Moderate intake of alcohol, defined as no more than one drink per day for women, may lower Apgar scores and reduce fertility in women (ADA 2002:1484).

2.2.3 Drugs

Cocaine and marijuana are drugs sometimes taken by pregnant women. Cocaine can easily cross the placenta and impair the growth and development of the foetus (Richardson, Goldschmidt & Larkby 2007:1017).

Perinatal complications are high with drug abuse during pregnancy. The complications are as follows: high incidence of stillbirths, meconium-stained fluid, premature rupture of the membranes, maternal haemorrhage (*placentae praevia*) and foetal distress (US Department of Health and Human Services 1992:61).

Drug use adversely affects the health of the mother and can create problems during pregnancy (Wright & Walker 2001:990). They can enter the foetal bloodstream and cross the placenta. There are so many problems that can occur, the most serious of which would be a baby born prematurely with birthweight being low, restriction in growth, neurodevelopment being impaired, motor skills being poor, problems concerning behaviour (abnormal cries and sleep), an increased risk of infection occurring and sudden infant death syndrome (SIDS) (Spear, Silveri & Casale 2002:324; Rivkin 2008:743). The pregnancy outcomes are also associated with hypersensitivity of the infants, and effects of toxicity and withdrawal are common among those who test positive for drugs. The growth of these children continues at a slow rate throughout childhood (Richardson *et al.* 2007:e1017).

2.2.4 Caffeine

Caffeine is a mild central nervous system stimulant, which is present in chocolate and various beverages like coffee, tea, energy and carbonated drinks. Traces of caffeine can also be found in over-the-counter medications such as cold and allergy tablets and diuretics (Bracken, Triche & Belanger 2003:458).

Reduction in birthweight has been associated with maternal caffeine intake. Caffeine of less than 300 mg/day has been linked with FGR, but studies have found with as little as 141 mg/day, a reduction in birthweight of 114 g has been observed among pregnant women (Konje & Cade 2008:2332; Boylan, Cade, Kirk, Greenwood, White & Shires 2008:1035). Konje and Cade (2008: 2332) conducted a study to examine the association of maternal caffeine intake with FGR. The study found that a reduction in birthweight of about 60-

70 g was associated with caffeine consumption of less than 200 mg/day, and with higher caffeine intake, a considerable trend for greater reduction in birthweight was observed in pregnant women.

The use of caffeine increases the risk of first-trimester spontaneous abortions. Caffeine may not contribute to IUGR or other major complications after the first trimester. However, it appears to be sensible to limit coffee and caffeine intake during pregnancy, although there are insufficient data for making a specific recommendation (Grosso, Triche, Belanger, Benowitz, Holford & Bracken 2006:1036).

2.3 Environmental contaminants

Air pollutants aggravate chronic diseases, such as asthma, and lead to exposure to developing foetuses and children. Exposure to air pollution alters the normal process of the development of the lungs and therefore it can have a lasting effect on respiratory health (Trasande & Thurston 2005:690). The primary route to air pollution exposure is through inhalation. Fossil fuels are the most dominant origin of pollution. In urban areas traffic related emissions are the major source of air pollution, with other sources being large industrial facilities such as industries and power plants (Aligne, Auinger, Byrd & Weitzman 2000:874).

A study conducted in the United States, New York City (NYC) by Berkowitz, Wolff, Janevic, Holzman, Yehuda and Landrigan (2003:595) reported on the destruction of the World Trade Center (WTC) on 11 September 2001. Great amounts of toxic materials were released into the air of NYC, and since the disaster new cases of asthma have been reported by children that were exposed to the air pollution. The attacks on the WTC and the exposure to pregnant women were associated with SGA babies. Another study found that women who lived within two miles of the WTC had babies with lower weight, reduced length and smaller head circumference (Lederman, Rauh, Weiss, Stein, Hoepner, Becker & Perera 2004:1774).

Pregnant women who have been exposed to environmental contaminants such as lead have babies who show a sign of delayed mental and psychomotor development. When a woman is pregnant and she has lead exposure, the lead moves across the placenta and causes damage to the developing foetal nervous system (Ribas-Fito 2003:583).

Another contaminant that is of concern to pregnant women is mercury. Some fish contains pollutant mercury and this can impair foetal growth and harm the nervous system and the developing brain (Halldorsson, Meltzer, Thorsdottir, Knudsen & Olsen 2007:690). *Lysteria monocytogenes* is a bacterium that causes foetal death. This infection is acquired during pregnancy when the mother eats contaminated foods such as unpasteurised soft cheese or uncooked meat. This organism can be transported to the foetus and cause stillbirth (Goldenberg, McClure, Saleem & Reddy 2010:1482).

2.4 Maternal age

A maternal age of less than 16 years or more than 35 years is often associated with low socio-economic status and malnutrition, and can also result in preterm deliveries. The risk for pregnancy-related death has been known to increase for women aged 35 and older, and women 40 years and older are four times more at risk than those aged 30-34 (Harrison, Keet & Shore 2001:71). Nestel and Rutstein (2002:24) report on aged-based standards of the first and second national health and nutrition examination surveys (NHANES 1 and 11) conducted in the United States. Women in the age bracket 25 years and older who also present a higher BMI are more likely to have pregnancies terminate in a miscarriage or stillbirth rather than a live birth. Terminated pregnancies are more likely to have occurred if the woman has either a low or a high BMI than for a woman with a normal BMI (19,8 – 25) under the age of 25 years (Mahan & Escott–Stump 2008:168).

In the developed world, women tend to postpone childbearing late into their reproductive years. This trend has been observed by vital statistics of the province of British Columbia (Provincial Board of Health 2010) in Canada,

Europe, Australia and United States, where in 1968 there were less than 7 per cent of first-time mothers over the age of 30 and in 2005 this increased to 44 per cent. In 2005 there was a prevalence of 15 per cent first-time mothers over the age of 35. The decline in fertility related to age is attributed to a decrease in conception rates and pregnancy loss rates. The decline begins around age 30, increases after the age of 30 and by the age 45 fertility is close to zero (Maheshwari, Porter, Shetty & Bhattacharya 2008:1040). Chronic conditions such as hypertension and diabetes can be associated with pregnant women who are older than 35 years. The babies of older mothers face problems of higher rates of babies born prematurely and with LBW (Whitney & Rolfes 2010:513).

Women at an advanced maternal age face complications such as delivery before 32 weeks, primary caesarean delivery, prolonged and dysfunctional labour and pregnancy hypertension (Luke & Brown 2007:780).

Bretherick, Fairbrother, Avila, Harbord and Robinson (2010:2163) conducted a self-reported survey in British Colombia, Canada, to determine fertility and aging. The study reported that women were aware that fertility decreases with age but were not conscious of the steep rate of fertility decline and they did not identify a woman's age as the strongest risk factor for miscarriage.

2.5 Maternal health

2.5.1 Sexually transmitted diseases and infections

Fifty per cent of stillbirths are due to maternal or foetal infections and this is most prevalent in low- and middle-income countries (Rawlinson, Hall & Jones 2008:154). Stillbirths are related to bacterial infections which reach the foetal compartment through the placenta and move from the vagina to the cervix. In transplacental infections like syphilis, the infection is in the placental villi and the organism reaches the foetus through the umbilical vein. In this case the liver is mostly affected (Kortweg, Gordijn, Timmer, Holm, Ravise & Erwich 2008:74).

Stillbirths have also been associated with maternal childhood viruses such as rubella, mumps, measles and chickenpox. Maternal rubella has been linked with major cardiac defects and stillbirth. Chicken pox can cause maternal pneumonia. This virus crosses the placenta and attacks the foetus (Gershon 2006:700).

Maternal influenza infection has been associated with maternal and foetal deaths. During 2009, there were several reports on influenza A HINI infections which were associated with maternal deaths and stillbirths. In low-income countries immunisations rarely occur and therefore influenza infections are high (Jamieson, Honein & Rasmussen 2009:453).

A number of pregnancy outcomes have been linked with sexually transmitted infections, including aborting spontaneously, stillbirth, prematurity and LBW. Infant morbidity and mortality of babies born prematurely and with LBW are major determinants, especially where neonatal intensive care facilities are not available in developing countries. Sexually transmitted infections, including human immunodeficiency virus (HIV), are believed to be of importance because the prevalence of infection is so high in developing countries (Mullick, Watson-Jones, Beksinska & Mabey 2005:294; Hossain, Broutet & Hawkes 2007:25).

Studies conducted in Africa found bacterial vaginosis in up to 40 per cent of pregnant women, and 2,5 to 17 per cent have serological evidence of syphilis. Syphilis has a dramatic impact on pregnancy outcomes if it is left untreated. Stillborn births are the most significant consequence of untreated syphilis in resource-poor settings, but the infection has also been associated with LBW, babies born prematurely and IUGR in Africa. Untreated maternal infections including vaginal infections still include stillborn birth, LBW, preterm birth and, in surviving infants, congenital infection (Villamor, Dreyfuss, Baylin, Msamanga & Fawzi 2004:1426).

2.5.2 Human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS)

Some of the highest HIV prevalence rates in the world are found in South Africa (SA). Approximately 554 million people are living with HIV in South Africa. The annual survey of HIV infection among pregnant women shows that the figures increased from 26,5 per cent in 2002 to 30,2 per cent in 2005 with 15,7 per cent in the Western Cape and 39,1 per cent in KwaZulu-Natal (Health Systems Trust 2006).

HIV is now the most prevalent sexually transmitted infection in pregnant women in many African settings. Women attending prenatal care clinics who are infected with HIV have an overall prevalence of 15 to 30 per cent. The Joint United Nations Programme on HIV/AIDS (UNAIDS) reports prevalences between 18 and 39 per cent in South Africa. HIV has been associated with LBW and stillbirth, and delivery of preterm by HIV positive mothers has increased in comparison to HIV negative mothers (Mullick *et al.* 2005:297; Rollins, Coovadia, Bland, Coutsoudis, Bennish, Patel & Newell 2007:325).

A region that continues to be affected by the HIV epidemic is sub-Saharan Africa. A study conducted in Gaborone, Botswana, reported that there is a 35.5 per cent prevalence of HIV in women of reproductive age. The study has zoned in on mother-to-child transmission prevention of HIV programmes in Botswana. The government of Botswana is offering counselling, testing, antiretroviral drugs and infant formula for babies born to infected mothers, all free of charge. The fear of knowing one's own HIV status, infant formula distribution stigma and lack of male partner's support were the only stumbling blocks to programme participation. There would be a reduction in AIDS-related mother and infant mortality if these barriers were removed (Kebaabetswe 2007:358). Reducing overall mother-to-child transmission of HIV does not appear to be effective with vitamin A supplementation (Coutsoudis, Pillay, Spooner, Kuhn & Coovadia 1999:1520; Papathakis & Rollins 2005:13).

A study conducted in Tanzania showed that perinatal mortality, prematurity, SGA, LBW and low Apgar scores have been associated with HIV. HIV testing and infection are also linked with socio-demographic factors (Habib, Dalveit, Bergsjo, Shao, Oneko & Lie 2008:620).

2.5.3 Diseases of lifestyle

The effect of specifically diabetes and hypertension will be described in this section. Women who are pregnant and suffer from diabetes are at great risk of developing complications during pregnancy. They are also at risk of adverse pregnancy outcomes such as foetal congenital abnormalities, macrosomia and neonatal complications. Severe glycaemic control is necessary from the onset of planning pregnancy, during pregnancy and labour (Berg & Sparud-Lundin 2009:27).

Women face high infertility rates if they do not manage maternal diabetes properly. Diabetic women who do conceive can experience incidences of severe hypoglycaemia or hyperglycaemia, preterm labour and pregnancy related hypertension (HAPO Study Cooperative Research Group 2008:1993). Infants born to diabetic women may be large, suffer physical and mental abnormalities and can also suffer from fatal complications such as hypoglycaemia and respiratory distress (Kitzmiller 2008:1063).

Gestational diabetes normally occurs in some women during pregnancy. It develops during the second half of pregnancy and can either return to normal after childbirth or develop into type 2 diabetes if women are overweight (Yogev & Visser 2008). Complications for gestational diabetes can occur during labour and delivery as the babies are big. Neural tube defects (NTDs), limb deformities and heart damage to the babies are all associated with this type of diabetes (American Diabetes Association 2008:S58).

Type 2 diabetes and hypertension can occur together as they are both components of metabolic syndrome (Hedderson & Ferrara 2008:2364). Pregnancies can be complicated by hypertension, threats of hypertension

including heart attacks and strokes. High blood pressure (BP) can lead to LBWs of infants or separation of the placenta from the wall of the uterus before birth, which can lead to stillbirths (Marik 2009:72). Women planning to fall pregnant should always keep their BP under control.

Gestational hypertension occurs during the second half of pregnancy and usually returns to normal within a few weeks post-pregnancy. A complication of it is pre-eclampsia which occurs after 20 weeks' gestation. This condition occurs by protein in the urine (proteinuria) (Vikse 2008:803). During pregnancy this condition occurs in 3-10 per cent and causes about 15 per cent preterm births. In developed countries the condition leads to maternal mortality and is associated with perinatal mortality (Weinberg 2009:715). Pre-eclampsia affects the mother's organs, mainly the liver, kidneys and brain, and therefore retards foetal growth. This is due to lack of oxygen and nutrients to the placenta (Vikse 2008:804). The risk of the infant developing epilepsy increases (Wu 2008:1074). Studies have found that the death rate of pre-eclampsia among black women is higher than among white women (Rudra 2008:1585).

A study by Hedderson and Ferrara (2008:2366) on the association of high BP on gestational diabetes mellitus was conducted in Northern California (US). The study found that women had a twofold increase in developing this disease if they suffered from hypertension either during five years before pregnancy or during the first trimester. The study also found that the association between high BP and gestational diabetes mellitus was greater among overweight women.

2.5.4 Maternal micronutrient deficiencies

An important element of reproductive health is proper nutritional status of women before, during and after pregnancy. Maternal health is maintained and the risk of adverse pregnancy outcome, chronic disease in children later in postnatal life and birth defects are reduced. It is widely accepted that micronutrients have a major function in pregnancy and lactation. Detrimental

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effects to the pregnant woman would be nutritional imbalances, which would then influence the outcome of the pregnancy and composition of breast milk in lactation. Poor intake of micronutrients or inadequate stores might adversely affect both the mother (hypertension, anaemia, complications during labour) and the foetus (congenital malformations, preterm delivery, IUGR). Improper nutrition could influence either gestational age, severity of deficiency or both (Kontic-Vucinic, Sulovic & Radunovic 2006:116).

A major predisposing factor for morbidity and mortality among African women is maternal malnutrition (Lartey 2008:105). The causes include food intake being inadequate, diets of poor nutritional quality, infections occurring frequently and intervals of short interpregnancy. The prevalence of anaemia ranges from 21 to 80 per cent across Africa with deficiency levels being high and in similar values for both vitamin A and zinc (Lartey 2008:117). Studies conducted in Durban, South Africa, and in Malawi report on the impact of vitamin A supplementation which assists in the reduction of anaemia, which in turn improves birthweight and neonatal growth (Kumwenda, Miotti, Taha, Broadhead, Biggar, Jackson, Melikian & Semba 2002). Limiting or excessive vitamins and minerals in the diets of pregnant women include vitamin A, D and B6, folate, calcium, iodine, iron and zinc. Multivitamin and mineral deficit combinations often co-exist.

- **Iron deficiency**

The most common nutrient deficiency in pregnant women is ID. During early stages of pregnancy it develops when a woman with low iron stores enters pregnancy and fails to consume enough iron during her pregnancy. The iron requirement increases in Hb production and storage of iron by the foetus during pregnancy (Murray-Kolb 2009:947).

Several studies have found that maternal mortality, preterm delivery and LBW are associated with ID (Bopape, Mbhenyane & Alberts 2008:332). Long-term or permanent impairment of psychomotor function and physical development can occur if infants are anaemic. Association with lower productivity, even in

tasks requiring moderate effort such as factory work and housework, may occur in adults if they are anaemic (Rao, Yajnik & Kanade 2001:1218).

ID is known for having an effect on children's behaviour and intellectual performance. Iron carries oxygen to the blood and transports oxygen within cells for energy metabolism. The regulation of the ability to pay attention, which is crucial for learning, is due to iron that makes neurotransmitters (McCann & Ames 2007:939). Children that are anaemic are disruptive in classes and perform poorly at school due to their poor attention span. Children who had IDA as infants continue to perform poorly as they grow older even if there was an improvement in their iron status (Lozhoff 2006:38).

The highest prevalence of anaemia in the world is found in Asia. In India about half of all women are anaemic. Eighty-eight per cent of them develop anaemia during pregnancy. The main causes of anaemia are poor absorbable iron and low iron intakes as well as malaria and hookworm infections (Yajnik 2006:S50). In Asia the prevalence of anaemia was estimated to be 60 per cent in pregnant women and at least 50 per cent of this amount has been attributed to deficiency of iron. According to Kaiser and Allen (2002), IDA maternally increases the risk of premature delivery and LBW and adds to the risk of morbidity and perinatal mortality in pregnant women.

The most common cause of anaemia is a nutritional deficiency such as iron, folate and vitamin B12 deficiency, among many factors including chronic inflammation, parasitic infection, socio-economic status and genetic factors (Lee, Kim, Kim, Kim & Kim 2006:1130). It was found through a study conducted by Lee *et al.* (2006) that 20-30 per cent of pregnant women in Korea are anaemic. The purpose of their study was to find what the prevalence of IDA was among Korean pregnant women and to ascertain the association between pregnancy outcome and maternal Hb level. Their study concluded that women with low Hb levels had infants with lower birthweight, height and Apgar scores. Similar results were found in a study conducted in the central region of Limpopo of pregnant women receiving antenatal care in local clinics (Mamabolo, Alberts, Steyn & Levitt 2006:128).

❖ Folate deficiency

Folate deficiency impairs cell division and protein synthesis. The replacement of red blood cells and gastrointestinal tract cells falter in folate deficiency and the first symptoms of deficiency are anaemia and mental confusion, weakness, fatigue, irritability and shortness of breath and possibly other symptoms experienced by pregnant women (Whitney & Rolfes 2010:329).

A study conducted by Siega-Riz, Savitz, Zeisel, Thorp and Herring (2004:1852) found that in pregnancy a maternal folate deficiency leads to increased risk in the foetus of NTD, which is reduced by folate supplementation early in pregnancy. Adequate folate intake is essential throughout pregnancy to ensure normal growth and development of the baby. LBW and preterm delivery have been associated with impaired maternal folate status.

Globally more than 300 000 new cases of NTDs per year are reported which are the cause of mortality and morbidity. This results in 41 000 deaths and 2.3 million disability-adjusted life years (Blencowe, Cousens, Modell & Lawn 2010:1111). Anencephaly and spina bifida are the two most common types of NTD. The upper end of the neural tube fails to close in anencephaly. Consequently the brain either fails to develop or is missing. Pregnancies affected by anencephaly often end up in miscarriage. Incomplete closure of the spinal cord and its bony encasement characterises spina bifida. The membranes covering the spinal cord (meninges) often protrude as a sac, which when ruptured can lead to meningitis (Grewal, Carmichael, Song & Shaw 2009:117). Club foot, dislocated hip, curvature of the spine, muscle weakness, mental disabilities and motor and sensory losses are the common problems associated with spina bifida (Whitney & Rolfes 2010:487). Research by Wilcox (2007) suggests that congenital birth defects such as cleft lip and palate may be prevented through the usage of folate/folic acid.

Blencowe *et al.* (2010:1113) have also reported that the highest incidence of NTD is in the most economically disadvantaged populations. A high risk of

NTD has been associated with lower maternal education in high-income countries.

Studies discovered that folate deficiencies were found in poor folate intake and it has been suggested that folic acid supplementation be given to all women of childbearing age (Bopape *et al.* 2008; Mamabolo *et al.* 2006).

2.6 Anthropometric indicators

2.6.1 Weight gain

Pregnancy and its outcome are both strongly influenced during gestation and before pregnancy by the nutritional status of the mother (IOM 2009). The Institute of Medicine's (IOM's) guidelines for weight gain for underweight mothers are 0,45–0,7 kg per week, for normal weight mothers 0,4 to 0,6 kg per week, and for overweight/obese mothers 0,25 to 0,4 kg per week. When the weight gain is within the guidelines mentioned it is associated with prescribed birthweight. Weight gain of women either above or below IOM guidelines are at higher risk of adverse outcomes (IOM 2009).

Underweight women have a high risk of having a LBW infant; this can happen if the woman is malnourished, or is unable to gain sufficient weight during pregnancy (Whitney & Rolfes 2010:500). Underweight women have a great chance of preterm labour, having LBW babies and infant deaths (Ward, Kruger & Van Graan 2007:112).

A study which was conducted in the North West at a Potchefstroom clinic on the influence of pre-pregnancy BMI and weight gain during pregnancy reported that all underweight women gained weight according to the IOM recommendations, or even more. The reason for this could be attributed to the mothers possibly making regular visits to the clinic, with dietary counselling and nutrient supplements (Ward *et al.* 2007:116).

A study conducted by Kruger (2005:43) on the monitoring of pregnancy weight gain in outpatient clinics in SA reported that in pregnant women a

MUAC of less than 22 cm can be defined as wasting. Kruger (2005:43) also states that in developing countries pregnant women start attending antenatal clinics late in pregnancy, so that pre-pregnancy BMI is unknown and antenatal care can be based on pregnancy weight gain only. Women with adverse pregnancy outcomes are those with short stature (<145 cm) and low body weight (<45 kg). For overweight women a weekly weight gain should range from 0,3 kg to 0,5 kg and for underweight women more weight gain from the second trimester (Kruger 2005:44).

Table 1 shows the IOM's published recommended weight gains by pre-pregnancy BMI.

Table 1: Recommended weight gains for pregnant women based on BMI

Weight category based on BMI	Total weight gain kg	1st trimester gain Kg	2nd and 3rd trimester weekly gain kg
Underweight (BMI <19,8)	12,5–18	2,3	0,49
Normal weight (BMI ≥19,8≤24,9)	11,5–16	1,6	0,44
Overweight (BMI >25 ≤29,9)	7–11,5	0,9	0,3
Obese (BMI >30)	6	-	-

Adapted from Van der Walt (2006:27)

2.6.2 Obesity and pregnancy outcomes

The most common risk factor for maternal mortality in developed countries is maternal obesity (Rowlands *et al.* 2010:94). The WHO estimated that 400 million adults were obese and this figure is to rise to more than 700 million by 2015 (WHO 2009). Maternal obesity is defined as a maternal BMI of >30 at the first antenatal consultation (Fitzsimons & Modder 2010:100). This condition causes great risks for cardiovascular and metabolic diseases in the mother. If a mother suffers from cardiovascular complications there is an increased risk of congenital heart disease in the offspring (Tan 2004:158).

In many parts of the world there is increased prevalence in overweight and obesity in women of childbearing age. Women of childbearing age are becoming more diabetic and the reason for this could be an imbalance between expenditure of energy and energy intake (Huda, Brodie & Sattar 2010:70). Gestational diabetes has grown rapidly over the last decade and this may be due to the consumption of food and drinks containing sugar. During pregnancy obesity and being overweight are associated with several serious complications which could include foetal intrauterine death, pre-eclampsia, gestational diabetes and thrombosis (Henriksen 2006:20).

During pregnancy being overweight and high weight gain are both strong determinants of large-for-gestational-age (LGA) infants, which are contributing factors in the increase in the prevalence of macrosomic newborns. Maternal overweight and diabetes have repeatedly been associated with complications during delivery. These include injuries to the baby and mother, increased use of instrumental vaginal deliveries, caesarean sections and postpartum haemorrhaging, prolonged birth and shoulder dystocia (Huda *et al.* 2010:72).

Obesity has the following effects on maternal health outcomes (Rowlands *et al.* 2010:94-95):

- Maternal medical disorders during pregnancy: These have been associated with diabetes, pre-eclampsia, thromboembolic disease, obstructive sleep disorder, asthma, lower back pain and urinary incontinence (Redman & Sargent 2009:39; Alessi & Juhan-Vague 2008:997). Sleep deprivation is also associated with postpartum depression and preterm delivery (Chang, Pien, Duntley & Macones 2010:107).

- Maternal perinatal and postpartum issues: These have been associated with postpartum haemorrhage, postpartum anaemia and lactation failure, due to abnormalities in the prolactin response (Hilson, Rasmussen &

Kjolhede 2006:144). Induction of labour is common among overweight women since they are less likely to have spontaneous onset of labour.

Maternal obesity has the following effects on neonatal outcomes (Rowlands *et al.* 2010:94-96):

- Macrosomia: This is associated with babies that are LGA, which results in slow progression of labour and a risk of injury during birth (McGuire, Dyson & Renfrew 2010:110).

- Preterm delivery: This is associated with women with very high BMI. Studies have found that obese women have a higher risk of elective preterm births and pre-eclampsia is one of the major factors contributing to elective delivery (Hendler, Goldenberg & Mercer 2005:883; Smith, Shah, Pell, Crossley & Dobbie 2007:160).

- Antipartum stillbirth: This condition is linked with hypertension and gestational diabetes, which are associated with stillbirth. The causes are intrauterine death and placental dysfunction (Nohr *et al.* 2005:255).

- Perinatal morbidity: Babies that are born to obese mothers have a greater risk of being admitted to the neonatal intensive care unit. They are at risk of suffering from shoulder dystocia and low Apgar scores (Heslehurst, Simpson & Ells 2008:640). With maternal obesity there is also a connection between neonatal hypoglycaemia, jaundice and respiratory distress.

- Birth defects: Abnormalities associated with maternal obesity include NTD, cardiac defects, intestinal tract abnormalities and orofacial clefts. These defects are associated with gestational diabetes mellitus (Dashe, McIntire & Twickler 2009:89).

- Long-term childhood obesity: Heavier babies (>90th centile) have an increased risk of obesity throughout adolescence and adulthood (Koupil & Toivanen 2008:75).

- Service delivery implications: Studies have examined the implications of maternal obesity on health care resources. They have found that women with a BMI >26 spent more on hospital bills due to complications and that obese women need more obstetric care (Catalano & Ehrenberg 2006:1129; Heslehurst, Lang & Rankin 2007:339).

Efforts need to be made by obese pregnant women and health care providers to avoid maternal obesity (Jarvie & Ramsey 2010:87).

2.7 Undernutrition and pregnancy

Maternal and child undernutrition results in overall disease burden and substantial increases in mortality (Black, Allen, Bhutta, Caulfield, De Onis, Ezzati, Mathers & Rivera 2008:243). Most studies focus on maternal nutritional status as it has been identified as an important factor that contributes to poor foetal growth in developing countries. Most of these studies were designed to assess foetal growth and the influence of maternal nutritional status (Neufeld, Haas, Grajeda & Martorell 2004:650).

Undernutrition includes stunting, malnutrition and obesity or over-consumption of specific nutrients in one form, and wasting and deficiencies of essential minerals and vitamins in another. According to Kramer (1998), a major problem of maternal undernutrition is evident where more than 20 per cent of women have a BMI of less than 18,5 kg/m² during gestation and before pregnancy in countries such as sub-Saharan Africa, South-Central and South Eastern Asia. Low BMI is prevalent in India, i.e. 40 per cent. Pregnancy outcomes are affected by low BMI and maternal short stature. Caesarean delivery and low maternal BMI is associated with IUGR as maternal short stature can be a risk factor (Black *et al.* 2008:245).

Poor maternal nutrition affects pregnancy outcomes in that the risk of LBW increases. LBW babies suffer from reduced immune competence and poor cognitive development and learning capacity (Shaheen, De Francisco, Arifeen, Ekstrom & Persson 2006:1355). The growth of the foetus is further influenced

by the genes as well as the availability of nutrients and oxygen from the mother. According to Rheeder (2004:8), the following factors affect the supply of nutrients to the foetus:

- Maternal body composition and size
- Maternal nutrient stores
- Maternal food intake
- Transport of nutrients to the placenta
- Transfer across the placenta of nutrients

The placenta is instrumental in the amount of nutrition supplied to the foetus. Mothers with a low pre-pregnancy weight have much lighter placentas than heavier mothers. In early pregnancy nutritional conditions are especially important because inadequate maternoplacental supply often underlies later manifestation of growth failure when placental function is established (Moore, Davies, Willson, Worsley & Robinson 2004:1822).

2.8 Conclusion

Pregnancy is a life-changing event when women are more inclined to hormonal and behavioural changes. Sometimes appropriate counselling and management during pregnancy for women could reduce the gestational weight gain. It can also improve perinatal outcome, which plays a contributing factor in persistent behavioural changes as far as nutrition and physical exercise are concerned. In Chapter 3 strategies used to improve folate and iron deficiency for pregnant women will be discussed.

Chapter 3

Strategies used to improve folate and iron deficiency in pregnant women

3.1 Introduction

In Chapter 2 the various factors associated with pregnancy outcomes were discussed. This study focuses mainly on addressing micronutrient deficiencies during pregnancy and therefore this chapter will highlight the different strategies that can be used to improve folate and iron deficiency in pregnant women.

Wherever possible, food of adequate quality and quantity must be obtained, transported and shared equally and on a regular basis and distributed to the needy population. Supplementary and therapeutic services are needed to create standardisation, and correct geographic distribution to ensure access is required to increase recovery, minimise the mortality rate and prevent malnutrition of the population. Considerable reductions in undernutrition by addressing general deprivations and inequity should be a global priority. Programmatic health and nutrition interventions are necessary for major reductions in nutrition deficiencies (Black *et al.* 2008:243). Both diet quality and quantity, with public interventions such as improved hygiene and sanitation, routine deworming and increased access to health services, are often required in many areas where the aetiology of ID and anaemia is complex. Sometimes combining strategies that address these is essential (Ramakrishnan & Semba 2008:495).

IDA prevention and control place strong emphasis on human development policies that share the opportunities for growth and fruits of development with children of the poor. For women and their children there are strong economic and social arguments supporting increased investment in iron adequacy. Firstly, iron enrichment will enhance human development and reduce poverty sustainability. The most critical period of brain development is the first three

years of life, and proper iron nutrition is a critical factor in neurosensory integration of the infant brain. Optimal development will be promoted by ensuring adequate nutrition, including iron, during infancy up to age 3 and even in the womb by providing adequate health and nutrition for the pregnant mother. Secondly, improved iron status lowers illnesses and dropouts. Thirdly, reversing IDA in children strengthens the prospects of long-term economic competitiveness and future quality and productivity of the labour force (Hunt 2002:795).

The basic principles in the prevention of IDA are to ensure regular consumption of iron to meet the requirements of the body and increase the content of bioavailable iron in the diet. Fortification of commonly consumed foods with iron, supplementation, education regarding nutrition and dietary diversification are the four main approaches (Gibney, Margetts, Kearney & Arab 2004:232).

3.2 Fortification

Many countries have implemented compulsory fortification of foods with folic acid, iron and other nutrients, ensuring an increase in the levels of folate and iron amongst the general population (Modjadji, Alberts & Mamabolo 2007:89).

Innovative and affordable ways to improve poor people's diets must be discovered and implemented. Fortified foods are a logical strategy in the sustainable solution to multiple micronutrient deficiency. Fortification is defined as "the addition of one or more essential nutrients to a food, whether or not it is normally contained in the food, in the population or specific population groups for the purpose of preventing or correcting a demonstrated deficiency of one or more nutrients" (FAO 1997). Fortification of cereal products with iron and B vitamins has been practised throughout the developing world for the past number of years (Darnton-Hill & Nalubola 2002:232).

Firstly, a suitable vehicle to which iron can be added must be chosen. Several factors must be considered to fortify foods and the vehicle chosen should not require the direct collaboration of the population:

1. It should be consumed in an adequate amount by the general population, and particularly by the vast majority of target groups.
2. It should be available for fortification at relatively few centres, so that quality control can be adequately supervised and maintained.
3. It should be stable after fortification, even under extreme conditions of storage (such as high temperatures and high levels of humidity).
4. It should remain palatable after fortification and not change the palatability of other foods that it may be mixed with.
5. The cost-effectiveness of fortification and the vehicle must be acceptable (Alnwick 1998:144).

Trials of food fortification have been performed in various countries. In countries such as the US flours and cereal products are enriched with iron, thiamine, riboflavin, niacin, folic acid and calcium. The US showed that food fortification played an important role in the decline of pellagra-attributed mortality in the 1930s and 1940s. Folic acid fortification of cereal products was authorised in the US in 1996 as a public health means to decrease the risk of NTDs. Educational outreach and the increase in consumer awareness have been noted to contribute to pregnancy affected by NTD and this has decreased by fortification to 19 per cent (Darnton-Hill & Nalubola 2002:234). Blencowe *et al.* (2010:112) assert that fortification of food is another form of ensuring increased folic acid intake around conception time. This approach has been implemented in 57 countries to date (Flour Fortification Initiative 2009). Studies conducted by Bol, Collins and Kirby (2006:806) and Cotter and Daly (2005:162) show reductions in the incidence of NTDs and perinatal mortality due to NTDs. These studies suggest that food fortification can reduce NTDs by 46 per cent. Another country which has a long history of fortifying wheat flour with iron is Sweden (Gibney, Margetts, Kearney & Arab 2004:233). In various communities fortification of some commonly consumed foods with iron is an attractive option to tackle the problem of inadequate dietary intakes.

Wheat flour, corn meal, rice, refined sugar, salt, condiments, infant foods and weaning foods have been considered as possible vehicles. The choice of vehicles is dependent on dietary habits. In Africa, salt may be considered as a possible vehicle, because of its wide consumption. Unfortunately, most soluble iron compounds cause discolouration. Furthermore, iron added to cereals may therefore be poorly absorbed as it stands to be affected by the same ligands (such as phytate) that inhibit the absorption of the intrinsic iron from various food items.

To ensure the improvement of nutrition and health of the population any fortification programme must be evaluated for its effectiveness, whatever the choice of vehicle and the iron compound (Koury & Ponka 2004:114). Iron-folic acid fortification during pregnancy suggests an increase of 12 g/L in haemoglobin at term, and a 73 per cent reduction in the risk of anaemia at term has been taken from a pooled analysis of data from eight different studies (Pena-Rosas & Viteri 2006). However, progress in combating ID has been hindered by technological limits on iron fortification of staple foods. There is no magic technological bullet to solve the problem of undernutrition.

Synthetic folic acid in fortified foods is more bioavailable than naturally occurring folate and there are cases where several international studies have reported improved folate status after fortification of foods (Hertrampf & Cortés 2004:S45). Koury and Ponka (2004) state that after the introduction of fortified foods some people are still at risk of developing folate deficiency due to malabsorption, which is a non-dietary factor.

3.2.1 Fortification in South Africa

In 1927, widespread goitre was reported for the first time in SA in the Langkloof area of the Eastern Cape. Through recommendations of the South African Goitre Research Committee optional iodisation of salt with potassium iodate was legally introduced in SA at a level of 10-20 ppm of iodine in 1954. The optional iodisation of salt did not resolve the endemic, however (Jooste, Weight & Kriek 1997:1376). In December 1995, mandatory iodisation of table

salt with a higher concentration was introduced in SA. The revised legislation stipulated that 40-60 ppm of iodine in the form of potassium iodate had to be added to all table salt. In 2006, the regulation was again revised to iodisation to 35-65 ppm (Jooste & Zimmerman 2008:11).

In 1999 the Department of Health (DoH) conducted a national food consumption survey among South African children with the aim of determining what types of food they were eating, how often they were eating and how much money was spent on food each week. This information allowed the DoH to identify vehicles for food fortification in South Africa. This led to a government decision that as from 2002, maize meal and white and brown bread flour should be fortified with 70 mcg RE vitamin A, 0,25 mg thiamine, 0,14 mg riboflavin, 4,16 mg niacin, 0,27 mg pyridoxine, 73 mcg folic acid, 2,01 mg iron and 2,01 mg zinc (bread per 100 g). Fortificant requirements for maize meal per 1 kg are 27,8000 mg vitamin A, 2,8045 mg thiamine, 1,6875 mg riboflavin, 25,0000 mg niacin, 3,8580 mg pyridoxine, 2,2099 mg folic acid, 35,7143 mg iron and 18,7500 mg zinc (Steyn, Nel & Labadarios 2008:23). The food fortification regulations are published in terms of the Foodstuffs, Cosmetics and Disinfectants Act in the Government Gazette. A need was identified to help South Africans follow a healthy diet. Consequently, the DoH (2003) enforced the fortification of staple foods in South Africa in October 2003.

The DoH (2000) reports on folic acid and makes the point very clear that half of the pregnancies during 2000 were unplanned even though about 50 per cent of women of child-bearing age met recommendations regarding folate. To address this problem fortification was suggested primarily to ensure widespread access to adequate folic acid. This process was to be accompanied by an educational campaign. It was estimated that 41 per cent of the incidences of pregnancies affected by NTDs would be reduced by such a move (Anderson 2001:500). The South African government has mandated the fortification of all cereal grains, except rice and wheat, with 0,14 mg (140 micrograms) of folic acid per 100 g of grain as established by the National Food Fortification Programme.

3.2.2 Successes in developing countries

For over 70 years the most common food fortification practice has been salt iodisation. Its success has been largely through its relative simplicity and cost effectiveness. Another similar product which has been enormously successful is sugar. During the 1970s sugar fortification with vitamin A was first implemented in Guatemala, followed by other central American countries, including Costa Rica, Honduras and El Salvador. These countries are currently operating successful sugar fortification programmes. Fortification of sugar with vitamin A was initiated in 1998 in Zambia and is ongoing despite economic constraints, the continuous infiltration of cheaper unfortified sugar from bordering countries and the fall in the international price of sugar (Hunt 2002:795).

National programmes of sugar fortification with vitamin A in central American countries have found success in the sense that the prevalence of vitamin A deficiency among preschool children has decreased. Fortification of complementary foods has been shown not only to improve the status of the young, but where the community is involved, to empower the women in these communities. Tragically provision is occasionally not made, which goes against the internationally recognised imperative of fortifying all food used in humanitarian aid (Darnton-Hill & Nalubola 2002:235).

According to Lochmann (2005), fortifying flour, salt and oil offers an effective and inexpensive way to get essential vitamins and minerals into food for low-income and most at-risk populations. It also improves children's cognitive development. Food fortification used to reduce micronutrient deficiencies helps to strengthen economies by lowering health care costs and increasing worker productivity.

Iron status has improved in the following countries: Chile, where nationally distributed dry milk, fortified with ferrous sulphate and vitamin C, lowered the prevalence of anaemia in infants by about 27 per cent; Ghana, where electrolytic iron, added to a complementary food, reduced anaemia and ID;

India, where a double fortification of salt with iodine and iron has the potential to prevent both iron and iodine deficiencies and fortification with iron has been effective in improving Hb concentrations (FAO 2002:71).

Women are much more liable to suffer from anaemia than men. Additional iron is required during menstruation, pregnancy and breastfeeding. During these periods of her life a woman needs at least twice as much iron, as anaemia can cause tiredness, lassitude and other symptoms of poor health (Mahan & Escott-Stump 2008:176).

Iron fortification of common food items such as wheat flour will affect the iron intake of all segments of the population except for infants. This non-targeted approach will benefit women of childbearing age as they have the most to gain (Ramakrishnan & Semba 2008:498). However, iron fortification is only suitable for areas with a high consumption of wheat flour (>80-100 kg/person/year), therefore, it is highly feasible and reasonable to fortify wheat flour with iron and other micronutrients, as experience to date indicates that it adds about 0,5 per cent to the overall cost of the flour (Ramakrishnan & Semba 2008:498). According to Dary (2002:36), in order to really overcome ID, fortification of staple foods should be complemented with the implementation of other interventions.

3.2.3 Successes of food fortification in SA

After the salt iodisation in 2006, great progress was seen in the elimination of iodine deficiency in SA. At retailer level, the mean iodine content of table salt increased from 14 to 33 ppm. The distribution of urinary iodine values from deficient to sufficient concentrations was observed in one year (Jooste & Zimmerman 2008:11).

In SA, a study was conducted by Modjadji *et al.* (2007) in a rural area of Limpopo situated in the Capricorn district. The purpose of the study was to assess the effect of fortification of staple foods on the folate and iron status of women of childbearing age. This study found a significant improvement in

folate status in the women approximately nine months after fortification of maize and wheat products. The study showed that before fortification 27,6 per cent of the population had low serum folate values (<3 ng/ml) and after fortification none of the women had low serum folate values. No improvement in iron status was found as measured by serum ferritin.

Steyn, Nel and Labadarios (2008:646) indicated in their study on the national food consumption survey (NFCS) that micronutrients added to staple foods make a significant difference to the intake of vitamin A, thiamine, niacin, vitamin B6, folic acid and iron.

Food fortification is likely to have played an important role in the current nutritional health and well-being of populations in industrialised countries. Treating a goitre with iodised salt, rickets with vitamin D-fortified milk, anaemia with B vitamins and iron-enriched cereals and risk of pregnancy affected by NTD with folic acid-fortified cereals are just some of the specific health conditions which can be targeted when applying fortification (Darnton-Hill & Nalubola 2002:232).

3.2.4 Challenges in fortification programmes

According to Jooste and Zimmerman (2008:13), the problem most experienced in the national salt iodisation programme was inadequate education and the lack of iodine knowledge of those involved. Several challenges face food fortification programmes (Fowles & Gabrielson 2005:126):

- Technical constraints: installation and maintenance of fortification machinery
- Socio-economic constraints: the targeted groups are often those with the least purchasing power; price of initial batch of fortification and capital costs

- Infrastructural constraints: poor distribution systems due to poor infrastructure; lack of access to commercially processed food limited by geography, poverty or cultural preferences
- Political constraints: political support may be lacking due to perceived priority of other health and nutrition interventions; lack of awareness of magnitude of problem and benefits of addressing it; lack of facilitating legislation and of equal opportunities for all potential fortifying companies

3.3 Supplementation

Maternal health and pregnancy outcomes have improved when routine supplements containing iron or a combination of iron and folic acid have been taken as suggested by Whitney and Rolfes (2010:433). Whether fortified or not, supplementation is the technical strategy required for acute situations in which the demand for iron is quite high and cannot be easily met from the iron available in foods. Typical situations for iron supplementation are found in pregnancy, particularly in the second trimester, and also in situations of severe anaemia. It is a curative solution, which deals with acute situations. Iron taken orally is the treatment of choice for prevention of IDA. In general, daily supplements providing about 100 mg of elemental iron are recommended for a period of 100 days to the most vulnerable groups such as pregnant women. Supplementation cannot be considered to be a sound preventative approach in view of its unpleasant side effects (constipation) and the passing of dark stools, compliance problems as well as joint pains which are experienced after prolonged usage (Shrimpton & Schultink 2002:224).

Based on limited evidence that folic acid improved haemoglobin response to iron in Africa and India, folic acid has for a long time been included in iron supplements for pregnant women in developing countries. Subsequent trials, however, failed to show that adding folic acid improved anaemia more than iron alone. Recent evidence suggests that poor maternal folate status is associated with a higher risk of abnormal pregnancy outcomes, including eclampsia, premature delivery and birth defects such as NTD, club foot and

cleft palate (Whitney & Rolfes 2010:497). Folic acid supplements for pregnant women can reduce the risk of infants having NTD, but only if the supplements are taken by susceptible women around the time of conception. Consuming more folate from foods or folic acid from supplements can lower plasma homocysteine and potentially lower the risk of dementia in the elderly and cardiovascular disease in adults (Blencowe *et al.* 2010:117).

Pena-Rosas and Viteri (2006) assessed the efficacy, effectiveness and safety of routine daily antenatal or intermittent iron supplementation with or without folic acid during pregnancy on the health of mothers and newborns. A total of 12 706 women involved in 40 trials were included in this systematic review. Daily antenatal iron supplementation increased haemoglobin levels in maternal blood antenatally and postnatally. Quantifying the increase was difficult because of significant heterogeneity between studies. However, haemoconcentration during pregnancy was less frequent with the weekly regimen. No differences were seen between daily and weekly supplementation with regard to gestational anaemia. Side effects and haemoconcentration were more common in women who received daily iron supplementation (Pena-Rosas & Viteri 2006).

Any supplementation programme must be evaluated for its effectiveness to ensure that it improves the nutrition and health of the population, whatever the choice of vehicle and the iron compound (Untoro, Timmer & Schultink 2010:96).

3.3.1 Supplementation in other countries and SA

A study conducted in Nepal previously reported that maternal micronutrient supplementation in rural Nepal decreased LBW by 15 per cent. A study by Christian, West, Khatry, Leclerq, Pradhan, Katz, Shrestha and Sommer (2003:1198) in Nepal examined the effect of daily maternal micronutrient supplementation on foetal loss and infant mortality. In this study it was found that maternal supplementation with folic acid (alone or with iron) results in

small but significant decrements in the incidence of LBW but not of preterm delivery (Christian *et al.* 2003:1200).

Stoltzfus, Chakraborty, Rice, De la Briere and De Francisco (2009) conducted a study in Matlab, Bangladesh, on pregnant and postpartum women using iron pills as a form of supplementation. The study showed that the prevalence of anaemia declined by 36 per cent and haemoglobin concentration increased from 0,9 to 2,1 g/dl.

Studies in Hungary by Banhidy, Acs, Puho and Czeizel (2010:4) investigated the efficacy of iron supplementation in anaemic women regarding pregnancy complications and birth outcomes. The study found that anaemic pregnant women without iron supplementation had a higher rate of preterm births and shorter gestational age at delivery and these outcomes were prevented by iron supplementation. Watson and McDonald (2010:191) found in their study on the association of dietary supplements during pregnancy on infant birthweight in New Zealand that of all dietary supplements associated with birthweight, iron was the only supplement nutrient that had a significant association.

Worldwide, 13.8 million newborns are at risk of iodine deficiency. Adequate maternal iodine supply is very important for foetal brain development (Melse-Boonstra & Jaiswal 2010:30). According to a study done in China, iodine supplementation during pregnancy has shown to improve psychomotor development scores in the baby and in Europe. Studies have also shown increased maternal urinary iodine excretion and reduced thyroid volume (Melse-Boonstra & Jaiswal 2010:32).

One of the major global health issues is LBW, particularly because infants born with low weight are at increased risk of being stunted and malnourished when reaching reproductive age and thus are at risk of maternal mortality and producing delivery of LBW babies. According to Friis, Gomo, Nyazema, Ndhlovu, Krarup, Koestel and Michaelsen (2004:179), a study was conducted amongst antenatal care attendees in Harare, Zimbabwe. This was done to assess the effect of prenatal multimicronutrient supplementation on gestational

length and birth size. Pregnant women were randomly selected to receive multimicronutrients in the form of a tablet or placebo supplement daily until delivery. Supplementation with iron and folic acid was part of the antenatal care. The results showed an increase in birthweight: the mean birthweight was 3 030 g, and gestational length increased: the mean gestational length was 39.1 weeks (Friis *et al.* 2004:179). According to the above studies, supplementation increased the birthweights of the babies.

Seck and Jackson (2009:489) investigated if the provision of free iron/folic acid tablets improves compliance in pregnant women. This study was conducted in Senegal, West Africa. This was the first study that tested the assumption that poor access to iron supplementation affects compliance negatively. The study found that 86 per cent of women who received free iron/folic acid tablets complied compared to 48 per cent who had to purchase their own tablets. The study concluded that the treatment of anaemia with free iron/folic acid tablets is less costly when compared to paying for these tablets, which leads to poor compliance and poor pregnancy outcomes.

In the prevention and treatment of anaemia during pregnancy, a national plan or policy is drawn up in most countries in sub-Saharan Africa, including South Africa. These include the provision of haematinics (ferrous sulphate and folic acid) to all pregnant women at municipal clinics. Recommendations have been made by the African Regional Consultation on the Control of Anaemia in Pregnancy of the WHO that studies of prevalence and aetiology be undertaken. This information would be useful for the DoH and for the national maternal, child and women's health programme development (Hoque, Kader & Hoque 2007:16).

One hundred and five pregnant coloured women in the Cape Peninsula were diagnosed with the prevalence of anaemia, and iron, folate and vitamin B12 deficiencies were found (Kruger *et al.* 1994:135). The pregnant women were in their third trimester. The aim of the study was to determine the prevalence of anaemia and haemopoietic nutrient deficiencies in pregnant women receiving selective iron supplementation and residing in an area with a

relatively high percentage of LBW babies. A high percentage (25 per cent) of the women had anaemia in spite of a policy of screening and selective treatment of anaemia at the antenatal clinic. In this study three-quarters of the pregnant women had dietary intakes of less than 2 mg of absorbable iron/day. Considering the iron intake of the study population, it is probable that many of the pregnant women had depleted iron stores at the onset of pregnancy and low dietary iron intake may have been the reason for their ID (Kruger *et al.* 1994:135).

Milman (2008:949) reasons that requirements for absorbed iron increase during pregnancy are from 0,8 mg/day in the first semester to 7,5 mg/day in the third semester, on average about 4,4 mg/day, and that dietary measures are inadequate to reduce the frequency of prepartum IDA. He reports 0-25 per cent prepartum anaemia in women taking iron supplements (depending on the doses of iron) and 14-52 per cent in women taking a placebo. There was only one placebo group and therefore 0-3 per cent IDA in supplemented women and 12-17 per cent in placebo-treated women. According to Milman (2008:954), in women with slight to moderate IDA (Hb of 90-105 g/L) treatment with oral ferrous iron of about 100 mg/day between meals is the therapeutic option. IDA is efficiently prevented by oral iron supplements in doses of 30-40 mg ferrous iron taken between meals from early pregnancy to delivery.

A study conducted by Bopape *et al.* (2008) in Limpopo, SA, on pregnant teenagers showed that the rate of compliance with iron supplementation was low due to the fact that no significant difference was found between the girls that were supplemented and those who were not. There was no significant difference ($p>0.05$) in haemoglobin, serum ferritin and serum vitamin B12 concentrations between the pregnant girls reportedly using supplements (ferrous sulphate: 175 mg once daily) and folic acid (5 mg once daily) and those who were non-supplemented. Serum folate was, however, significantly ($p=0,03$) higher in the supplemented group.

Promising work on the development of protocols that allow only once- or twice-weekly supplementation without compromising efficacy, and with reduced side effects relative to daily supplementation, is being done. The limited approach is difficult to maintain in developing countries. Iron supplementation should always be accompanied by a food-based approach which, once the curative phase of the intervention has been completed, can be implemented (Nantel & Tontisirin 2002:840).

If the prevalence of a micronutrient deficiency in a population is high, then supplementation would be the best option, especially if the requirement for a nutrient is difficult to achieve through the normal diet. Supplements are normally provided to a well-defined target group. Pregnant and lactating women and infants represent the largest risk groups whose nutrient needs are also the highest, and who merit the provision of micronutrient supplements during this period of increased nutritional vulnerability. Supplementation is especially indicated if a distribution system is available that will allow the target population to be fully covered at a reasonable cost. Even though supplementation is traditionally considered a short-term approach, in reality it may be a long-term one in many situations, with the result that dietary intakes of nutrients such as iron and folate are enhanced in this segment of the population with no apparent risk or side effects. In industrialised countries between 10 and 30 per cent of the population regularly take dietary supplements (Shrimpton & Schultink 2002:224).

3.3.2 Challenges of supplementation

Many challenges exist in supplementation programmes. The delivery should be done through the existing primary health care systems. The success of supplementation programmes depends on the distribution of adequate quantities of iron supplements and adherence to treatment. A typical example would be the experience in India of shortcomings of such programmes when attempted on a large scale. In 1970, India adopted a national programme of supplementation of daily iron and folic acid tablets (for 100 days) to pregnant and lactating women. Evaluation of this programme indicated that, owing to

inadequate and irregular supplies of the supplements, there was no change in the prevalence of IDA in the country (Ramachandran 2002:32). Similarly, in Indonesia, even after ten years of distribution of 120 mg of iron daily for three months to all pregnant women, the prevalence of IDA remained high. Unfortunately, under the present socio-economic conditions in which the current dietary intakes are not adequate, pregnant women in developing countries will continue to require iron supplementation to meet their iron needs. Alternative approaches to supplementation such as a small dosage of iron supplementation and slow-release iron preparations are required (Christian *et al.* 2003:1199).

Therefore, Untoro *et al.* (2010:92-95) summarise the constraints to supplementation:

- Supply and distribution: Responsible people involved in this need to be transparent and accountable. Distribution channels or delivery mechanisms need thorough planning.
- Communications, public education and role of health care workers: An effective marketing campaign is important. Compliance with supplement use depends on communication by trained staff.
- Targeting supplementation: Pregnant women need to receive supplementation through preconception programmes, since pregnancy is often detected at a later stage. Supplementation to all women at reproductive age is necessary in cases where it is difficult to reach women.
- Cost of supplementation: Supplementation can be cost effective if done correctly.
- Monitoring: This is important to ensure that the programme is running smoothly and goals and objectives are being met.
- Political commitment and sustainability: Planning for sustainability is important in low-income countries. Political commitment is important in adopting new programmes.

During pregnancy supplementation can improve both maternal and infant iron status for up to about six months postpartum. According to Mora and Nestel (2000:1359), for preventing anaemia, daily supplementation during pregnancy is more effective than weekly, especially for severe anaemia. The total amount of iron consumed is the most important predictor of the maternal Hb response. LBW infants are born with very low iron stores, and these are depleted by two to three months postpartum. In malaria-endemic areas, antimalarial prophylaxis combined with iron supplementation is particularly important for preventing maternal anaemia and LBW babies (Mora & Nestel 2000:1359). This finding was contradicted by a study conducted by Kabyemela, Fried, Kurtis, Mutabingwa and Duffy (2008:165), who found that placental malaria was not as frequent in iron deficient Tanzanian women as among those with normal iron status. This was one of the first studies which reported that ID offers protection against placental malaria. This study found that by enhancing erythropoiesis and production of reticulocytes, iron supplementation increases susceptibility to the parasite *Plasmodium falciparum*, which affects young red blood cells.

3.3.3 Advantages of supplementation

There are significant benefits of iron supplementation, including a reduction in the prevalence of anaemia, improved physical performance and better cognitive function. Some studies suggest that during pregnancy an adequate iron supply during the first trimester may have a beneficial effect on infant birthweight. However. it is important to note that, especially for women whose menstrual losses are in the upper-normal range, the beneficial effect of iron supplementation in terms of accumulating iron stores is temporary (Lynch 2000:449). The additional iron is used to correct any anaemia or functional tissue ID present. When supplementation is initiated in an iron-deficient individual, the percentage of absorption is high. More iron is absorbed than is needed to replace losses. As stores increase, absorption is down-regulated. A new equilibrium is eventually established, and then the quantity of iron absorbed (derived from both the diet and the supplement) again matches the requirement. The percentage of absorption is now much lower than it was

before supplementation. When the supplement is withdrawn, the percentage of absorption from the diet will initially be equal to that at the end of the period of supplementation. When the quantity of iron being ingested is much less, a period of negative iron balance will follow. The predicted changes in iron storage size and the percentage of iron absorption can be calculated from the well-established relationship between the percentage of iron absorption and the size of iron stores. Storage iron will be consumed to make up the difference in the absorption required. The store will gradually diminish with a rise in the percentage of absorption until the pre-supplementation balanced state is reached again (Shrimpton & Schultink 2002:227).

The percentage of iron absorption from the diet will be too low initially if the supplement is withdrawn. To maintain iron balance the store regulator has been set for the higher iron intake during the period of supplementation. The initial rate of loss from stores will equal the difference between the requirement and the rate of absorption at the time the supplement is withdrawn (Stoltzfus *et al.* 2009:7). As iron stores are used up, the rate of absorption will increase proportionately until it again matches requirements. The average rate of consumption of storage iron will therefore equal half the initial rate. Iron will be withdrawn initially from the store to make up the shortfall. The period of time between removal of the supplementation and reestablishment of the pre-supplementation steady state is expected to be between 5 and 16 months. Absorption will rise exponentially with reduction in iron storage size. Consequently, half of the iron store will be lost over a period considerably less than half the time required to return to the original steady state. If the supplement is discontinued several months before conception, the amount of storage iron available for pregnancy will therefore be relatively small (Fowles & Gabrielson 2005:129).

Iron supplementation, if done correctly, does work as confirmed by Patterson, Brown and Roberts (2001) in Australia and Stoltzfus *et al.* (2009) in Bangladesh.

3.3.4 Oral iron-folate therapy

Universal iron supplementation of women and children would be appropriate in the developing countries, where IDA is widely prevalent. In segments of the population of higher socio-economic groups, selective provision of iron supplements only to anaemic individuals would be preferable. Requiring suitable skilled staff and laboratory facilities this approach requires screening of individuals for IDA (Gibney *et al* 2004:233).

Iron taken orally to prevent IDA is the treatment of choice. For pregnant women daily supplements providing about 100 mg of elemental iron are recommended for a period of about 100 days. The dosage is fixed, taking into consideration the biological effectiveness and the side effects. The common side effects of iron therapy taken orally are gastrointestinal disturbances such as constipation and the passing of dark stools. Prolonged use may lead to joint pains (Gibney, Margetts, Kearney & Arab 2004:234). Iron therapy taken orally usually has to be taken for 6 to 12 months to replace deficient iron stores and has many disadvantages because soluble iron salts tend to upset the gastrointestinal tract and because of their low availability when taken with food (Bourne 1985:60).

Factors affecting the proportion of iron absorbed from a given dose are the following (Bourne 1985:61):

- The chemical form of the iron
- Solubility
- The effect of the various additives
- The physical form

Supplements can play an important role in meeting the micronutrient needs of the developing world, but their full potential is still far from being realised. Obtaining political support for and placing a high priority on iron supplementation programmes have been avoided by the lack of evidence of a clear-cut link between maternal and child outcomes and the coverage of the supplements. In the later parts of the 1990s experience with vitamin A

supplementation was very positive. As a result of the large-scale use of these supplements in the latter years of the 1990s it is likely that at least one million children's lives have been saved in a cost-effective manner, even though ID is a much larger problem than vitamin A deficiency, and iron supplementation has similar cost-effectiveness in terms of disability-adjusted life year gains (Shrimpton & Schultink 2002:228).

A pooled analysis of data from eight studies of iron-folate supplementation during pregnancy suggests an increase of 12 g/L in Hb at term and a 73 per cent reduction in the risk of anaemia at term (Pena-Rosas & Viteri 2006). There is no easy technological way to solve the problem of undernutrition. However, progress in combating ID has been hindered by technological limits on iron supplementation of staple foods.

Trials on children and women in developing countries evaluate the impact of providing multiple micronutrients. The addition of other micronutrients is so small and adds relatively little to a supplement's price, most of which will reflect in the cost of distribution and packaging (Seaman 1999:309).

3.4 Food diversification

Food variety is recommended by all national food-based dietary guidelines (FBDGs) and in global dietary guidelines. Micronutrients can be improved by eating a variety of foods (Steyn, Nel, Nantel, Kennedy & Labadarios 2006:644).

3.4.1 Nutrition education programmes (NEPs)

Rapid physiological growth takes place during the periods of pregnancy, infancy and early childhood. Insufficient nutrition during these periods places infants and children at risk of impaired emotional and cognitive development and adverse health outcomes. Sustained nutrition/health education programmes should become compulsory as part of the health services of every country. Nutrition education emphasising the importance of special attention

to pregnant women is urgently required to reduce malnutrition in women and children (Devaney 2003:5).

3.4.2 South African and global studies on NEPs

3.4.2.1 South Africa

Because of the micronutrient deficiencies in SA, the Integrated Nutrition Programme (INP) included the National Micronutrient Food Fortification Plan as part of its strategic plan and the national food consumption survey of 1999, which was the first ever for children from 1-9 years old. This study provided the DoH with information about the nutritional status of children, foods consumed and purchased in South African households. The DoH could then implement strategies to address malnutrition. The secondary objective of the survey was to propose appropriate NEPs (Labadarios, Swart, Maunder, Gericke, Kuzwayo, Ntsie, Steyn, Schloss, Dhansay, Jooste, Dannhauser, Nel, & Molefe 2008:253).

Love, Maunder and Green (2008:17) conducted a study on the willingness and the ability of SA women to apply the new FBDGs. Country-specific FBDGs for SA were adopted as national guidelines in May 2003. Before the FBDGs were introduced conflicting and confusing nutrition education messages were used with a variety of food guides from western countries. Women who participated in the study understood the FBDGs and were able to draw up a day's menu using them. The study concluded that all NEPs, including the FBDGs, need appropriate interpretation by nutrition educators.

The Nutrition Supplementation Programme (NSP) was introduced in Cape Town and a qualitative study of the perceptions of the mothers on delivery of the NSP was made. This NSP was to help underweight children to gain weight and empower parents to address malnutrition. The study was conducted by using focus group discussions and the results showed that all the mothers had received the supplements for the NSP, they were grateful for the product and some reported that their children had gained weight after consuming the

product. Through discussions with the mothers it became apparent that they received very little nutrition education. None of the mothers got the opportunity to see any of the South African health authorities' NEP materials related to the NSP. It was concluded in the study that nutrition education and quality of delivery are vital for any NSP (Andresen, Wandel, Eide, Herselman & Iversen 2009:92).

3.4.2.2 India

The Nutrition Foundation of India developed several exhibits on nutrition education. Three communication leaflets were drafted targeting policy makers, medical professionals and pregnant women. All the leaflets were aimed at alleviating anaemia and maternal illnesses. The leaflet designed especially for pregnant women described the adverse effects of anaemia on mother and child and the steps to take for prevention (Nangal 2000).

3.4.2.3 United States of America

Obesity is of great concern in the US. Previous studies there showed that child dietary behaviour is influenced by home food availability and parenting behaviours around food. The dietary behaviour of the child improves when the mother's does. Cullen, Smalling, Thompson, Watson, Reed and Konzelmann (2009:384) conducted a study in Texas to evaluate the Expanded Food and Nutrition Education Programme in the prevention of obesity. This programme consisted of six weekly sessions. Short videos, with goal setting, problem solving and handouts, were incorporated in the programme. The class activities reported that the most useful and helpful activities were videos (50 per cent), class discussions (66 per cent) and food preparation activities (70 per cent). Dietary behaviour was also reported to have positive changes.

The Supplemental Nutrition Programme for women, infants and children provides nutrition education and health care referrals to low-income pregnant, breastfeeding and postpartum women who are at nutritional risk. This nutrition education focuses on the relationship between nutrition and good health to

achieve positive dietary practices. The birth outcomes of women, infant and children participants are better than non-participants. This is the largest and most visible programme providing services to improve the nutritional status of pregnant women and children in the US (Devaney 2003:5; Dollahite, Kenkel & Thompson 2008:135).

NEPs are also known to reduce risk factors for cardiovascular diseases in African-Americans with a 12-week NEP. A study conducted in Alabama on 89 African-Americans aged between 35 and 75 years using the NEP, which focused on dietary and lifestyle changes and physical exercise to reduce these diseases. The programme was done by means of PowerPoint presentations, videos, games and role playing. The study found that the mean baseline body weight of the participants was 87,0 kg and after NEP it was 84,6 kg. BMI showed a reduction from 32,5 to 31,5 kg/m^2, about a 3,2 per cent reduction. The NEP also showed a decrease in cholesterol levels, thus reducing the risk of cardiovascular diseases (Qian, Wang, Dawkins, Gray & Pace 2007:254).

Patients' lack of knowledge of general nutrition and poor overall nutritional status at conception and during pregnancy were identified by the Mississippi State Department of Health (Boyd & Windsor 2003:139). Therefore, an NEP was developed for pregnant women by a group of health professionals and nutritionists. The group identified eight essential content areas: 1) maternal and infant nutrition; 2) health problems and solutions; 3) eating healthy and healthy baby; 4) how to make decisions; 5) saving for mother and baby; 6) food, friends and fun; 7) caring for baby; and 8) delivery. The NEP lessons were designed to be delivered in a sequence of eight consecutive weekly sessions of 60 minutes each. The content focused on knowledge and skill development to enhance behavioural capacity. The programme was evaluated and was found to produce a statistically significant improvement in nutrition education and dietary behaviour, successful recruitment of peer educators and complete information on questionnaires. Unfortunately the recruited participants were unable to retain the programme (Boyd & Windsor 2003:139).

3.4.2.4 United Kingdom

A study was conducted in the United Kingdom to develop, deliver and evaluate an NEP for pregnant teenagers. Pregnant teenagers have an increased risk of having LBW babies due to poor nutrient intakes. The intervention package was developed and consisted of educational strategies, behavioural approaches (practical ways of incorporating foods into low-cost meals) and motivational strategies (Wrieden & Symont 2003:73). Through various qualitative interviews and focus group discussions it was found that the participants in the NEP had gained valuable knowledge about dietary practices.

3.4.2.5 Thailand

In a regional hospital in Thailand a study was conducted where there was no systematic health education programme for pregnant women (Thassri, Kala, Chusintong, Phongthanasarn, Boonsrirat & Jirojwong 2000:1456). The aim of the study was to develop, with the assistance of health professionals, a health education programme using participatory action research. Another aim was to evaluate the outcomes of the programme using pre-test-post-test nutrition education as well as working in postpartum units. After attending the programme, a moderate level of satisfaction regarding the knowledge of the participants for nutrition during pregnancy and breast-feeding practices were understood by the women (Thassri *et al.* 2000:1456).

3.4.3 Advantages of NEPs for pregnant women

According to Devaney (2003:8), Nangal (2000) and Dollahite *et al.* (2008:139), NEPs have the following advantages:

- A decreased rate in preterm deliveries
- Increased head circumference of infants
- Reduced incidence of foetal death
- Increased birthweights

- Increased mean haemoglobin or haematocrit levels and reduction in childhood anaemia
- Better choices of food resources by caregivers
- Improved living standards of beneficiaries
- Nutrition education through FBDGs are effective in promoting the use of appropriate micronutrient-rich foods
- Cost effective
- Retention of improvements

3.4.4 Disadvantages of NEPs

NEPS have the following disadvantages according to Anderson (2007:17):

- Recruiting participants and retaining them for post-intervention assessments
- Beliefs and food habits of participants passed from one generation to the next influences choice of food
- Lack of strong political and administrative commitment
- Inadequate integration of nutrition into nation's developmental plan
- Poor coordination, monitoring and evaluation
- Insufficient budgetary resources
- Capacity to produce audiovisual aids and training materials
- Access to media services
- Shortage of qualified personnel

3.5 Agricultural diversification

Diversification within agriculture is considered in the shift of resources, from one crop to a larger mix of crops, keeping in mind the expected returns from each activity which leads to the generation of profits. Hayami and Otsuka (1992:35) describe agricultural diversification as:

- A shift of resources from farm to non-farm activities
- A larger mix of diverse and complementary activities
- A movement of resources from low to high value agriculture

Diversification of staple food production is led by technological change in agricultural production, improved rural infrastructure and diversification in food demand patterns. This can be classified as the supply and demand side forces (Joshi, Gulati, Birthal & Tewari 2004:2458). In South Asia the population depends on agriculture for income, employment and food security, and diversity permits the farmers to cultivate a variety of crops. There are two sources of crop diversification in South Asia: augmentation and crop substitution (Joshi *et al.* 2004:2459).

3.5.1 Advantages of agricultural diversification

Several benefits of agricultural diversification are (Butler & Mazur 2007:608):

- Shifting consumption patterns
- Improving food security
- Increasing income
- Stabilising income over seasons
- Generating employment opportunities
- Alleviating poverty
- Improving productivity of scarce resources (e.g. water)
- Promoting exports
- Improving environmentally sustainable farming systems through conservation and enhancement of natural resources

3.5.2 Disadvantages of agricultural diversification

Constraints in agricultural diversification can be as follows (Joshi *et al.* 2004:2460):

- Technological slack
- Weak input delivery system
- Poor infrastructure
- Poor weather conditions

3.6 Dietary diversification

Without external support dietary diversification is an intervention strategy that is sustainable and has the ability to simultaneously combat multiple micronutrient deficiencies. This strategy has to be supported with an NEP. This approach includes assessing dietary consumption, expanding and diversifying food production, improving food processing, preservation, storage and marketing, and improving food preparation (Tontisirin, Nantel & Bhattacharjee 2002:245).

Dietary diversity has been inversely associated with adjusted mortality rate, lower incidence of macrovascular disease, obesity, diabetes and cardiovascular risk diseases (Temple 2006:29). The reason for this is that great food variety is necessary for an adequate nutrient intake in order to lessen the chances of deficient or excessive intake of single nutrients (Clausen, Charlton, Gobotswang & Holmboe-Ottesen 2005:87). Ruel (2003) states that among the poor from developing countries a lack of dietary diversification is a severe problem because their diets are mainly high in starchy staple foods containing little or no animal or dairy products and few fruits and vegetables.

Tehranian women were studied and a report conducted to determine the relationship between dietary diversity within food groups and the probability of nutrient adequacy and dietary diversity score (Mirmiran, Azadbakht & Azizi 2006:355). The results showed a positive significant correlation between the diversity score of grains and protein, calcium and vitamin B2 intake. Dietary diversity had the strongest association with improved nutrient adequacy. Energy intake was a strong predictor of the mean probability of adequacy in models controlled for age, BMI, education level and job status (Mirmiran *et al.* 2006:355).

3.6.1 Food multimixes

Gopaldas in 1974 and Cameron and Hofvander in 1983 first discovered the food concept called multimix (Amuna *et al.* 2000:116). Since 1990, Zotor and

Amuna have also been working on improving the multimix concept (Amuna *et al.* 2000:116). These authors conducted a study on the traditional cereal, legume and fruit based multimixes in developing countries. Their choice of cereals, grains and legumes provided only 50 per cent of dietary energy supplies, even though they were evenly distributed worldwide. According to their study, the following factors influence the levels of nutrients in foods:

- Methods of processing
- Length and methods of storage
- Food preparation techniques
- Season of the year
- Exposure to heat, air and light
- Interactions between inhibitors (anti-nutrients) and promoters in the mix

3.6.2 Advantages of dietary diversification

The advantages of dietary diversification are as follows (Amuna *et al.* 2000:121; Ruel 2003:3912; Steyn *et al.* 2006:645):

- Variety of food choices
- Culturally acceptable
- Affordable
- Sustainable
- Combats malnutrition
- Income generation
- Reduces mortality rate
- Lowers incidence of macrovascular disease, obesity, diabetes and cardiovascular risk diseases
- Encourages consumption of a variety of food items
- Useful indicator of nutrient adequacy in older adults, adults, adolescents and children

3.6.3 Disadvantages of dietary diversification

Amuna *et al.* (2000:121), Ruel (2003:3911) and Clausen *et al.* (2005:93) identify the following disadvantages of dietary diversification:

- For it to be sustainable, the local government should support the programme
- Budgetary constraints
- Poor access to varied dietary intake
- Lack of uniformity of methods to measure diversity
- Lack of uniformity in approaches to develop and validate indicators

3.7 Conclusion

Failure to address the problem of neglected nutrients will mean that a high proportion of the world's population, especially children and women of reproductive age, will continue to suffer the consequences of micronutrient deficiency. Therefore, solutions should be found to this problem. A pilot study was conducted, reported on in Chapter 4, which assessed the nutritional status of pregnant women in the Vaal region in order to determine a cost-effective and sustainable solution to the problems experienced by the pregnant women in this part of SA.

Chapter 4

Nutritional status of pregnant women in the Vaal region

4.1 Introduction

This chapter is presented as the pilot study conducted to determine the need for an intervention study to improve the nutritional status of pregnant women in the Vaal region. Part of this chapter was published in an accredited scientific journal, the details being as follows:
KESA, H. & OLDEWAGE-THERON, W. 2005. Anthropometric indications and nutritional intake of women in the Vaal Triangle, South Africa. *Journal of the Royal Institute of Public Health*, (6):1-7 (Annexure A).

ID is among the most common nutritional disorders in the world. It is a serious threat to the health and well-being of women and young children. It is reported from nationally representative surveys that from 1993-2005, 42 per cent of pregnant women across the world have anaemia (WHO 2006). Sixty per cent of this anaemia was assumed to be due to ID in areas with no malaria and 50 per cent in malaria areas (Black *et al.* 2008:249). Risk factors for ID include low income, poor diet, pregnancy, heavy menstrual losses or bleeding from other causes (Whitney & Rolfes 2010:506).

The most commonly used indices of iron status in pregnancy are Hb and serum ferritin. Due to haemodilution during the second trimester, cut-off values (g/l) for anaemia for pregnant women in the first, second and third trimesters are Hb, 110, 105 and 110, respectively, and for haematocrit (Hct) 33, 32 and 33, respectively. Even in iron-supplemented women, the Hb concentration falls by an average of 20 g/l in the second trimester to a mean of 116 g/l. The IOM cut-off is 110 g/l throughout pregnancy and 120 g/l for non-pregnant women (IOM 2003:4)

Anaemia is a major cause of postpartum maternal mortality, and the anaemic pregnant woman is at greater risk of death during the perinatal period. In women of childbearing age, folate, vitamin B12 and iron deficiencies have

been reported as a global problem (Modjadji *et al.* 2007:89). A review of 21 studies in Africa and Asia concluded that a reasonable estimate of the risk of maternal mortality attributable to anaemia is 20 per cent in Africa and 22,6 per cent in Asia (Gillespie 1998:15). The risk of preterm delivery, inadequate gestational weight gain and increased perinatal mortality are all directly related to anaemia (Abdelrahim *et al.* 2009:494).

The association between anaemia and both preterm delivery and growth retardation is strongest during the early months of pregnancy. It is suggested that prepregnancy improvement in iron status is warranted (Beard 2008:2535).

Dietary assessment is an aid in the interpretation of anthropometric, clinical and laboratory findings that provide a foundation for dietary counselling. It is also an important aspect of surveys of nutritional status of population groups. Different methods are used to obtain food consumption patterns at individual level, for example weighed record, estimated record, 24-hour recall, food diary, QFFQ and diet history (Whitney & Rolfes 2010:E3).

It is difficult for mothers to meet their very high iron requirements through diet alone. This problem is compounded by the high prevalence of insufficient dietary iron intakes among pregnant and lactating women in developing and developed countries, as well as the low absorption of non-haeme iron from cereal-based diets. If the iron stores are depleted, then dietary iron requirements during the second half of pregnancy can be double those of a non-pregnant woman (Scholl 2005:1220).

The aim of this part of the study was to determine the association between food consumption patterns and iron status by means of biochemical and anthropometric (weight/height) status, and to describe the related demographic background of pregnant and lactating women in the Vaal region, which is approximately 80 km south of Johannesburg and is a semi-industrial, low-income area consisting of formal and informal settlements. Lactating women were part of this study conducted by Kesa (2001). The intervention study that is described in Chapter 6, however, involves pregnant women only as the

outcome of the intervention study reflected on the nutritional status of the mother and baby during lactation. The Vaal region was chosen for research because it is a disadvantaged area, with a high prevalence of malnutrition amongst the lower-income households (Oldwage-Theron & Slabbert 2010:3).

4.2 Subjects and methods

The study population consisted of 431 females, 116 of whom were lactating and 315 were pregnant, aged between 16 and 35 years. A sample of the clinics in Vereeniging, Meyerton and Vanderbijlpark was drawn at random and all pregnant and lactating women visiting these clinics were included on a list. Stratified random sampling was then used because it was necessary to have a full list of individuals in each stratum, and also to determine the demographic profile such as age groups, geographical areas and social class categories (Katzenellenbogen, Joubert & Karim 1999:253).

The inclusion criteria for participation in the project were females, aged between 16 and 35 years old, pregnant and/or lactating and a monthly income of less than R1 000 per household (US$1 = R6,40 at the time of writing).

A total of 19 clinics were used in the project. These clinics provided antenatal and post-natal care on different days for the pregnant and lactating women. The survey was conducted between November 1999 and April 2000.

The researcher was advised by the various clinic sisters that a sample size of 30 volunteers at 19 clinics should be used. This was due to the fact that most pregnant and lactating women are anaemic or iron deficient and if too much blood is drawn this could in fact affect the mother and the baby. The sample size of blood specimens was therefore chosen according to the availability of pregnant and lactating women who were willing to have their blood drawn (Massey 1992:390; Ziegler & Filer 1996:281).

The Medical Ethics Committee for research on human beings at the University of the Witwatersrand approved the ethical clearance for the study, reference number: R14/49, protocol number: M040110 (Annexure H).

The consent form included information explaining the purpose of the study as well as the procedures to be followed. All subjects gave their written consent to participate in the project, and were told that they could leave the study at any time. All the clinics were given copies of the form because the clinic sisters performed the actual drawing of the blood (Annexure K). Thirty blood samples were drawn for the determination of Hb, Hct, red blood cell count, mean corpuscular volume, iron, ferritin and transferrin.

4.3 Training of fieldworkers

Ten third-year Hospitality Management students from the Vaal University of Technology were recruited as fieldworkers. All were Sotho speaking.

Before any training was done the fieldworkers were given a detailed briefing on the objectives and the importance of the project. This was done to ensure that they understood the importance of their role in the study.

All the fieldworkers chosen for this study were given extensive training and detailed instructions on the administering of the QFFQs, the use of food models, anthropometric measurements and the 24-hour recall questionnaires. In addition to the fieldworker training an instruction manual was compiled and it included all the necessary information that was needed for the study (Annexure B). This manual was printed in English and used by all the fieldworkers during the study. The purpose of the manual was to ensure standardisation and uniformity of procedures.

4.4 Measuring instruments

4.4.1 Questionnaires

A pilot study, including five volunteer Vaal region staff members, was done in January 2000 to familiarise the fieldworkers with the methodology, to test comprehension and to solve any possible problems that might occur. Aspects addressed included the suitability of the questionnaires, the use and

standardisation of all instruments, the willingness of subjects to participate in this study and the time needed to complete the study per person. Discussion and solution of the problems encountered during this period equipped the fieldworkers to troubleshoot any possible problems they might experience during this study.

The following questionnaires were compiled and used in the study:

- Socio-demographic questionnaire

This questionnaire included questions on age, race group, current employment, breadwinner in the family, geographical area and, if the respondent was lactating, the age of the baby. The reliability of the questionnaires was tested by having ten students at the university complete one questionnaire each week for four weeks and comparing the answers. Having ten different respondents completing the questionnaire verbally and in writing tested validity (Annexure C).

Fieldworkers interviewed the pregnant women and assisted in the completion of the questionnaire. All the questions in the questionnaires used for this study were coded. Figures 2 and 3 show a fieldworker assisting with the completion of the questionnaires.

Figure 2: Fieldworker completing questionnaires

Figure 3: Fieldworker explaining the questionnaires to a participant

❖ QFFQ

The validated QFFQ that was used in the Transition and Health during Urbanisation in SA (THUSA) study was used as a test measure in this study to obtain qualitative, descriptive information about usual food consumption patterns, specifically those containing iron.

The QFFQs used in this project had been validated by MacIntyre (1998:20). They were distributed to the pregnant women of the lower income households of the Vaal region, and completed and collected by fieldworkers by means of interviews at the clinics (Annexure D). These questionnaires were used to determine the consumption patterns of foods commonly consumed by pregnant women in the Vaal region.

The relative validity of the QFFQ was tested in the THUSA study using 74 volunteers. The reference measurements were a seven-day weighed record and validation of nitrogen intakes against nitrogen excretion in 24-hour urine collections. An additional measure of relative validity was the ratio of reported energy intake to estimated basal metabolic rate (MacIntyre 1998:268). The QFFQ developed for the assessment of dietary intakes of the African population of the North West appeared to give relatively validated results for

energy, the macronutrients, calcium, vitamin A and vitamin C (MacIntyre 1998:347).

- Reproducibility

The reproducibility of the QFFQ was tested on a subsample of 125 volunteers from the THUSA study. The purpose was to obtain the same results when administered to the same subjects at different times. The QFFQ was completed by means of an interview of an interval of 6-12 weeks between repeat administrations. Reproducibility was tested for energy, macronutrients, cholesterol, calcium, iron, vitamin A and C (MacIntyre 1998:221). Reproducibility was consistent among all subgroups and therefore it was concluded that the QFFQ used in the THUSA study was a relatively reproducible measure of dietary intake (MacIntyre 1998:267). The main objective of the study reported here was to determine the food consumption patterns and nutritional intake of pregnant and lactating women in the Vaal Region. The subjects in the THUSA study consisted of males and females aged between 15 and 65 years, and for this reason it was decided to use the same QFFQ for this study.

- Food diaries

The food diary included a list of foods with a very high iron content, the reason being that the researcher wanted to determine if ID was prevalent in the Vaal region. These questionnaires were used as a reference measure for the QFFQ and completed simultaneously with the QFFQ. The main purpose of the food diary was to test the actual intake of iron-rich foods and the main purpose of the QFFQ was to test the usual food consumption patterns. The results of both questionnaires were compared to each other to test for validity. All the subjects completed the questionnaire with the assistance of the fieldworkers. A B.Tech. student tested the reliability of the questionnaire on 20 students at the Vaal University of Technology (VUT) as part of her research project. Having the same people complete this test four times tested reliability and the answers were then compared to each other. Having 20 different respondents completing the questionnaire verbally and in writing tested validity. Based on

the results the questionnaire was accepted to be reliable and valid in both these tests, and a correlation of 70 per cent was found using Fisher's exact (two-tail) test (Annexure E).

4.4.2 Anthropometry

At the clinics the fieldworkers recorded the target population's anthropometric measurements, namely pre-pregnancy weight, height and weight-for-height, which were compared with the weight-for-height tables to determine who was overweight or underweight (IOM 2003). The fieldworkers recorded the pregnant women's weight according to the trimesters in order to determine their weight gain during pregnancy and the actual and ideal weight differences. In measuring the pregnant women, the following two variables were measured: weight and height. These can be combined into one indicator, called the body mass index or BMI. The BMI is calculated by dividing weight (kilograms) by the square of height (metres) ($kg/m^{2)}$ (Mahan & Escott-Stump 2008: 165).

BMI is considered a good index of body fat stores. This index is also known as Quetelet's index. It is best used for individuals between the ages of 20 and 65 years. A BMI score of over 18,5 is believed to signify adequate nutrition, while a BMI under 16 is a strong sign of chronic energy deficiency (Mahan & Escott-Stump 2008: 165).

A tail T test was done to determine the difference between the ideal weight and actual weight of the pregnant women. All the subjects were weighed in light clothes without shoes on a portable Philips electronic scale. Height was measured with an upright stadiometer placed against a perpendicular wall. Two measurements were made and were not permitted to differ by more than 0,5 kg (weight) or 0,5 cm (height).

4.4.3 Iron status assessment

Laboratory assessment is important as it provides information on the nutritional status of the target population. The clinic sisters drew all the blood

samples. All the clinic sisters were briefed on the blood samples by a haematologist.

The subjects were required to fast overnight (12 hours). Venous blood samples were collected by nursing sisters using a 21-gauge scalp vein infusion set. All the blood samples were drawn with minimal stasis between 07h00 and 10h00 to avoid affects of diurnal variation.

The following samples were collected from each subject:

- 5 ml ethylene diamine tetra-acetic acid (EDTA) (whole blood) for the full blood count and measurement of haematogical markers: Hct, MCV, red blood cell count and Hb
- 10 ml serum for the analysis of ferritin, transferrin and serum iron

The blood samples were drawn from the pregnant women. All the samples were collected and handled by a haematologist under controlled, standardised conditions. The assessment of the iron status of the sample population was important in order to determine whether the sample population was iron deficient or anaemic.

A haematologist using the laboratory-based cyanomethaemoglobin method of assessment determined the haemoglobin concentrations. In using this method blood is mixed with Drabkin's solution, which contains ferricyanide and cyanide. The ferricyanide oxidises the iron in the haemoglobin, thereby changing haemoglobin to methaemoglobin. The methaemoglobin unites with the cyanide to form cyanomethaemoglobin. The haematocrit or packed cell volume method is more variable than haemoglobin assessment, and can be done using the electronic method. In this method the average red cell volume is determined, the red cell count is made and the haematocrit is determined by calculation (Dacie & Lewis 1995: 138).

The most common methods for performing red cell counts are the microscopic method and the automatic method. The microscopic method is referred to as the manual method. It consists of diluting the blood, transferring a small portion of the solution to a counting chamber, counting the red cells with a

microscope, and making the calculations. The following methods were used in the study: The colorimetric method is used for iron and the immunoturbidimetric method is used for ferritin and transferrin. The ABX Micros analyser was used to analyse haemoglobin, haematocrit, red cell count and mean cell volume. The Cobus Mira was used to analyse iron, ferritin and transferrin (Dacie & Lewis 1995:141).

The Hb levels were determined using venous blood, anticoagulated with EDTA. Three different sets of criteria can be used for the analysis of Hb data (Gibson 2005 :353). Table 2 refers to the Hb cut-off points derived from the NHANES II white population were 11,8 g/dL for females aged 11-14 years old, 11,7 g/dL for females aged 15-19 years old and 11,9 g/dL for females aged 20-44 years old.

The criteria given as the upper limit of "moderate risk" of deficiency were 11,5 g/dL for females aged 13-16 years old and 12 g/dL for females older than 17 years old (Gibson 2005:353). Therefore the concentration of Hb was below 12 g/dL where anaemia is likely to be present for females older than 14 years old.

Table 2: Female Hb and Hct levels below which anaemia is present

	Critical level	
Age/physiological status	**Hb (g/dL)**	**Hct (%)**
Non-pregnant female	12,0	36,0
Pregnant female	11,0	33,0
Pregnant female – severe anaemia	7,0	-
Pregnant female – very severe (life threatening)	4,0	-

(MI 1998:8)

The Hct is defined as the volume fraction of packed red cells. During iron deficiency the Hct falls only after Hb formation has become impaired. A marginally low Hb value may thus be associated with a near-normal Hct, but both are reduced in severe IDA (Gibson 2005:354).

Due to impaired erythropoiesis less red blood cells as well as smaller red cells will be produced. Hence the importance of the red cell count (RCC) and the mean cell volume (MCV).

The normal reference values are:

- MCV 80-97 fl
- RCC 3,80-5,80 x $10^6/mm^3$

The full blood was done on a haematology auto-analyser, the ABX $MICROS_{CT,}$ within six hours of blood collection:

- The cell counting principle is based on an impedance variation penetrated by the passage of the cells through the calibrated micro-aperture. The sample is diluted in an electric diluent (current conductor) and the dilution is pulled through the calibrated micro-aperture. Two electrodes are placed on each side of the aperture. Electric current passes through the electrodes continuously. When the cell passes through the aperture, electric resistance between the two electrodes increases proportionately with the cell volume. Two measuring chambers and detection circuits separately carry out the analysis of white blood cells and red blood cells. Each type of cell is analysed by the micro-processor.
- To determine the Hb, blood is mixed with a reagent which contains potassium ferricyanide and potassium cyanide. The ferricyanide oxidises the iron in the haemoglobin, thereby changing haemoglobin to methaemoglobin. The methaemoglobin unites with the cyanide to form cyanomethaemoglobin. The cyanomethaemoglobin produces a colour which is then measured by spectrophotometry, with a wave length of 550 nm.
- The height of the impulse generated by the passage of a red cell through the micro-aperture is directly proportional to the volume of the analysed cell (MCV).
- The haematocrit is measured as a function of the numeric integration of the MCV.

The method used for serum iron measurement was the Roche Unimate 5 Iron (8X30 mL) art. 07 5181 2 Colorimetric test with Ferrozine ® or ascorbic acid. This is an in vitro diagnostic reagent system for quantitative determination of iron in serum. Iron is released from transferrin by guanidine hydrochloride and reduced to Fe^{2+} by ascorbic acid. Bivalent iron forms with ferrozine, a red coloured complex. The colour intensity is directly related to the iron concentration and is measured photomerically (Gibson 2005:354). Table 3 refers to the cut-off points that were used to determine the iron intake for the respondents according to their ages.

Table 3: Cut-off points used to determine iron intake in pregnant women

Age	Recommended dietary allowance
<18	27 mg
19-30	27 mg
31-50	27 mg

(IOM 2003)

4.5 Statistical methods

4.5.1 Questionnaires

Data from the socio-demographic and anthropometric questionnaires were captured on an Excel spreadsheet and analysed using the Statistical Package for Social Sciences (SPSS) for Windows, version 13. Exploratory data and descriptive statistics were used for analyses of the socio-demographic data. Descriptive statistics as well as paired T tests were used in the analysis of the anthropometric data.

The data collected by the QFFQs and food dairies were analysed by a statistician using the FoodFinder software program with the SA food composition tables (1991) as part of the calculations. The top 20 foods were therefore determined and means and standard deviations (SDs) were calculated for food and nutrient intakes compared to estimated average requirement (EAR).

4.5.2 Anthropometry

The anthropometric results were analysed by using BMI. The fieldworkers at the clinics collected this information, which was compared against the weight-for-height tables to determine who was overweight or underweight.

Weight category based on BMI (Flegal 2005:1861):

- Underweight (BMI <18,5)
- Normal weight (BMI = 18,5-24,9)
- Overweight (BMI => 25-29,9)
- Obese (BMI >30)

Women who are of normal weight prior to pregnancy should aim for a weight gain in the 11,3–15,9 kg range during pregnancy. Underweight women should gain weight in the 12,7–18,1 kg range. Women who are overweight prior to pregnancy should gain between 6,8 and 11,3 kg. Descriptive statistics and paired T-test statistical analyses were used to determine the actual and ideal weight gain of the pregnant women before and during pregnancy (Flegal 2005:1861).

4.5.3 Iron status assessment

The results of the blood analyses were computerised and statistically analysed by a qualified statistician using SPSS, version 13. The data entry programs had a number of quality control mechanisms, including validity checks, duplicate detection and verification procedures, written in SPSS.

The means and SDs were firstly compared against the reference values and thereafter the differences between the pregnant and lactating group for all variables were compared using the Levene's two-tailed test for equality of variances. Differences were considered to be significant if $p<=0,05$. Chi-square and Fisher's exact test (two-tail) correlation coefficients were used to test for associations between BMI and macronutrient and iron intake. Correlation was considered to be present if $r \geq 0$ with significance level of $p \leq 0,05$.

4.6 Results

4.6.1 Socio-demographic data

Twenty-seven per cent (116 of 431) of the study population was lactating and 73 per cent (315 of 431) was pregnant. According to the demographic data, most of the women were black and between the ages of 21 and 30 years, 98 per cent of them resided in towns and 79,3 per cent were unemployed. The average monthly income of the majority of the lactating women (61 per cent) and pregnant women (52 per cent) was between R0 and R500 (US$1 = R6,40) per month (2001). Fifty-eight per cent of the babies of the lactating women were between 0 and 3 months old.

Tables 4 and 5 refer to the demographic data of the pregnant and lactating women.

Table 4: Socio-demographic data of pregnant women

Demographic variable	n	%
Age distribution (years)	**315**	**100**
16-20 years	54	17,2
21-25 years	114	36,0
26-30 years	89	28,3
31-35 years	53	16,9
36+ years	5	1,6
Race group	**315**	**100**
Black	302	95,8
Coloured	5	1,6
Indian	8	2,6
Currently employed	**315**	**100**
Yes	76	24,2
No	239	75,8
Sole provider	**315**	**100**
Yes	46	14,7
No	269	85,3
Geographical area	**315**	**100**
Vereeniging	147	46,8
Meyerton	5	1,3

Table 4 continued ....

Demographic variable	n	%
Vanderbijlpark	163	51,9
Monthly household income	**315**	**100**
R0-R500	165	52,4
R501-R1 000	71	22,4
R1 001-R3 000	61	19,4
R3 001–R5 000	17	5,3
R5 001 +	1	0,6
Pregnant months	**315**	**100**
1	3	1,0
2	10	3,2
3	30	9,4
4	32	10,0
5	47	14,8
6	52	16,5
7	49	15,5
8	61	19,7
9	31	10,0

Table 5: Socio-demographic data of lactating women

Demographic variable	n	%
Age distribution (years)	**116**	**100**
16-20 years	14	12,4
21-25 years	33	28,3
26-30 years	38	32,7
31-35 years	29	24,8
36+ years	2	1,8
Race group	**116**	**100**
Black	114	98,3
Indian	2	1,7
Currently employed	**116**	**100**
Yes	20	17,2
No	96	82,8
Sole provider	**116**	**100**
Yes	15	13,0
No	101	87,0
Geographical area	**116**	**100**
Vereeniging	36	31,3

Table 5 continued ...

Demographic variable	n	%
Meyerton	3	2,6
Vanderbijlpark	77	66,1
Monthly household income	**116**	**100**
R0-R500	71	61,4
R501-R1 000	10	8,8
R1 001-R3 000	27	22,8
R3 001-R5 000	6	5,3
R5 001 +	2	1,8
Age of baby in months	**116**	**100**
0-3	67	57,5
4-6	31	26,5
7-12	15	13,3
13+	3	2,7

4.6.2 Dietary intake

The mean intake of all QFFQs per subject represented the usual consumption patterns and nutritional intake. The diets of the subjects consisted primarily of plant foods, and animal foods were scarce except for milk. Most of the items consumed were low in iron.

Tables 6 and 7 refer to the top 20 foods consumed by the pregnant and lactating women.

Table 6: Top 20 foods consumed by pregnant women

Number	Food item	Mean quantity per day
1	Milk, whole fresh	695 ml
2	Tea, brewed	238 ml
3	Coffee, brewed instant	139 ml
4	Cold drink, squash	169 ml
5	Maize meal	478 g
6	Cold drink, low calories	208 ml
7	Fruit juice, baby	133 ml
8	Bread brown	209 g
9	*Mahewu/magou* (non-alcoholic fermented maize drink)	87 ml

Table 6 continued ...

Number	Food Item	Mean quantity per day
10	Bread white	269 g
11	Rice, white cooked	281 g
12	Sugar, white granular	499 g
13	Yoghurt, low fat fruit	128 g
14	Fruit juice-dairy mix	94 ml
15	Apple, raw with skin	252 g
16	Chicken, roasted	289 g
17	Custard, whole milk	243 ml
18	Maltabella, uncooked	181 g
19	Beef, rump steak	227 g
20	Banana, raw	236 g

Table 7: Top 20 foods consumed by lactating women

Number	Food item	Mean quantity per day
1	Milk, whole fresh	237 ml
2	Tea, brewed	83 ml
3	Coffee, brewed instant	43 ml
4	Maize meal	161 g
5	Cold drink, low calories	68 ml
6	Cold drink, squash	55 ml
7	*Mahewu/magou* (non-alcoholic fermented maize drink)	48 ml
8	Bread, brown	80 g
9	Bread, white	103 g
10	Yoghurt, low fat fruit	55 g
11	Rice, white cooked	102 g
12	Sugar, white granular	184 g
13	Chicken, roasted	111 g
14	Fruit juice, baby	25 ml
15	Fruit juice-dairy mix	33 ml
16	Apple, raw with skin	96 g
17	Custard, whole milk	89 ml
18	Maltabella, uncooked	60 g
19	Banana, raw	88 g
20	Beef, rump steak	79 g

4.6.3 Nutrient intake

Table 8 below summarises the nutrient intake compared to the EAR for the pregnant and lactating women.

Table 8: Nutrient intake of sample population

		Pregnant women		Lactating women		
Nutritional analysis	**Unit**	**Mean daily intake**	**Standard deviation**	**Mean daily intake**	**Standard deviation**	**#EAR for women**
Kilojoules	kJ	8 425,71	2 279	8 511,94	2 047,9	11 103
Protein	G	73,18	23	76,24	25,9	45,5
Fat	G	62,29	23,7	61,95	22,3	-
Cholesterol	Mg	217,66	99,6	222,83	103,7	-
Carbohydrates	G	292,45	72,2	294,37	64,2	135
Calcium	Mg	741,92	360,2	718,52	296	Pregnancy 1 300 Lactation 1000
Iron	Mg	9,74	3,8	10,50	4,0	Pregnancy: 22 Lactation: 13
Magnesium	Mg	280,08	84,4	287,11	79,7	300
Phosphorus	Mg	1 158,87	380,9	1 169,09	346,8	580
Potassium	Mg	2 462,27	782,5	2 455,24	699,3	-
Sodium	Mg	1 747,47	682,6	1 790,95	621,9	1 600
Chloride	Mg	0,00	0,0	0,00	0,0	450
Zinc	Mg	9,32	3,2	9,76	3,0	Pregnancy 9,5 Lactation 10,4
Copper	Mg	1,16	0,4	1,20	0,4	-
Manganese	Mg	2,17	0,8	2,31	0,7	-
Vitamin A	ug RE	1 518,68	1 161,4	1 608,24	1282,5	550
Thiamine	Mg	1,16	0,4	1,20	0,4	1,2

Table 8 continued ...

Nutritional analysis	Unit	Mean daily intake	Standard deviation	Mean daily intake	Standard deviation	#EAR for women
Riboflavin	Mg	1,64	0,7	1,65	0,7	1,2
Niacin	Mg	15,17	5,8	16,63	7,6	14
Vitamin B6	Mg	1,47	0,6	1,56	0,6	Pregnancy 1,6 Lactation 1,7
Folate	ug	196,38	72,8	208,06	74,7	Pregnancy 520 Lactation 450
Vitamin B12	ug	9,12	10,1	9,43	11,5	2,2
Pantothenic acid	Mg	3,91	1,3	3,98	1,3	6
Biotin	Mg	18,96	7,9	18,84	7,5	
Ascorbic acid	Mg	70,11	62,6	56,25	52,5	Pregnancy 70 Lactation 100
Vitamin D	ug	1,80	1,3	1,97	1,2	Pregnancy 5 Lactation 5
Vitamin E	Mg	7,77	3,5	8,08	3,4	Pregnancy 12 Lactation 16

Mean < EAR

#EAR= Estimated average requirement (IOM 2003)

Estimated energy requirement is used as the reference value for energy intakes (IOM 2003). This is because it would be undesirable to advise people to consume a level of energy which was above the needs of most of the population. The EAR is intended for use of a group. This represents the + 2 standard deviation and thus covers only 50 per cent of the population. The iron intake for pregnant women was 12,26 mg below the EAR and for lactating women 2,5 mg below the EAR. In both groups the following nutrients fell

below the EAR: kilojoules, zinc, calcium, vitamin B6, folate, vitamins D and E. For vitamin C (ascorbic acid), however, only the lactation group fell below the EAR.

4.6.4 Food diary

Figures 4 and 5 below illustrate the food items consumed by the pregnant and lactating women according to the food diaries.

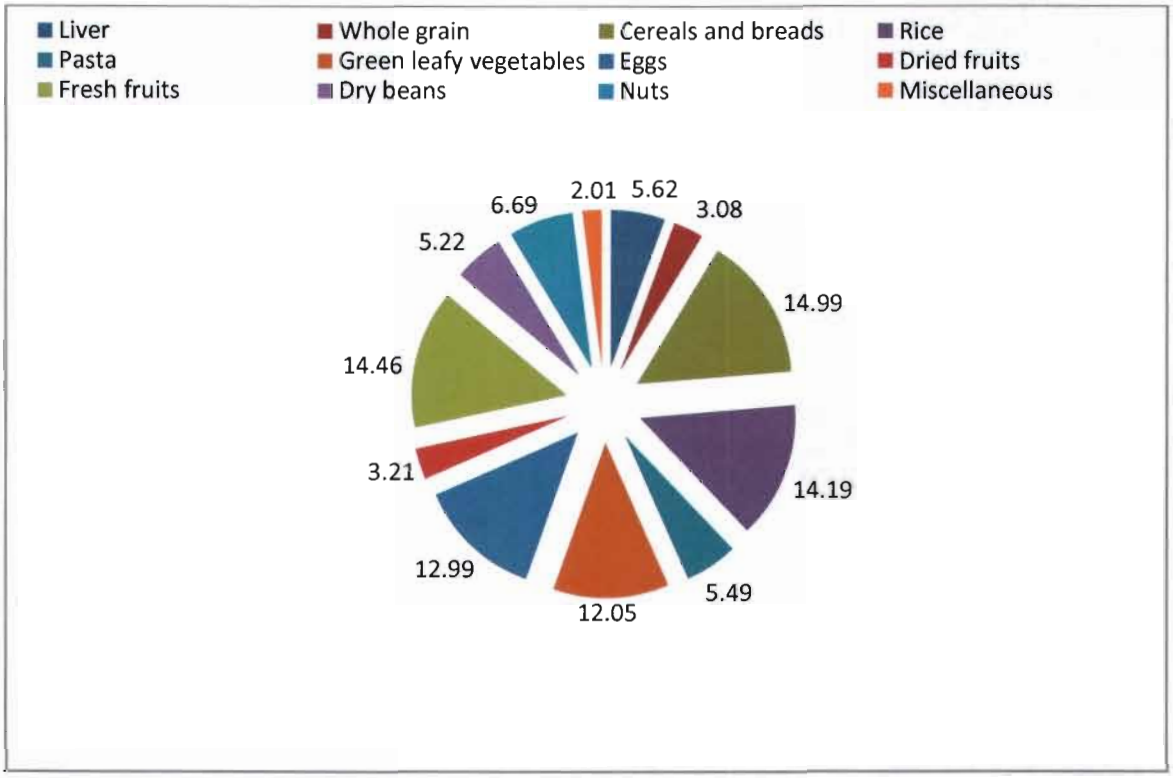

Figure 4: Foods consumed by pregnant women according to the food diaries

Figure 4 represents the number of pregnant respondents who ate certain food items according to the food diaries. According to this graph, the respondents ate cereals and bread (14,9 per cent), fresh fruits (14,4 per cent) and rice (14,1 per cent).

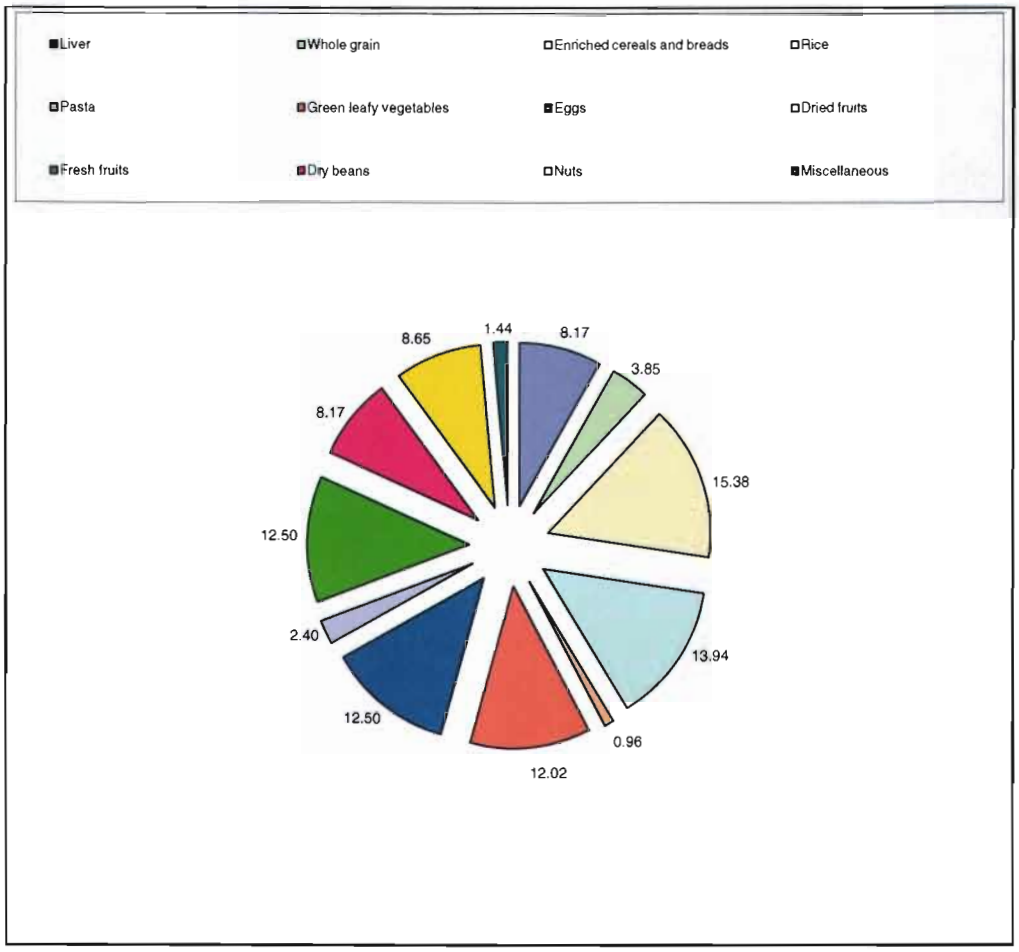

Figure 5: Foods consumed by lactating women according to the food diaries

Figure 5 represents the number of lactating respondents who ate certain food items according to their food diaries. According to this graph, most respondents ate cereals and bread (15,3 per cent) and rice (13,9 per cent). When comparing this to the pregnant women it can be seen that that there were similarities between their eating patterns, like the cereals and vegetables.

As per the results of the food diaries, the foods most consumed by the subjects had a relatively high iron content. The following items were consumed by pregnant women: 34,44 per cent ate minced meat, 25 per cent ate beef, 53,8 per cent ate tuna, 68,64 per cent ate chicken, 53 per cent ate eggs, 14,46 per cent ate fresh fruit, 27,5 per cent ate nuts, 23 per cent ate liver and 14,99 per cent ate enriched cereals and breads. The following items were consumed by lactating women: 30,3 per cent ate minced meat, 33,3 per cent ate beef, 86,67

per cent ate fish, 84,62 per cent ate tinned fish, 88 per cent ate chicken with skin, 8,17 per cent ate liver and 15,38 per cent ate enriched cereals and breads.

4.6.5 Anthropometric data

According to the BMI cut-off point of 25, the majority of the sample population was overweight or obese. The pregnant women could have been overweight before pregnancy since the results were as follows:

- 39,93 per cent fell in the normal to overweight range
- 1,12 per cent fell in the overweight range
- 26,87 per cent fell in the overweight to obese range
- 2,24 per cent fell in the obese range
- 8,96 per cent fell in the above obese range

The lactating women could have been overweight before pregnancy since the results were as follows:

- 40,20 per cent fell in the normal to overweight range
- 1,96 per cent fell in the overweight range
- 27,45 per cent fell in the overweight to obese range
- none fell in the obese range
- 10,78 per cent fell in the above obese range

According to the above results and the BMI cut-off point of 25, the majority of the sample population was between overweight and obese. Of the pregnant women 79,1 per cent were overweight before pregnancy and 80,4 per cent of the lactating women were between overweight and obese before and after pregnancy.

4.6.6 Iron status

The iron status was evaluated by concentrations of serum iron, ferritin, transferrin, Hb, Hct, MCV and RCC. The normal ranges for the different indicators are as follows (Brutis & Ashwood 2001):

Serum iron:	9,0–30,4 µmol/l
Ferritin:	12–160 ng/ml
Transferrin:	2,0–3,6 g/L
Red cell count:	4,5–6,5
Haemoglobin:	11,5–15,5 g/dl
Haematocrit:	36–48 per cent
Mean cell volume:	80–95 fl

Iron deficiency refers to iron stores that have been depleted without regard to the degree of depletion or to the presence of anaemia. Iron deficiency anaemia refers to iron stores that have been severely depleted and lead to low Hb levels. In IDA the synthesis of Hb decreases, which results in pale and small red blood cells (Whitney & Rolfes 2010:429).

According to the results, 50 per cent of the pregnant women and 83,33 per cent of the lactating women suffered from IDA. Table 9 shows the iron status results from blood samples.

Table 9: Interpretation of iron status from blood samples

	% pregnant	% lactating
Normal	4,17	16,6
Iron deficient	41,6	0,00
Iron deficient anaemia	50,0	83,3
Missing values	4,17	0,00
Total	**100,0**	**100,0**

The following cut-off points were used to determine the daily iron intake (IOM 2003):

- First trimester of pregnancy: 13 mg
- Second trimester of pregnancy: 18 mg
- Third trimester of pregnancy: 23 mg
- Lactation: 13 mg

Table 10 depicts the Fisher exact test correlation coefficient that was found for the association between iron intake, macronutrients and BMI. There was a strong association between iron intake and energy, protein, fat and carbohydrates, especially for lactating women. The correlations for pregnant women were not as strong and not as statistically significant as those for lactating women. No correlations were found between BMI/weight and nutrient intakes for either pregnant or lactating women.

Table 10: Summary of the associations using Fisher exact test (p = 0,05)

Variable	Pregnant (Correlation R^2)	Lactating (Correlation R^2)
Energy vs iron	0,4715	0,9862*
Protein vs iron	0,3291	0,9235*
Carbohydrates vs iron	0,4221	0,9064*
Fat vs iron	0,2884	0,9027*
BMI vs iron	0,0007	0,0199
BMI vs energy	0,008	0,0226
BMI vs protein	0,0014	0,0611
BMI vs carbohydrates	0,0211	0,0025
BMI vs fat	0,0028	0,0408

*Statistically significant

4.7 Discussion

One of the limitations to this study was the food consumption patterns and dietary intake which were determined by means of the QFFQ. The food diaries were used as a reference measure for the QFFQ and completed simultaneously with the QFFQ. The food diary included a list of foods with a high iron content. The fieldworkers assisted the subjects in completing the QFFQ. They experienced the problem of the subjects not understanding the QFFQ too well and therefore it took a long time for the fieldworkers to explain the questionnaires to the women and then to complete the QFFQs correctly.

When comparing the results of the QFFQ, food diaries and iron status, discrepancies are found. According to the QFFQ, the mean total iron intake for pregnant women was 9,74 mg/day and for lactating women 10,50 mg/day.

Both fell below the recommended daily allowance (RDA) of 18 mg/day for pregnant women and 13 mg/day for lactating women. By comparison, the food diaries showed that most of the food consumed by the subjects were rich in iron. Respondent bias must have occurred in that respondents may truly not have remembered their food consumption accurately, and thus omitted foods consumed, they may have made inferences using partial information from memory to provide answers or they may have simply given an answer that they thought was appropriate, whether that food was consumed or not. Bias must have occurred in that the QFFQ was completed with the assistance of the fieldworkers and the food diaries were completed with no assistance from the fieldworkers. The food diaries included only items with a high iron content, whereas the QFFQ contained food items from all groups. Both interviewer bias or recall bias could have been present in that the interviewers had to translate some of the information into Sotho and information translated could have been distorted. Recall bias could have been due to the fact that the subjects only had to complete the quantities consumed for the items on the list and could have had a perception that those food items had to be eaten and thus over-reported on the intake. They may also have picked up intentional or unintentional cues in the interviewer's tone of voice, an expectant pause, or the interviewer agreeing in an effort to maintain a rapport. If a separate validation study had been done, this problem would not have occurred and therefore it is recommended that in the case of studies such as food consumption patterns a separate validation study be included.

When using a food diary as a reference measure for QFFQs it is advisable to include the quantities consumed on the questionnaire instead of yes/no answers. This was a problem in the food diaries of this study, where quantities consumed were not included in the food diaries. Therefore nutritional comparisons could not be done for the food diaries. Food diaries should not only be completed once only, but should be completed on a weekend and a weekday because eating patterns vary on these days.

In African societies, both rural and urban, the number of single-mother households is increasing. Rural women deserted by their husbands are forced to go out and work. Although this is very much part of the African lifestyle, it

often puts a greater strain on rural families and communities. This has had an impact on this sample population as shown in the demographic data of this study, as most of the subjects were black, residing in townships and their monthly earnings were between R0 and R500 (US$1 = R6,40 in 2001 and R8,00 in May 2010).

Their way of living affects their food consumption patterns. The results of this study show that the food items consumed most frequently by the subjects contained very little iron. According to Whitney and Rolfes (2010:341), many factors influence iron absorption. Nutrients that may enhance iron absorption include vitamin C (ascorbic acid), sugar (fructose) and citric acid. The addition of a serving of a vitamin C-rich food at every meal will significantly enhance the absorption of dietary iron. Factors enhancing absorption are animal protein, human milk, acid medium, calcium, intrinsic factors and physiological state. The ten items consumed most frequently by the subjects contained very little vitamin C and animal protein. The ten items most frequently consumed by pregnant women were, in descending order, fresh milk, tea, coffee, cold drink, maize meal, fruit juice, bread, *magou* (non-alcoholic fermented maize drink), rice and sugar. Results for lactating women were fresh milk, tea, coffee, maize meal, cold drinks, *magou*, bread, yoghurt, rice and sugar. Daily intakes (mean ± SD) for pregnant women were 8 425,71 ± 2 279 kJ, 73,18 ± 23 g protein, 62,29 ± 23,7 g fat, 292,45 ± 72,2 g carbohydrate and 9,74 ± 3,8 mg iron. Daily intakes for lactating women were 8 511,94 ± 2 047 kJ, 76,24 ± 25 g protein, 61,95 ± 22,3 g fat, 294,37 ± 64,2 g carbohydrate and 10,50 ± 4,0 mg iron.

The mean total iron intake for pregnant (9,74 mg/day) and lactating (10,50 mg/day) women fell below the RDA of 18 mg/day (IOM 2003) for pregnant women and 13 mg/day for lactating women. The reason for the low intake may be the types of foods consumed, since most of the subjects were from low-income households and could not afford the more expensive iron-containing foods like meat, poultry and seafood. Cereal-based food items are cheaper and more filling.

There are two major sources of food iron: haeme iron and non-heame iron. The two forms of iron in the diet are absorbed with different efficiency. Haeme iron is readily bioavailable, since it is absorbed intact within the porphyrin ring and is not influenced by most inhibitory factors in the diet. The non-haeme iron in food enters an exchangeable pool which is markedly affected by inhibitory iron-binding ligands. Some forms of non-haeme iron, like ferritin and haemosiderin, only partially enter the exchangeable pool and are poorly absorbed. Organic (haeme) iron must be hydrolysed from any protein to which it is attached and is then absorbed relatively easily but slowly. The overall absorption of iron from meat, poultry and fish may be 20-25 per cent. The most efficient absorption takes place in the duodenum, and is inversely related to the iron store level (Conway, Powell & Geissler 2007:30).

Non-haeme iron must first be solubilised and hydrolysed before absorption is possible. Hydrochloric acid in the stomach performs this function and also converts any ferric iron in food to its absorbable ferrous state. This reaction is facilitated by ascorbic acid (vitamin C). Other factors enhancing the absorption of inorganic iron include citric acid, lactic acid, fructose and peptides derived from meat. All of these form ligands with the ferrous iron, maintaining its solubility and thus facilitating absorption (Conway *et al.* 2007:31).

The three most important factors that determine the amount of iron absorbed from the diet are the amount of iron ingested, its bioavailability and the iron status of the individual. Low dietary intake and the lack of iron supplements were the main reasons for ID in the present study. Low bioavailability of the dietary iron was also a factor due the high intake of plant sources, for example maize meal porridge and bread, together with a low intake of haeme iron sources such as meat, fish and chicken. The availability of iron from non-haeme foods could also be decreased by the high intake of tea and coffee with meals. Tea and coffee were amongst the top ten foods consumed by the participants. Ascorbic acid is considered the most potent enhancer of non-haeme absorption. The effect of ascorbic acid on iron absorption is so pronounced that it has been recommended that each meal contain at least 25-

50 mg of ascorbic acid. The more inhibitors present in a meal, the more ascorbic acid is necessary to achieve the same increase in absorption (Kruger *et al.* 1994:135). In the present study, the iron status of pregnant women was as follows: 4,17 per cent normal, 41,67 per cent iron deficient erytropoiesis and 50 per cent IDA and for lactating women: 16,67 per cent normal and 83,33 per cent IDA.

In the same way as simple food dislikes may develop into disgust aversions, food preferences can be elevated to the rank of intense longing or craving under some circumstances. Foods eaten by pregnant women are often associated with the physiological status of pregnancy. It has been suggested that pica, the craving for substances with little or no nutritional value, may be associated with ID. Studies have shown that the most common substances eaten are dirt, clay, starch and ice. Some pica substances such as starch are high in calories and may contribute to obesity. Many studies of pica have focused on low-income blacks, and pica appears to be prevalent (Fieldhouse 1995:201) among this group. The aetiology of pica is poorly understood. One theory suggests that a deficiency of an essential nutrient, such as calcium or iron, results in the eating of non-food substances that contain these nutrients (Rainville 1998:293). However, Karimi, Kadivar and Yarmohammadi (2002:490) did not find any correlation between pica of any kind and low serum ferritin levels in pregnant women of Southern Iran. According to another theory, pica may be practised for cultural reasons (Corbett, Ryan & Weinrich 2003:187). These authors found that 38 per cent of socially disadvantaged pregnant women in their study practised pica, most of them African-American women. Some recent evidence supports including pica in the obsessive-compulsive spectrum of disorders (Rose, Porcerelli & Neale 2000:356).

According to the BMI cut-off point of 25, 79,12 per cent of the pregnant women and 80,39 per cent of the lactating women in this study were found to be overweight or obese. In a study done in Kenya, Mexico and Egypt it was found that women who were heavier and fatter at conception had retained

substantially less weight and fat at two to four weeks postpartum, reflecting the lower weight gain of fatter women during pregnancy (Allen 1994:72).

The prevalence of anaemia in the present study was 50 per cent for pregnant women and 83,33 per cent for lactating women. This compares unfavourably with studies done in other parts of SA. In a study done on black pregnant women at Baragwanath Hospital, Johannesburg, the prevalence of anaemia (Hb<11 g/dl) was found to be 20,5 per cent and in a study done on pregnant women at the antenatal clinic at Pelonomi hospital, Bloemfontein, the prevalence of anaemia was found to be 26,2 per cent (Dannhauser, Bam, Joubert, Nel, Badenhorst, Barnard, Slabber, Badenhorst & Du Toit 2000:39). Higher prevalences have been reported for pregnant women in sub-Saharan Africa (50 per cent) and South Asia (64 per cent) (Hallberg, Sandstrom & Agget 1993:178).

The reason for the high prevalence of anaemia in the present study may be the fact that most of the subjects were from towns, were unemployed and came from low-income households and, therefore, were not consuming iron-rich food. MacIntyre (2002: 245) describes the effects of urbanisation on the food consumption of an African population of the North West. Intakes of the staple, maize meal, are still high in the urban middle and upper class strata, but are being replaced to some extent by animal protein and fat. Increased intakes of vegetables and fruit appear to be taking place to a lesser extent and primarily in the upper class urban stratum (professionals), resulting in somewhat better micronutrient intakes than in the rural and informal settlement subjects. Seventy-six per cent of the women in the informal settlement stratum in the 16-24,6-year age group had iron intakes below 67 per cent of the RDA and 67 per cent of the women in the 25-44-year age group had intakes below 67 per cent of the RDA.

4.8 Conclusion and recommendations

Dietary improvement by means of food fortification, food diversity and iron supplementation is essential. Fortification of suitable food vehicles with

absorbable forms of iron is a cost-effective approach to controlling ID. Food fortification with iron is an important strategy for improving iron nutrition on a sustainable basis. In developing countries, most diets are plant based. Although they may contain high amounts of iron, the iron is not readily bioavailable because of the presence of inhibitory substances such as phytates and polyphenols. Most developing countries do not practise iron fortification. As industries become established and the processing of foods becomes centralised, opportunities for fortification can be developed. There have been notable successes in countries such as Chile, Venezuela and the US, where iron has been added to staple foods. If a fortifiable food exists and is consumed by many people at risk of ID, fortification is likely to be the most cost-effective strategy. There are many possible strategies for iron fortification. One approach is to fortify staple food that is consumed in significant quantities by most of the population. Fortification of wheat flour with iron is technically relatively simple and this has been implemented successfully in several countries in South America, North America, Great Britain and also in South Africa as recently as 2003 (maize as well as wheat flour). Another approach is to fortify a widely consumed condiment that women from low-income households can afford.

Iron supplementation refers to the distribution of iron in medicinal form (tablets, liquid form or parenteral injection) and is often the only way to improve iron status. The WHO considers pregnant women as a priority group for iron supplementation. The subjects in the present study did not take any iron supplements since they did not understand the need for it. Blanket supplementation need not be expensive, because preventative rather than therapeutic doses of supplementation can be used. Side effects of iron supplementation which are usually minor (constipation, diarrhoea and nausea) will be less with lower iron doses and can be improved by counselling about the diet and supplement use. Motivating the patient, explaining why and how the tablets should be taken, as well as reduction of side effects are some of the essential recommendations for iron supplementation programmes. It is recommended that all women in low socio-economic communities be supplemented with iron during the second half of pregnancy, when iron

requirements are increased (Kruger *et al.* 94:136). Part of their daily iron requirement can be supplied as iron fortified food, which will reduce the dose of iron to be taken in tablet form. Information on the importance of iron to the pregnant and lactating women and the unborn child, on how to take the iron supplements and how to handle side effects will improve compliance with and efficacy of the supplements.

No nutrition education was given at the clinics included in this study; therefore an intervention programme is recommended that includes dietary diversification with an NEP. The NEP should include proper dietary guidelines within a limited budget and ways to increase iron intake during pregnancy and lactation. To increase dietary iron, dietary diversification needs to be encouraged among this population. Iron-rich foods like organ meat, meat, poultry, fish, legumes, whole wheat, green leafy vegetables and nuts should be included in the diets. If possible, the intake of the highly absorbable haeme iron should be increased by increasing meat, poultry or fish intake. Tinned sardines in tomato sauce are very popular amongst South African blacks and reasonably priced. The absorption of non-haeme iron can be increased by including ascorbic acid rich food, such as citrus fruit or tomatoes, in the same meal. On the other hand, tea and coffee, which are known to decrease the absorption of non-haeme iron, should be avoided during and after meals. Further research on dietary diversification in this population of pregnant and lactating women is recommended.

The results clearly show that the women were from low-income households and that food insecurity was prevalent among this population. Therefore by analysing the socio-demographic profile and the food consumption patterns of the sample population, it was evident that an intervention study that was cost effective and culturally acceptable was needed. Dietary diversity by means of an FMM was therefore developed for pregnant women in the Vaal region. Successes have been obtained in dietary diversification in Ghana, and similar principles were adopted. In Chapter 5 the FMM concept is introduced, and the development, chemical analysis, shelf life testing, recipe development as well as sensory evaluation of the product is explained.

Chapter 5

Development of the food multimix (FMM)

5.1 Introduction

In Chapter 4, the pilot study which determined the nutritional status of pregnant women in the Vaal region was discussed. The study found that 41,6 percent of pregnant women in the Vaal region were suffering from ID and 50 percent were suffering from IDA and that an intervention strategy was needed to improve the nutritional status of pregnant women in the Vaal region. In Chapter 3 various strategies on how to address IDA and malnutrition were highlighted. The approach chosen to address IDA for this study was food and dietary diversification, specifically a food-based approach through the development and implementation of a food multimix consisting of iron and folate. Therefore, in this chapter, the development of the FMM will be discussed.

5.2 Background

The introduction of the FMM was discussed in Chapter 3. Since 1990, Zotor and Amuna from the University of Greenwich have also been working on the development of nutritious, low-cost multimixes to improve the health of pregnant women, malnourished people in the developing world and those with diabetes mellitus in the United Kingdom (Amuna, Zotor & Tewfik 2004:129). Tests have shown that whilst foods provided by the Food and Agriculture Organization as part of the World Food Programme are energy-rich, the FMMs developed at the University of Greenwich have a higher mineral and vitamin content for a more complete diet with longer lasting benefits (Amuna *et al.* 2004:131).

According to Amuna *et al.* (2004:131), the FMM project has been designed to utilise affordable foods that are culturally acceptable to the specific subject

group. Processing methods are being examined to avoid overcooking and loss of food nutrients. Affordable nutrient-dense FMMs will significantly improve the nutritional status of malnourished pregnant women and reduce negative effects associated with pregnancy and birth. In the absence of good nutritional support, drugs alone will not produce the best outcomes for the malnourished (Amuna *et al.* 2004:136).

Product development is defined as the process of designing, creating and marketing a product. The product can either be one that is new to the marketplace or one that has been improved. All product development goes through a similar planning process (Heleigh 2006:2). Successes have been obtained in dietary diversification in Ghana (Amuna *et al.* 2004:130) and similar principles have been employed in the present study.

Results of previous studies revealed the poor state under which pregnant women of the Vaal region live (Kesa 2004:5). Therefore, in this chapter a novel approach is described to develop a cost-effective, culturally acceptable and nutrient-dense FMM supplement that will meet 20-25 per cent of the RDA of pregnant women 16-35 years of age in the Vaal region. This research was conducted to improve the nutritional status of pregnant women of the Vaal region.

Specific objectives of the research reported in this chapter are to:

- Formulate, prepare and chemically analyse an FMM supplement that satisfies a certain proportion of the nutrient needs of pregnant women in the Vaal region
- Determine the shelf life of the FMM supplement
- Develop two recipes (soup and gravy) and recipe leaflets incorporating the developed FMM supplement
- Conduct sensory evaluation to test for consumer acceptability

5.3 Methodology

Steward-Knox and Mitchell (2003:59) suggest the following procedures when developing a product:

- Consider the use of the product (for example as a food supplement in the case of the FMM supplement for pregnant women)
- Method of preparation
- Minimum or maximum nutrient content
- Expected shelf life
- Type of storage
- Target group
- Cost

After the development of a product, the target group should test the acceptance of the product through sensory evaluation. Details required from the target group should include the purpose of design (does the product fulfil the purpose for which it was designed?), whether it meets the needs of the target group, whether the product is easy to prepare and store and if it is affordable and safe for consumption. To ensure quality control, recipes and quantities of ingredients must be used for each product (Steward-Knox & Mitchell 2003:59; Rudder, Ainsworth & Holgate 2001:658).

Figure 6 explains the stages and processes involved in the development of the FMM supplement for this study. This framework was adapted from Amuna *et al.* (2004:135), taking into consideration the procedures recommended by Steward-Knox and Mitchell (2003:59).

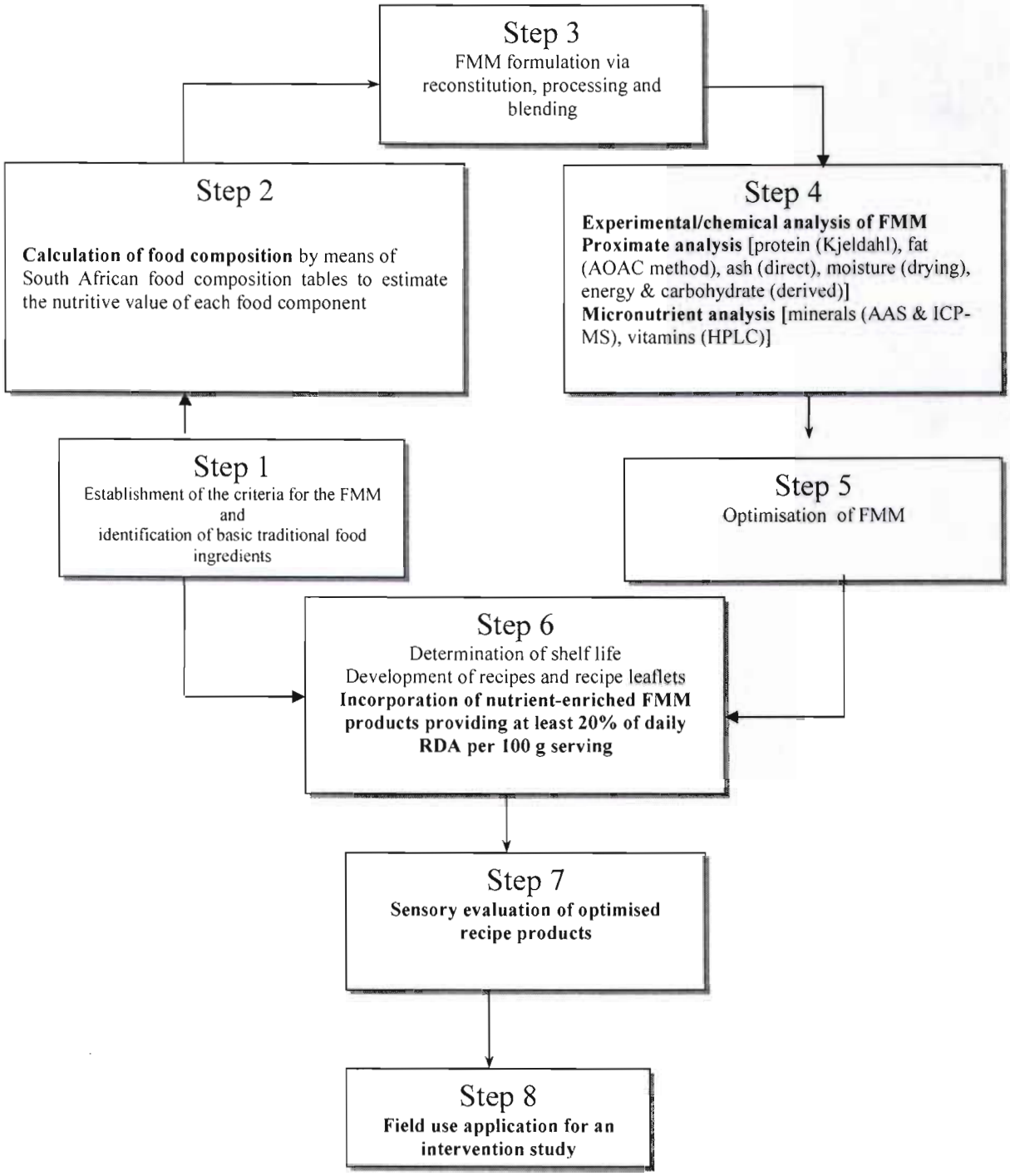

Figure 6: Stages and processes in the development of the FMM (adapted from Amuna *et al.* 2004)

5.3.1 Step 1a: Criteria for FMM formulation

The nutrients that were found to be deficient in the diets of pregnant women in the Vaal region were protein, energy, iron and folate (Kesa 2001). The aim was therefore to develop an FMM supplement that was nutrient dense to meet 20 per cent of the RDA for protein, energy, iron and folate for pregnant women. The extra money that pregnant women were prepared to spend on food, snacks or supplements was R1,75/day (Kesa 2001) and this amount was thus used as the cost criterion for the formulation of the FMM supplement. This step included the preparation of the multimix by drying the ingredients and blending them into a fine powder. Choosing ingredients from the top 20 food items mostly consumed by pregnant women as well as sensory analyses ensured cultural acceptability, and safety for human consumption was based on microbiological testing. Using FoodFinder, 20 FMM supplements were formulated, and the one chosen was theoretically found to be closer to the criteria in terms of nutrient content (carbohydrate, folate, iron and protein) when compared to the other 19 FMM. Thus, the rest of the chapter will focus on the development of the FMM used for this study.

5.3.2 Step 1b: Identification of basic food ingredients

First of all basic traditional foods (ingredients that are known and used by the community being studied) that are cost effective, nutrient dense and culturally acceptable were identified. Some of the food items were selected from the top 20 food items consumed by pregnant women in the Vaal region. This list was compiled by Kesa (2001:145) during a study conducted to determine the nutritional status of pregnant women in the Vaal region. During selection, the carbohydrate (staple), protein, vitamin, mineral and fat content of food items were considered. The nutrient content of the chosen foods was estimated by means of a food composition database (Langenhoven, Kruger, Gous & Faber 1991). The nutrient values of each food component were estimated. At least four, but not more than five, food items were chosen for each multimix to avoid overloading of certain micronutrients within a multimix in case of

nutrient interactions within the same multimix and to ensure the availability of ingredients in the household (Cameron & Hofvander 1983:129). Table 11 explains the food groups and the reasons for their inclusions.

Table 11: Commodities and rationale for inclusion

Food group/commodities	Rationale for inclusion
Cereal, grains, tubers, roots, legumes	Major staples and primary carbohydrate sources (including fibre)
Energy-dense and protein-rich foods, e.g. cow peas, soybeans, melon seeds, black-eyed beans, dried fish	Foods that are locally available and that provide reasonable amounts of key macronutrients and micronutrients as well as that are complementary to other foods that are nutrient limiting.
Vegetables, fruits, pulses and nuts	Seasonality, locally accessible and affordable
Vegetable oils, dairy products, eggs, animal products	Accessibility and affordability
Wide ranging varieties of food choice	Socio-cultural and religious factors that govern food choice
Appropriateness of product	Appearance, texture, taste, digestibility

(Adapted from Amuna *et al.* 2004)

5.3.3 Step 2: Calculation of food composition via databases

The nutrient composition of each ingredient and formulated multimix was calculated using FoodFinder, based on the South African food composition tables (Langenhoven *et al.* 1991).

5.3.4 Step 3: Weighing, drying and grinding of ingredients

Ingredients selected for the various FMMs were accurately weighed before and after drying and differences in pre- and post-mass weight were recorded. The items were then dried in a pre-heated Rational combi steamer oven at accepted temperatures (between 95 and 110 °C) and time set depending on the type and quantity of food being dried at a time. Checking was done at 30-minute intervals. Dried food items were then ground into a fine powder. To

test for dryness, the food items crumbled easily when crushed in the palm. These ingredients were then proportionately mixed together to form the FMM supplement, taking into consideration the calculated ratio proportion of each food item to a 100 g of multimix supplement.

5.3.5 Step 4: Chemical analysis of FMM

The FMM supplement was analysed by the Agricultural Research Centre (ARC) laboratory for protein, fat, moisture, ash, energy, carbohydrate, vitamin and mineral content of the FMM. ARC, an accredited laboratory in South Africa, used standardised procedures to determine the nutritional content of the formulated FMM as summarised in Table 12.

Table 12: Chemical analysis methods of multimixes to determine nutrient content

Nutrient	Method	Basic principle
Protein	Adapted Kjeldahl (modified Berthelot reaction)	Acid is used to release nitrogen in the sample, which is then measured and used to derive protein value by using a conversion factor.
Fat	Acid-hydrolysis	Acid is used to release fat in the sample, and ethers are then employed to remove the fat.
Ash	Direct	Organic matter is removed by heating the sample in a furnace at 550 °C.
Moisture	Drying	Water is evaporated by drying the sample in an oven at 105 °C.
Carbohydrate	Derived	100% - (% protein + % fat + % ash + % moisture).
Energy	Derived	(Protein x 16,8 kJ) + (Carbohydrate x 16,8 kJ) + (Fat x 37,8 kJ).
Minerals (Ca, Zn & Fe)	Atomic absorbance spectroscopy (AAS)	Sample is digested in acid to release minerals. AAS atomises sample, then passes a beam of radiation through it – absorption is measured at wavelength corresponding to mineral of interest.
Minerals (Cu, Mg)	Inductively coupled plasma mass spectroscopy (ICP – MS)	Sample is digested in acid to release minerals. ICP-MS ionises sample, then separates ions according to mass and counts the ions.

Table 12 continued ...

Nutrient	Method	Basic principle
Vitamins (B's, A, C & folate)	High performance liquid chromatography (HPLC)	A procedure for the separation of non-polar solutes. Non-polar solutes are chromato-graphic on a column having a non-polar liquid immobilised on an inert matrix. A more polar liquid that serves as the mobile phase is passed over the matrix, and solute molecules are eluted in proportion to their solubility.
Vitamins (other)	Theoretical calculations	Standard food composition tables and FoodFinder/Dietary Manager.

5.3.6 Step 5: Optimisation

Optimisation of FMM recipes: the actual and theoretical values were compared and ingredients adjusted to meet the formulation criteria.

5.3.7 Step 6: Shelf life

The FMM was kept at room temperature (±25 °C) and analysed by ARC on day 0 (12 September 2005, arrival day), day 3 (15 September 2005), day 7 (19 September 2005), day 14 (26 September 2005), day 21 (3 October 2005) and day 28 (10 October 2005).

An aliquot of 10 g of sample was removed aseptically from the tube of FMM each time it was analysed. The sample was homogenised in a Stomacher 400 (DHK Pty Ltd) with 90 ml of diluents (buffered peptone water). The sample was analysed for total aerobic plate count on tryptone soy agar and incubated at 25 °C for 72 hours (± 3 days) and for Coliform and *Escherichia coli* (*E. coli*) counts on violet red bile MUG agar and incubated at 37 °C for 24 hours (± 1 day). The yeast and mould counts were analysed on Rose Bengal agar with chloramphenicol and incubated at 25 °C for 5 days.

Development of two recipes and recipe leaflets

Two recipes (soup and gravy) were developed incorporating the FMM. Basic soup and gravy recipes were adapted to include the FMM supplement. Some

of the ingredients removed from the original recipe included flour and flavourings because the FMM supplement had its own thickening power and the ingredients used had their own natural flavours.

Reasons for choosing soup and gravy

Soup and gravy were chosen because they are easy to prepare and are common accompaniments to staples like rice, maize porridge and potato. Through the interviews in the baseline study by the researcher and the fieldworkers, it was observed that the sample population ate soup and gravy with thick porridge. The property of soups and gravies to moisten food during meals was thus considered ideal.

Development of recipe leaflets

Simple and colourful illustrations in the form of ladles, spoons and water flowing through a tap were used to develop recipe leaflets to make reading and cooking easy for subjects. The pictures of the spoons and cups used made it easy and understandable for the illiterate subjects (Annexure F).

Costing of recipes

Costs of the various recipes (soup and gravy with FMM) were calculated with prevailing prices of ingredients used in 2006.

5.3.8 Step 7: Sensory evaluation of developed recipes (soup and gravy)

An information session was held at the Vaal University of Technology, to which all the clinic sisters were invited. They were given information about the FMM and how it would be implemented in their clinics. The clinic sisters represented all the clinics in the Vaal region. They were briefed about the sensory evaluation, what it was and how it was going to be conducted.

Sensory analysis for the soup and gravy prepared with the FMM was conducted with the nursing sisters invited from Johan Haynes and Sharpeville

Clinics. The sisters approved all the products for their colour, taste, appearance and consistency. A second sensory evaluation was performed to test the acceptability of the products by the target group in the same clinics, namely Johan Haynes and Sharpeville Clinics, both in the Vaal region, with a random sample of 25 pregnant women (14 in Johan Haynes Clinic and 11 in Sharpeville Clinic). The reason why those clinics were chosen was for their antenatal days, which were from Monday to Thursday, and this made it possible to visit those two clinics any day between Monday and Thursday. A structured validated Hedonic scale facial expression questionnaire was used to collect data for analysis to arrive at acceptability of the products. A pre-tested hedonic scale questionnaire (Annexure G) was used for the sisters as well as the subjects and was later analysed by a statistician using SPSS version 13 to detect the acceptability of the various foods by the pregnant women.

The process of sensory evaluation with the subjects began at Johan Haynes Clinic. Nursing sisters in charge welcomed and introduced the researchers to the pregnant women who had assembled for a routine pre-natal check-up. All the pregnant women were briefed about sensory analysis and they had already been informed of the intended procedures. Those willing to participate were asked to do so immediately after their usual pre-natal checks. The products to be evaluated were displayed on a table in a room selected for the purpose. Pregnant women were called in one after the other, to taste the foods displayed. They were helped to express their opinions about each particular food tasted.

5.4 Results and discussions

Using South African food composition tables, 20 FMM supplements were formulated targeting the RDA for pregnant women of selective nutrients. Iron, folate, protein, and carbohydrate were the nutrients considered. These are nutrients known to play protective roles against adverse outcomes of pregnancy (Gibney, Margetts, Kearney & Lenore 2004:291).

5.4.1 Step 1

5.4.1.1 Criteria for the FMM formulation

The main aim of this project was to develop an FMM supplement, meeting the following criteria, for pregnant women in the Vaal region:

* Affordable in that a daily portion should not cost more than R1,75. This was found to be the amount that pregnant women were prepared to spend daily on extra food, snacks and supplements per day as 61,4 per cent of the women earned between R0 and R500 per month and 82,2 per cent were unemployed (Kesa 2001:144).

* Nutritious, meeting 20 per cent of the RDA for iron, folate and protein. An interpretation of iron status of selected pregnant women showed that 50 per cent were anaemic (Kesa 2001:161). Results of nutrient intake by sampled pregnant women also by Kesa (2001:147) depicted 72,8 µg of folate (0,3 per cent of RDA), 3,8 mg iron (12,6 per cent of RDA) and 23 g (38 per cent of RDA) of protein.

*Culturally acceptable by choosing ingredients familiar to the pregnant women in the area. According to the results of Kesa (2001), these were based on the top 20 most consumed food items by pregnant women of the Vaal region and through sensory testing.

* Safe for human consumption as proved by microbiological testing.

5.4.1.2 Identification of basic traditional food ingredients

In step 1 basic traditional food items (ingredients that are known and used by the community) that are cost effective, nutrient dense and culturally acceptable were identified and used for the FMM. Some of the food items were selected from the top 20 most consumed food items by pregnant women in the Vaal region which was compiled by Kesa (2001: 145). During the selection, food items with carbohydrates, protein, vitamins, minerals and fat

sources were considered. Food items chosen for the formulation of the FMM supplement included maize meal (one of the most commonly consumed food items by pregnant women of South Africa) (Kesa 2001: 146), which contains (per 100 g) 0,7 mg iron, 8,9 g protein and 16 μg folate, kidney beans which provided 5,9 mg iron, 3,2 g protein and 370 μg folate, peanuts which had 1,8 mg iron, 5,17 g protein and 126 μg folate, and pea powder which also had 2,7 mg iron, 3,3 g protein and 49 μg folate. Milk contained no iron, 33,6 g protein and 350 μg folate.

5.4.2 Step 2

5.4.2.1 Formulation and theoretical calculation of nutrient composition data

A FMM was chosen for the study (chemical analysis, shelf life determination, development of recipes incorporating the FMMs and sensory evaluation). Multimixes were incorporated into the recipes for soup and gravy and sensory evaluations were done. A recipe leaflet was also developed to guide the pregnant women in the preparation of the soup and gravy. Illustrations were used to make reading and understanding of the recipes easy.

In Table 13 the nutritional content of 20 formulated FMM supplements (iron, carbohydrate, folate and protein) and their RDA are displayed. FMM C1 was chosen for the study because it contained more folate and iron than the others and thus met criteria 2 mentioned in section 5.4.1.1. The RDA of 30 mg was used for iron in the formulation of the FMM as at the time of formulation of the FMM, that was the RDA for pregnant women (Food and Nutrition Board 1989:285). The RDA was revised to 27 mg for iron during 2001 (IOM 2003).

Table 13: Nutrient content of formulated multimixes 1-20

Multimix	Iron RDA 30 mg/day	Carbohydrate RDA 175 g/day	Folate RDA 400 µg/ day	Protein RDA 60 g/day
C1	**6,2 mg/100 g**	**60,16 g/100 g**	**76,5 µg/100 g**	**19,6 g/100 g**
2	2,4 mg/100 g	48,05 g/100 g	8,62 µg/100 g	10,35 g/100 g
C3	15,8 mg	66,28 g/100 g	54,1 µg/100 g	13,78 g/100 g
4	2,0 mg/100 g	54,08 g/100 g	24,40 µg/100 g	7,86 g/100 g
5	7,8 mg/100 g	46,4 g/100 g	18,4 µg/100 g	4,63 g/100 g
6	3,11 mg/100 g	29,3 g/100 g	16,39 µg/100 g	10,04 g/100 g
7	2,63 mg/100 g	27,6 g/100 g	22,2 µg/100 g	9,03 g/100 g
8	1,64 mg/100 g	29, 99 g/100 g	23,50 µg/100 g	8,23 g/100 g
9	3,60 mg/100 g	21,46 g/100 g	12,52 ug/100 g	9,58 g/100 g
10	1,84 mg/100 g	40,71 g/100 g	13,93 µg/100 g	8,2 g/100 g
11	4,60 mg/100 g	27,39 g/100 g	13,8 µg/100 g	9,97 g/100 g
12	6,09 mg/100 g	47,42 g/100 g	13,75 µg/100 g	11,05 g/100 g
13	1,90 mg/100 g	25,66 g/100 g	22,05 µg/100 g	12,6 g/100 g
14	3,40 mg/100 g	23,55 g/100 g	21,1 µg/100 g	9,85 g/100 g
15	2,30 mg/100 g	29,51 g/100 g	13,06 µg/100 g	6,73 g/100 g
16	5,90 mg/100 g	54,9 g/100 g	14,40 µg/100 g	10,15 g/100 g
17	7,16 mg/100 g	20,3 g/100 g	10,02 µg/100 g	10,10 g/100 g
18	0,2 mg/100 g	10,9 g/100 g	10,8 µg/100 g	5,4 g/100 g
19	2,4 mg/100 g	33,8 g/100 g	21,05 µg/100 g	5,92 g/100 g
20	5,2 mg/100 g	17,7 g/100 g	17,53 µg/100 g	4,45 g/100 g

RDA = Recommended dietary allowance (Food and Nutrition Board 1989:285)

Table 14 provides a list of ingredients, the quantities used and the nutritional value of each food item used in the multimix.

Table 14: Formulation and theoretical nutrient composition of food items used in formulation of nutrient-enriched multimix

Food description	*Wht G	Ener #kJ	Prot #g	*CHO g	Fat G	Prot %	*CHO %	Fat %	*Fib g	*Ca #(mg)	*Fe (mg)	Vit C (mg)	*Fol #(µg)	Vit B12 (µg)	Vit A (µg)
RDA	*	10,500	30	175	20	30	45	35	28	1 200	30	70	400	2,2	800
Maize meal	30	453	2,79	21,6	1,1	2,8	21,5	2,6	0,6	5,1	0,75	0,9	7,6	0	*
Peanut dry	25	605	5,7	5	11,	5,72	5,0	25,2	0,7	12,2	0,95	0,25	27,5	0	0
Pea dry	15	204	3,3	8	0,1	3,3	8,4	0,4	0,9	13,5	2,7	0	4,95	0	2,25
Kidney beans	20	277	4,4	11,4	0,3	4,4	11,3	0,7	0,9	38	1,64	0,2	36	0	660
Dry milk Non-fat	10	149	3,5	5,21	0,0	3,5	5,2	0,2	0,03	14,1	0,17	0,4	0,4	0	*
TOTAL	100	1 688	19,6	51,21	12,	19,7	51,4	29	3,1	82,9	6,2	1,7	76,5	0,0	662

RDA = Recommended dietary allowance (Food and Nutrition Board 1989:285)

*Wht – Weight
*CHO – Carbohydrate
*Fib – Fibre
*Ca – Calcium

kJ – kilojoule
g - gram
mg - milligram
µg – microgram

*Fol – Folate
*Fe – Iron

In Table 14 the nutritional content of food items used in formulating the FMM supplement is displayed. The food items used were nutrient dense and therefore met the nutrient formulation criterion of the FMM.

5.4.2.2 Cost of FMM

Table 15 reflects the cost of the FMM.

Table 15: Cost of FMM

Item	Quantity used in FMM	Cost per kg	Cost of quantity used
Maize meal	30 g	R6,99	R0,20
Peanut powder	25 g	R6,99	R0,17
Pea powder	15 g	R4,99	R0,07
Kidney beans	20 g	R6,99	R0,13
Milk powder	10 g	R24,99	R0,25
Total			**R0,82**

The cost of the FMM was lower than the R1,75 criterion set in section 5.4.1.1.

5.4.3 Step 3: Weighing, drying and grinding of ingredients

Table 16 depicts the food items used in the formulation of the FMM, the temperatures used and the before and after cooking mass. Milk powder was the only ingredient that was used as purchased and therefore its mass remained the same. The reason for this was that it had already gone through the appropriate processes by the manufacturer.

Table 16: Food items used in formulation of FMM and related factors

Food item	Temperature	Before mass	After mass	Cooking time
Maize meal	99 °C	1,5 kg	1,35 kg	50 min
Peanut dry	99 °C	1,2 kg	1,1 kg	50 min
Pea	100 °C	1,5 kg	1,35 kg	60 min
Kidney beans	110 °C	1,5 kg	1,4 kg	60 min
Milk powder	*	*	*	*

5.4.4 Step 4: Chemical/experimental analysis of the FMM

In step 4, FMM supplements were sent to the ARC laboratory where results were established for protein, fat, moisture, ash, energy and carbohydrate content of the FMM. Micronutrient,

mineral and vitamin contents of the FMM were also established by the ARC laboratory. Results are shown in Table 17 below.

Table 17: ARC results of laboratory analysis of multimix supplement per 100 g

Analysis	Accreditation Number	Unit	Sample
Ash	ASM 048	%	2,65
Dry matter	ASM 013	%	96,18
Moisture	ASM	%	0,82
Fat (ether extraction)	ASM 044	%	12,38
Protein		%	20,99
Vitamin A		mg/100 g	0,09
Vitamin B1	ASM 025	mg/100 g	0,06
Vitamin B2	ASM 025	mg/100 g	0,16
Vitamin C	ASM 057	mg/100 g	0,19
Calcium		mg/100 g	204
Magnesium		mg/100 g	133
Copper		mg/100 g	0,26
Iron		mg/100 g	4,20
Zinc		mg/100 g	3,80
Carbohydrates (calculated)		g/100 g	60,16
Energy		kJ/100 g	1 838
Folate		µg/100g	40

Table 18 shows the results of the laboratory analysis and the theoretical results of the multimix supplement per 100 g.

Table 18: Comparison between ARC experimental results and theoretical results for critical nutrients in FMM

Nutrient	Unit per 100 g	RDA for pregnant women	Theoretical results	RDA% of theoretical results	Experimental results	RDA% of experimental results
Protein	G	60	19,6	32	20,99	35
Energy	kJ	10 500	1 688	16	1 838	18
Carbo-Hydrate	G	175	51,21	29,2	60,16	34

Table 18 continued ...

Nutrient	Unit per 100 g	RDA for pregnant women	Theoretical results	RDA% of theoretical results	Experimental results	RDA% of experimental results
Iron	mg	30	6,2	20,6	4,2	14
Folate	µg	400	76,5	19,1	40	10
Calcium	mg	1 200	82,9	6,9	204	17

RDA = Recommended dietary allowance (Food and Nutrition Board 1989:285)

According to Table 18, the experimental results show that the protein, energy, carbohydrates and calcium values were actually higher than those calculated theoretically, but the critical nutrients, namely iron and folate, were considerably lower.

5.4.5 Step 5: Optimisation

During this step, the FMM formula was adjusted theoretically in order to increase the folate and iron content as the chemical analyses resulted in much lower values. The FMM was initially calculated theoretically (refer to Table 14), thereafter the FMM was chemically analysed (refer to Table 17). The results of the chemical analyses showed iron to be much lower by 2 mg. Therefore, in order to reach the 20 per cent of the RDA for iron, folate and protein optimisation was needed. Tables 19 and 20 show the optimisation of the macronutrients and micronutrients of the FMM.

Table 19: Optimisation for FMM (macronutrients)

Food description	*Wht	*Ener	*Prot	*CHO	Fat	*Prot	*CHO	Fat
	(g)	kJ	G	g	G	%	%	%
RDA		10 500	60	175	15	20	45	35
Cornmeal 96% extract	25	107,82	2,32	18,5	0,94	2,78	21,5	2,6
Groundnut – dry	25	144,25	5,8	5	11,25	5,72	5	25,2
Pea, dried	20	48,285	4,4	11,2	0,22	3,29	8,4	0,4
Kidney beans	20	65,9	4,4	11,4	0,3	4,38	11,3	0,7
Milk, dry, full cream	10	35,528	3,51	5,21	1,9	3,49	5,2	0,2
Total	100	401,78	20,43	51,31	14,61	19,66	51,4	29

*Wht – Weight kJ – kilojoule *Ener - Energy

*CHO – Carbohydrate g - gram *Prot - Protein

Table 20: Optimisation for FMM (micronutrients)

Food description	*Wht	*Ca	Iron	Vit B1	Vit B2	Vit B6	Vit C	*Fol	Vit B12	Vit A
	(g)	(mg)	(mg)	(mg)	(mg)	(mg)	(mg)	(µg)	(µg)	(µg)
RDA		1 200	30	1,5	1,6	17	70	400	2,2	800
Cornmeal 96% extract	25	4,25	0.63	0,09	0,02	0,54	0,9	6,35	0	*
Groundnut – dry	25	30	0,95	0,2	0,04	3,875	0,25	39	0	0
Pea, dried	20	18	3,6	0,13	0,03	0,45	0	6,6	0	2,25
Kidney beans	20	9,8	1,64	0,07	0,03	0,48	0,2	36	0	660
Milk, dry, full cream	10	0,0413	0,174	0,09	54,9	170,5	0,399	0,4	*	*
Total	100	62,0913	6,994	0,6	55	175,8	1,7	88,35	0	662

*Fol – Folate g – gram mg – milligram *Ca – Calcium µg – microgram Vit – vitamin

This step resulted in theoretically adjusting the iron and folate content to 6,99 mg and 88,35 µg as 20 per cent of the RDA for pregnant women, respectively.

5.4.6 Step 6

5.4.6.1 Microbiology tests for shelf life

The microbiology tests for shelf life of the FMM are indicated in Table 21.

Table 21: Results of FMM stored at 25 °C for 28 days

Sample	Total aerobic plate count Cfu/g	*E. coli* Cfu/g	Coliform Cfu/g	Yeast and moulds Cfu/g
Day 0	360	–	–	40
Day 3	130	<10	<10	10
Day 7	100	<10	10	50
Day 14	21 000	<10	10	30
Day 21	<1 000	<10	<10	75
Day 28	<1 000	<10	25	625

Cfu/g = Colony forming units per gram of sample

Note: <10 reflects the accuracy of the test procedure and for all practical purposes implies the absence of the organism indicated

Coli-form and *E. coli* count

No *E. coli* (Table 21) was detected for the multimix throughout the trial.

The Coli-form count for the multimix started as <10 cfu/g and remained very low throughout the trial.

The total aerobic count for the FMM started at 360 cfu/g and increased by 2 log/g to 21 000 cfu/g on day 14, and then decreased to less than 1 000 cfu/g. The reason for the counts not having a value on days 21 and 28 are that the sample was evaluated according to the results from the previous day's analysis, and since the count was at log 4 per gram, the analyst assumed that the count would increase, and did not prepare a full dilution range. No growth could be detected on a 10^{-3} dilution, and thus the count can only be expressed as less than 1 000 organisms per gram.

The last two points for the FMM (days 21 and 28) are not a true reflection of the counts. The counts for these two days for the total aerobic plate count were less than 1 000 cfu/g. Since the true value is not known the counts were given as though the counts were 999 cfu/g, to complete the graph.

Yeast and mould count

The yeast and mould count for the FMM started at a very low 40 cfu/g and increased by 1 log/g to 650 cfu/g. The reason for the fluctuation of the yeast and mould counts is that the sample material was not uniform. The sample consisted of different textured powder particles and this may cause uneven distribution of the microorganisms in the sample. It might be that a bigger load of organisms was concentrated on the portion that was sampled on day 21 than, for instance, on day 3. This reason can also be applied to the total aerobic count for both the samples where there is also a fluctuation in the counts.

The counts for the FMM in general were less than the overall counts. The sample was still safe for human consumption on day 28 and will have a shelf life of longer than 28 days.

5.4.6.2 Recipe development

Recipes for developed soups and gravy for the FMM are shown in Tables 22 and 23.

Table 22: Multimix soup

Ingredient	Quantity used
Multimix powder	100 g
Onions	30 g
Cooking oil	2 teaspoons
Salt	½ teaspoon
Water	450 ml

The above recipe yielded 450 ml of soup, thus two portions.

Method

Onions were washed, peeled and finely grated. The multimix was formed into a paste with 100 ml of water. Oil was heated, and onions were added and fried till golden brown. The multimix paste was added and carefully stirred to avoid lumps. Water was added to the correct consistency, stirring continuously. The multimix soup was seasoned with salt and allowed to simmer for 20 minutes.

Table 23: Multimix gravy

Ingredient	Quantity used
Multimix powder	100 g
Fresh tomatoes	15 g
Onions	30 g
Cooking oil	2 teaspoons
Salt	½ teaspoon
Water	250 ml

The above recipe yielded 250 ml of gravy, thus two portions.

Method

Onions were washed and grated. Tomatoes were also washed and finely chopped. A multimix paste was formed with 100 ml of water. Grated onions were fried in heated oil till golden brown. Tomatoes were added and cooked for two minutes. The multimix paste was

added and carefully stirred to avoid lumps. Consistency of the gravy was corrected. The multimix gravy was seasoned with salt, and allowed to simmer for 20 minutes and served.

5.4.6.3 Recipe leaflet

Simple recipe leaflets were developed to assist the subjects in the preparation of the soup and gravy. Simple illustrations were used in the form of ladles and spoons. These illustrations were made easy for the illiterate subjects (Annexure F).

5.4.6.4 Recipe cost

Table 24: Cost of recipe with FMM (soup)

Ingredient	Quantity used	Cost
Multimix	100 g	R0,82
Onions	100 g	R0,30
Cooking oil	2 teaspoons	R0,25
Water	450 ml	R0,01
Salt	½ teaspoon	R0,01
TOTAL		**R1,39**

In Table 24 the individual cost of ingredients used and the total cost of soup made with food multimix CI are displayed. The total recipe yielded two portions of ± 250 ml at a cost of R1,78 per portion, which still meets the "low-cost, affordable" criterion.

Table 25: Cost of recipe with multimix gravy

Ingredient	Quantity used	Cost
Multimix	100 g	R0,82
Onions	30 g	R0,50
Fresh tomatoes	15 g	R0,60
Ingredient	**Quantity used**	**Cost**
Tomato puree	Two teaspoons	R0,20
Cooking oil	2 teaspoons	R0,25
Water Salt	250 ml ½ teaspoon	R0,01 R0,01
TOTAL		**R2,39**

In Table 25 the individual cost of ingredients used and the total cost of gravy made with the FMM are displayed. The total recipe yielded two portions of ± 250 ml at a cost of R1,68 per portion, which still meets the "low-cost, affordable" criterion. However, the nutrient content per portion is on the low side.

The theoretical nutrient composition was calculated by FoodFinder and is summarised in Table 26 for all the recipes per portion.

Table 26: Nutritional value of nutrients in FMM (soup & gravy) per portion

Nutrient	Unit	Soup	Gravy
Energy	KJ	1 751,5	702
Protein	G	13,51	6,88
Carbohydrate	G	38,85	19,99
Nutrient	**Unit**	**Soup**	**Gravy**
Fat	G	23,73	6,9
Iron	Mg	2,19	1,18
Folate	µg	71,5	71,5
Calcium	Mg	166,5	167

Folate, however, was very close to the formulated criterion, i.e. 76,5 µg. Only 14 per cent of the RDA for iron was met and only 6,5 per cent of the RDA for folate was met.

5.4.7 Step 7: Sensory evaluation results

The sensory evaluation was developed for the soup and gravy recipes. Figures 7 to 11 below show the acceptability rate of the multimix in the form of a soup and gravy.

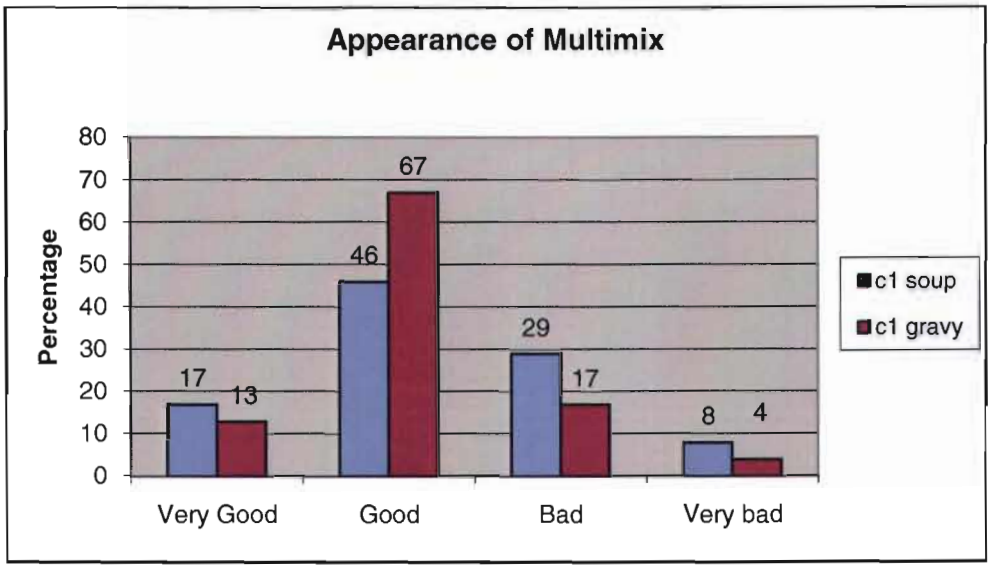

Figure 7: FMM appearance acceptability rate of the soup and gravy

Most respondents had a positive response to the acceptability and to the appearance of the soups and gravies. According to the above graph, in general, 67 per cent of the respondents indicated that the appearance of the gravy was acceptable and 46 per cent indicated that the appearance of the soup was acceptable.

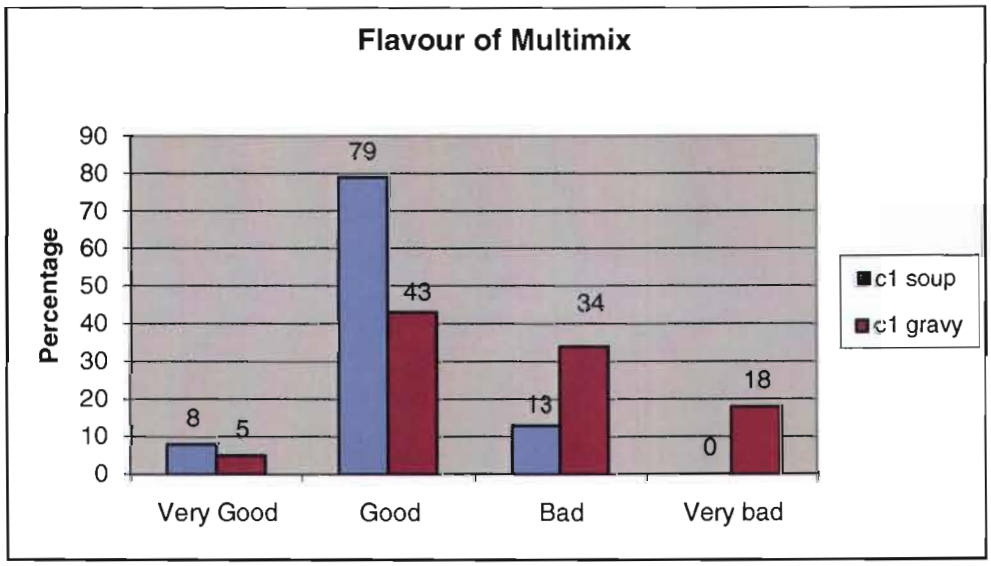

Figure 8: FMM flavour acceptability rate of soup and gravy compared

Most of the respondents (79 per cent) found the flavour of the soup to be acceptable and 43 per cent agreed that the gravy was acceptable to them.

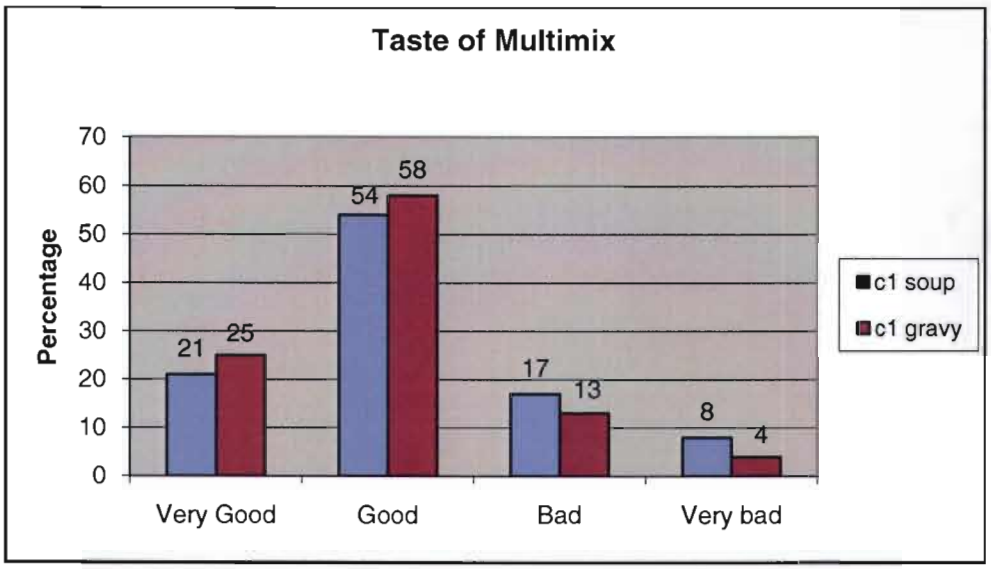

Figure 9: FMM taste acceptability rate of soup and gravy compared

The taste acceptability rate looked very promising as over 50 per cent of the respondents found both the soup and the gravy acceptable and 25 per cent of the respondents found the gravy to have a very good taste.

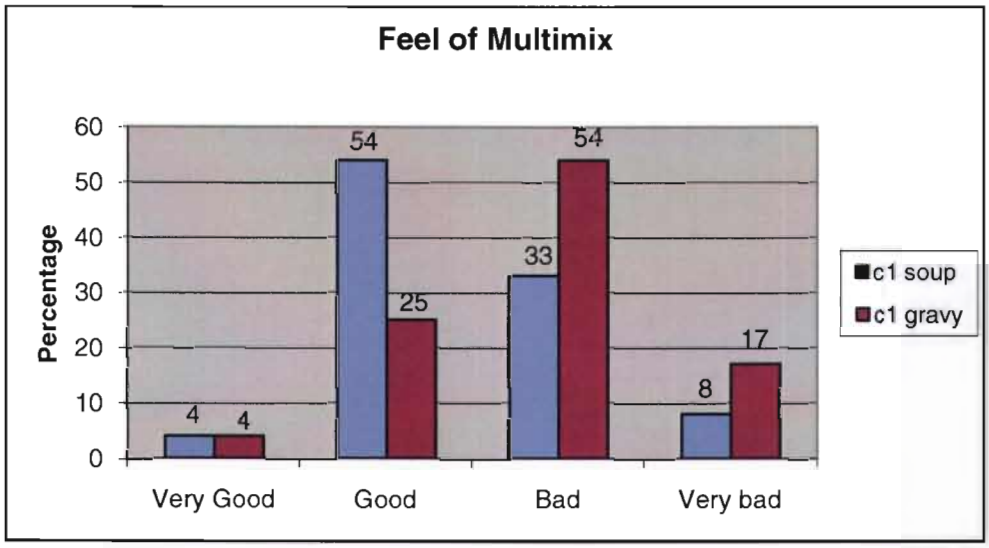

Figure 10: FMM feel acceptability rate of soup and gravy compared

The feel of the gravy in the mouth was not acceptable to 54 per cent of the respondents, although 54 per cent agreed that the feel of the soup was acceptable.

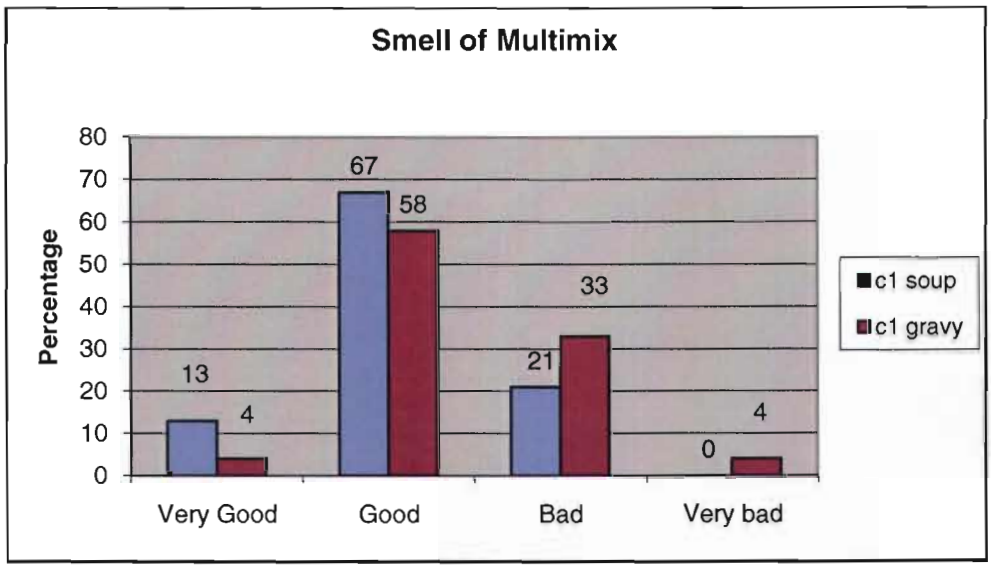

Figure 11: FMM smell acceptability rate of soup and gravy compared

Over 50 per cent of the respondents agreed that the smell of both the soup and gravy was acceptable.

The responses to the soup and gravy were positive, although some did not like the feel of the gravy and therefore it was suggested that these be prepared in a smoother consistency.

5.5 Discussion

On the basis of the study mentioned in Chapter 4, it is clear that iron and folate deficiency are most prevalent in pregnant women. In summary, this chapter explained in detail the entire process of the formulation of the FMM product. It started with the compilation of 20 formulated FMM supplements stating the RDA for pregnant women. Iron, folate, protein and carbohydrate were the nutrients considered since these are the nutrients that play protective roles against adverse outcomes during pregnancy (Gibney, Margetts, Kearney & Arab 2004:291). Studies conducted by Blencowe *et al.* (2010:1112) and Felkner, Suarez, Brender, Scaife and Henricks (2005:422) both refer to the importance of folate and iron intake to diminish deficiency and negative pregnancy outcomes such as NTDs, congenital birth defects such as cleft lip and palate, maternal mortality, preterm delivery and LBW.

The FMM C1 supplement was chosen for the study because it was found to contain more folate and iron than the other mixes. The limitation of the study was that the criterion for the formulation was that it had to meet 20 per cent of the RDA for iron, folate and protein. The chemical analysis showed that the FMM developed contained 21 g of protein. The 20 per cent RDA criterion for protein was therefore met. The nutritive value for iron was 4,2 mg, thus meeting 14 per cent of the RDA. The folate content was 40 μg, therefore meeting 10 per cent of the RDA. It was very difficult to meet the 20 per cent criterion for both macronutrients and micronutrients for a food-based approach. The RDA for iron and folate was not met in the multimix. This was due to the fact that the chemical analysis machine at the Vaal University of Technology broke down during analysis and therefore the FMM had to be sent to ARC for chemical analysis. The results of the chemical analysis took very long to return from ARC and the cost involved was R6 300 per sample. Due to the delay the FMM was developed for the intervention study based on the theoretical results. The theoretical re-analysis was done, but the chemical analysis of the optimised FMM could not be done due to the high costs involved.

5.6 Conclusion

Food items used to formulate the FMM supplements, oven temperatures used to cook each food item, before and after mass and cooking times have been displayed as recorded. The nutritional value of food items used in formulating the FMM supplement was shown, as was the percentage ratio of each commodity used. This was necessary to determine the processes used to develop the FMM. A similar process was used in the study conducted by Amuna *et al.* (2000:118) whereby four FMMs were formulated for weaning infants and children. In this study the bulk of the components used were also plant based and commonly available.

Costs involved in preparing the FMM supplement were given in various tables above. The costs of the FMM had to be minimal as the study conducted by Kesa (2001:144) (Vaal region) and the recent study conducted by Bopape *et al.* (2008:332) (Mankweng Township, Limpopo) among low-income South African pregnant women show that the majority of the women were unemployed, or if employed earned a salary between R0 and R500 per month. Recipes formulated and their methods of cooking were also

mentioned and explained in this chapter. The conversion factors for the formulated recipes were determined for soups and gravies made with FMM supplements. Each of the recipes formulated and prepared were costed with prevailing prices. According to the sensory evaluation, the appearance, flavour, taste, feel and smell of the soup and gravy was also well accepted by the pregnant women.

The shelf life testing proved to be very positive as the microbiological growth for the FMM was very low and thus the FMM would have a long shelf life. The test results also showed that the FMM was still edible on the 28th day of testing and therefore would have a shelf life of longer than 28 days.

This FMM was one of the first FMMs developed for pregnant women in South Africa. An overall conclusion would be that an FMM can be developed and optimised to meet criteria for pregnant women, but not all criteria were met in this study as it was not possible to meet the 20 per cent of the RDA for iron, folate and protein. This product needed to be tested in an intervention study to address its impact on the nutritional status of pregnant women. This will be discussed in Chapter 6, as well as the implementation process of the FMM in the clinics.

Chapter 6

Intervention Study

6.1 Introduction

In Chapter 4 the pilot study conducted in 2001 to determine the need for an intervention to improve the nutritional status of pregnant women in the Vaal region was discussed. The results clearly indicated the need for an intervention study as 41,7 per cent of the pregnant women were iron deficient and 50 per cent suffered from IDA. Poor dietary intake was a main concern as the food items consumed by the pregnant women provided very little iron. The motivation for an FMM was also included in Chapter 4.

In Chapter 5 the formulation and development of a cost-effective, culturally acceptable, nutrient-dense FMM was discussed. The intervention programme will now be explained, including how the FMM was introduced and implemented, and the effect of this on the nutritional status and dietary diversity of pregnant women in the Vaal region.

Dietary diversification is a strategy designed to reduce exposure to risk of malnutrition by combining a variety of ingredients into a cost-effective means to provide medium- and long-term sustainable food-based solutions to food and nutrition security of low-income households. The diversification of the diet to increase the consumption of iron, vitamin A and other micronutrients on a daily or continuing basis is a practical, long-term measure to eliminate and prevent micronutrient deficiencies. Activities that improve production, availability and access to micronutrient-rich and locally produced foods are a major focus of this type of intervention (Heleigh 2006:3).

Many dietary diversification activities are in operation at community level where they are more likely to be sustainable and cause enduring behaviour change in macronutrient and micronutrient consumption (USAID 2002:8). Food diversifying involves transforming traditional food items into enriched food mixes for poor communities (Amuna *et al.* 2004: 131). Dietary diversity is defined as the number of

different foods or food groups consumed over a given reference period and it is also seen as the latest trend to assess overall diet quality (Ruel 2003:3912S). Food variety is quantified by the number of different food items consumed and dietary diversity is quantified by the number of food groups consumed over a certain period of time (Clausen *et al.* 2005:86).

The objectives of this part of the study were to determine the food consumption patterns and dietary intake and nutritional status of pregnant women (pre- and post-intervention) in the Vaal region.

Furthermore, the impact of the consumption of the FMM on nutritional status and dietary diversification of the pregnant women and the outcomes of their pregnancy were assessed after the intervention study.

6.2 Sample

6.2.1 Study population

The study population consisted of pregnant women resident in the Vaal region. Figure 12 is a map of the Vaal region. The areas mostly covered in this study were Vanderbijlpark and Vereeniging.

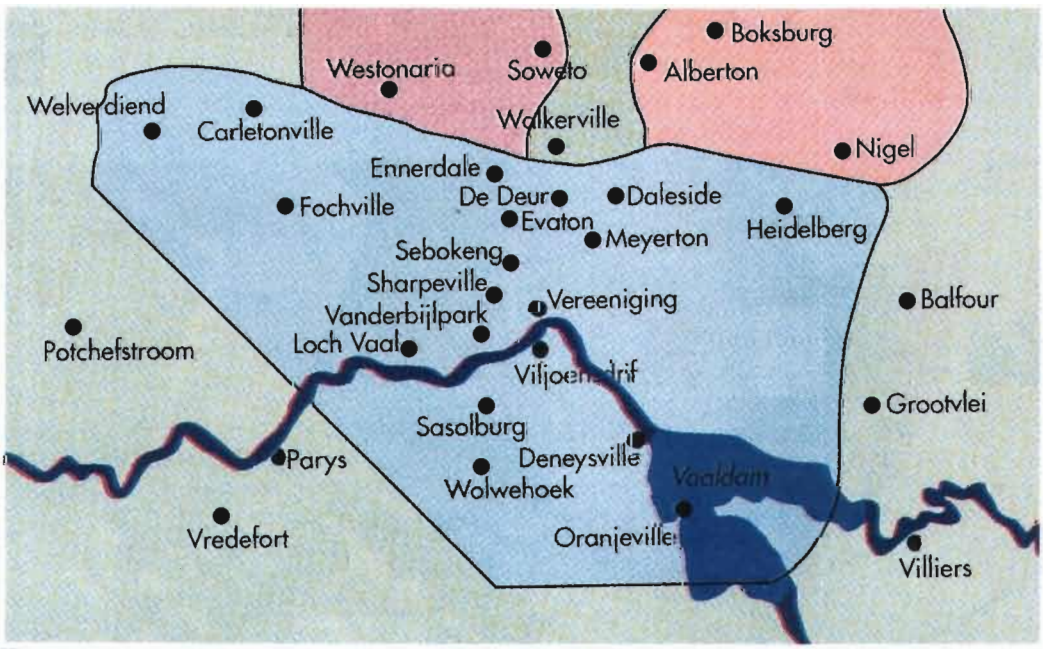

Figure 12: Geographical map of the Vaal region

6.2.2 Planning

The first step was to obtain permission by interviewing key role players and decision-makers. These included representatives from sub-directorates of maternal, child and women's health, nutrition and health promotion, academic institutions and community-based nutrition organisations (Annexure I). A letter was written to the District Manager, Department of Health (Vaal region) to obtain permission to conduct the study in the Vaal region, mainly Vereeniging and Vanderbijlpark. Permission was granted. Refer to section 4.2 for ethical clearance for this study.

Random sampling was done where a full list of clinics in Vereeniging and Vanderbijlpark was drawn up, a purposive sample of the various clinics in the different towns was drawn at random and pregnant women visiting these clinics between October 2005 and February 2006 were included on a list. Women visiting the antenatal clinics in the selected areas were asked to volunteer as participants for the study. All participants received an information letter explaining the purpose of the project (Annexure J) and the letter was explained to the participants by the fieldworkers and the researcher. All participants signed an informed consent form (Annexure K). A list was drawn up, including the names of all the participants who signed the consent form.

Random sampling was then used because it was necessary to have a full list of individuals in each stratum which consisted of women living in that township or zone within the clinic, women who were from low-income households and were pregnant in either their first or second trimesters. This also helped to determine the demographic profile such as age groups, geographical areas and social class categories.

The inclusion criteria for participation in the project were the following:

- Females
- Aged between 16 and 35 years old
- Pregnant (first or second trimester)
- Monthly income less than R3 000 per household
- Resident in the Vaal region

The sampling procedure resulted in a sample size of 86 that consisted of randomly selected pregnant women who were between the ages of 16 and 35 years old in the Vaal region. The clinics were allocated by the Department of Health in the Vaal region.

Before the intervention programme was implemented, the researcher held an information session with the clinic sisters to explain the entire procedure and it was then suggested by the clinic sisters that the experimental and control groups be at separate clinics to ensure control.

The random sample was thus purposively divided into an experimental group and a control group. Both groups participated in the pre- and post-intervention trial.

Experimental group

The pre-intervention consisted of 54 participants and the post-intervention of 33 participants.

Control group

The pre-intervention consisted of 32 participants and the post-intervention of 24 participants.

Table 28 explains the allocation of the clinics for the experimental and control groups.

Table 28: Allocation of clinics for experimental and control groups

Name of clinic	Group
Bophelong	Experimental
Retswelapele	Experimental
Tshepiso	Control
Beverley Hills	Experimental
Dr Helga Kuhn	Experimental
Johan Deo Polokong	Experimental
Mpumelelo	Control
Levai Mbata	Experimental and control (different days)
Boitumelo	Experimental

Figures 13 to 15 below are the clinics used for the experimental groups

Figure 13: Bophelong Clinic used for the intervention trial

Figure 14: Beverley Hills Clinic used for the intervention trial

Figure 15: Boitumelo Clinic used for the intervention trial

6.3 Methods

6.3.1 Objectives

The objectives of the study were as follows:

- Using the QFFQ to collect information on usual dietary intake and food consumption patterns.
- Analysing the dietary intake by using FoodFinder. Correlations were drawn between the 24-hour recall questionnaire and the QFFQ.
- Using anthropometric measurements, namely the weight, height, BMI, waist and hip circumference and MUAC of the pregnant women to determine who was overweight or underweight.
- Using biochemical and haematological measurements, namely Hct, HB, MCV, full blood cell count, serum ferritin and transferrin levels as a measure of the status of iron to determine micronutrient deficiencies. Folate and serum vitamin B12 were also measured to determine micronutrient deficiencies.

After permission was granted by the Manager of Health and Welfare Services in the Vaal region (Annexure L), questionnaires were taken by the fieldworkers to the sample population, including municipal antenatal clinics in the Vaal region.

All the measuring instruments used in this study were identified by the logo Dietary Diversification for Pregnant Women (DDPW). This logo made it easy for the clinic sisters as well as the respondents to identify all questionnaires and FMM bags used in this study.

Figure 16 below shows the DDPW logo.

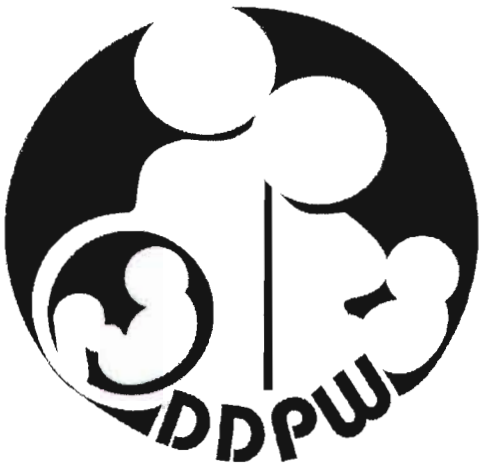

Figure 16: DDPW logo

At the same time, the target population's iron status measurements were recorded as well as their anthropometric measurements, namely weight, height and MUAC. The fieldworkers completed the QFFQs themselves in an interview situation in order to ensure reliability (Annexure M).

The clinic sisters at the specific clinics took the blood samples of the pregnant women in order to determine their iron status and measure the level of Hb, Hct, red cell count, iron, ferritin and transferrin, folate and vitamin B12.

6.3.2 Training of fieldworkers

Refer to section 4.3 as the same methods were used.

6.3.3 Measuring instruments

Most of the measuring instruments used in this study were also used in the baseline study in Chapter 4 and will not be discussed here again. The following were not used in the baseline study and will therefore be discussed in this chapter:

- The health and medical as well as the 24-hour recall questionnaires
- Anthropometric measurements: MUAC and waist-to-hip ratio measurements
- Biochemical measurements: folate and vitamin B12
- Intervention programme
- Birth data
- Dietary diversification

6.3.4 Questionnaires

The following questionnaires were compiled and used in the study:

- **Socio-demographic questionnaire**

The same socio-demographic questionnaire used for the pilot study (refer to section 4.4.1) was used for this study. This was completed before the intervention programme. The same data collection and analyses procedures described in section 4.4.1 were followed for this part of the study. Figure 17 shows a fieldworker completing a questionnaire with a respondent.

Figure 17: Fieldworker completing questionnaires

- **Health and medical questionnaire**

The questionnaire included questions about infections, high blood pressure, physical activity, smoking, use of alcohol, use of supplements and medication (Annexure N). This questionnaire was completed before the intervention programme as it was used to determine the health and medical status of the respondents and to give the researcher an indication of any serious health and medical issues that some of the pregnant women may have had before the study began. The trained fieldworkers administered the questionnaires by means of interviews.

Figure 18: Fieldworker explaining the questionnaires to a participant

❖ **QFFQ**

The same QFFQ questionnaire as used in the pilot study was used. Refer to section 4.4.1. The QFFQ was completed before and after the intervention programme.

❖ **24-hour recall questionnaire**

These questionnaires were used as a reference measure for the QFFQ and completed simultaneously with the QFFQ. The main purpose of the 24-hour recall questionnaire was to test the actual intake of foods ingested by the subject for the previous 24 hours and the main purpose of the QFFQ was to test the usual food consumption patterns.

The results of both questionnaires were compared with each other to test for validity. All the subjects completed the questionnaire with the assistance of the fieldworkers. Fieldworkers completed the questionnaires with the help of food models to assist with the identification of food items and portion sizes (Annexure O). This questionnaire was completed before and after the intervention programme.

6.3.5 Anthropometry

In measuring the pregnant women, the following three variables were recorded: age, pre-pregnancy weight and height. The BMI was calculated by dividing weight (kilograms) by the square of height (metres) (kg/m^2) (refer to section 4.4.2). The BMI measurements were calculated before the intervention programme. The MUAC

measurements were measured between the acromion process of the shoulder and tip of the elbow. The waist-to-hip ratio is mostly used to indicate obesity. Circumferences were measured using plastic, inflexible measuring tapes. The smallest circumference below the last rib of the rib cage and above the navel indicated the waist. The largest circumference between the waist and the knees was measured as the hip. Anthropometric measurements besides BMI were recorded before, during and after the intervention programme.

At the clinics the fieldworkers recorded the respondents' anthropometric measurements, namely weight, height and weight-for-height, and compared them with the weight-for-height tables to determine who was overweight or underweight. MUAC and waist-to-hip ratio were also measured (Annexures M).

6.3.6 Biochemical assessment

The following samples were collected from each subject:

- 5 ml EDTA (whole blood) for the full blood count and measurement of haematogical markers: Hct, MCV, red blood cell count and Hb
- 10 ml serum for the analysis of ferritin and transferrin and serum iron, folate and vitamin B12

Refer to section 4.4.3 for iron status laboratory and statistical analysis methods.

The following cut-off points were used for folate and vitamin B12 status (Brutis & Ashwood 2001):

Folate: 7 – 36 nmol/l
Vitamin B12: 74 – 517 pmol/l

Folate method of analysis

The AIA-PACK FOLATE was used for the analysis of folate. It is designed for in vitro diagnostic use only for the quantitative measurement of folate in human beings. The AIA-PACK FOLATE is a competitive enzyme immunoessay which, after sample pre-treatment, is performed entirely within the AIA-PACK. Sample pre-treatment reagents containing sodium hydroxide release folate from serum-binding proteins in

the sample. Folate-binding protein then binds to fluorescein isothiocyante (FITC) antibody immobilised on magnetic heads. The amount of enzyme-labelled folate that binds to the heads is inversely proportional in the folate concentration in the test sample. A standard curve using a range of known standard concentrations is constructed and unknown folate concentrations are calculated using this curve (AIA-PACK FOLATE manual).

Vitamin B12 method of analysis

The AIA-PACK B12 was used for the analysis of vitamin B12. It is designed for in vitro diagnostic use only for the quantitative measurement of vitamin B12 on TOSOH AIA system analyses. The AIA-PACK B12 is a competitive enzyme immunoessay which, after sample pre-treatment, is performed entirely within the AIA-PACK. Sample pre-treatment reagents (containing potassium cyadane, sodium hydroxide and dithiotheitol) release vitamin B12 in serum-binding proteins in the sample and convert cyanocoattin into a stable measurable form of vitamin B12. The heads are washed to

remove the unbound enzyme and incubated with fluorogenic substance. A standard curve using a range of known standard concentrations is constructed and unknown vitamin B12 concentrations are calculated using this curve (AIA-PACK B12 manual). Figure 19 shows the clinic nurse drawing blood from one of the participants.

Figure 19: Clinic nurse drawing blood from participant

6.3.7 Blood pressure measurements

Blood pressure was measured to determine if the women were suffering from hypertension or gestational hypertension.

Pregnancy-induced hypertension is defined by a systolic blood pressure of 140 mm Hg or a diastolic pressure of 90 mm Hg, or both. Low pre-pregnant BP is from 90/60 mm Hg and normal is 120/80 mm Hg (Chobanian 2003:2560). Figure 20 shows a clinic sister recording the blood pressure of a respondent.

Figure 20: Clinic sister recording the blood pressure of one of the respondents

6.3.8 FMM intervention programme

The subjects were divided into two groups, namely the experimental group and the control group. The experimental group was given the FMM and the control group was given a basic vegetable brown onion soup powder.

The total duration of the intervention was four months. According to Margetts and Nelson (2000), an experiment should be just long enough to allow the effect of exposure change to achieve the result. Gibson (2005) confirms that most of the iron in erythrocytes is recycled for haemoglobin synthesis at the end of their functional lifetime (i.e. on average 120 days). At this time the erythrocytes are degraded by the macrophages of the reticular endothelium, and the iron is re-released in the form of iron bound to transferrin or ferritin. This process is called iron turnover; each day 0,66 per cent of the total iron content of the body is recycled. Therefore, an intervention period of 122 days was used for this study.

The FMM was first weighed into 100 g portions and then packed into plastic bags and thereafter into brown paper bags. Each subject in the experimental group was given a two-week supply at a time. A day's supply consisted of two 100 g plastic bags packed into one brown bag (one for lunch and the other for dinner). The recipe leaflets were all included in the packaging (refer to section 5.4.6.3). The FMM packet was labelled with a red sticker. This was done in order to assist the researcher and fieldworkers to identify the difference between the FMM brown bags and soup brown bags as can be seen in Figures 21 and 22.

Figure 21: FMM in 100 g plastic bags

Figure 22: Two-week supply of FMM and soup powder packed and ready to be delivered

The soup powders were packed identically to the FMM, but consisted of only one 55 g package each, the reason being that they were purchased in 55 g packets from the

supplier. The vegetable soup was chosen because it was the safest option for the vegetarian subjects. The nutrient content did not differ much from the other commercially sold soups. The soup powder packets were labelled with a blue sticker. The ingredients in the soup powder were thickener, salt, onion, wheat flour (gluten), sugar, vegetable fat, antioxidant, colourant, flavour enhancer, acidifying agent and spices.

Table 29: Nutrient content of brown onion soup powder compared with FMM and EAR

Nutritional analysis	Unit	Nutrient composition of portion soup powder	Nutrient composition of portion FMM	#EAR for pregnant women
Kilojoules	KJ	804	1 688	11 103
Protein	%	17	19,7	30
Protein	g	8,2	19,6	45,5
Fat	g	1,2	12	
Fat	%	15	25	35
Carbohydrates	g	32,2	51,2	135
Carbohydrates	%	67	51,4	35
Calcium	Mg	14	82,9	1 300
Iron	Mg	1,9	6,2	22
Vitamin A	Mg	-	662	550
Folate	Mg	34	76,5	520

#EAR= Estimated average requirement (IOM 2003)

The pregnant women from the control group received the same training as the experimental group in the preparation of the soup powder for a soup and gravy. The same recipe leaflets were used. The only difference in the preparation method was that they needed to add salt to taste or sparingly as the soup powder contained salt.

The portion sizes of the final product were the same as the FMM. Recipes were tested for the FMM and soup powder and both were tested for sensory analysis.

Compliance

Compliance was tested by visits to the subjects' homes by the researcher and the fieldworkers. During the visits the following was done:

- The subjects were questioned on how they prepared the FMM.
- They were questioned as to whether they understood the methods of preparation.
- It was explained to the subjects that it was important for them to consume the FMM and not share it with their families. Therefore every subject also received a 1 kg bag of maize meal for their families.
- The number of FMM supplies left for the week was shown to the researcher and fieldworkers by the pregnant women to ensure that they were consuming the FMM.

Compliance was also tested using the sensory evaluation form mentioned in 5.3.8 during the last month of the intervention programme. The results were then compared to the pre-intervention results.

6.3.9 Birth data

Once the intervention was completed and some of the pregnant women had given birth, the researcher and fieldworkers collected the available birth data from the clinic records. The available birth data for both experimental and control groups were recorded. The birth data questionnaire (Annexure P) consisted of questions including:

- The gender of the baby
- Gestation period
- Delivery methods
- Weight of the baby
- Length of the baby
- Head circumference
- Apgar scores
- Placenta weight
- Mother's post-birthweight

An infant's length is measured with the baby lying down on a measuring board with a fixed headboard and a movable footboard. Two people are needed to measure the infant's length (Whitney & Rolfes 2010:E5).
Infants are weighed with scales that allow them to lie or sit. They are weighed naked, without nappies (Whitney & Rolfes 2010:E6).
An infant's head circumference is measured with a non-stretchable tape so that it encircles the largest part of the infant's head, just above the eyebrow ridges, just above the point where the ears attach and around the back of the head (Whitney & Rolfes 2010:E6).

The Apgar score is determined as follows (Cooper 2006:77):
Immediately after the baby is born, and if necessary again five minutes later, five tests are done to ascertain the health status of the baby. The tests measure:

- Heart rate
- Breathing
- Muscle tone
- Skin colour
- Reflex response

For each test a score of 2, 1 or 0 is recorded, with 2 being entirely healthy and 0 an absence of response. Most babies score between 7 and 10 out of 10. If necessary, the tests are repeated five minutes later to see if the baby's responses have improved.

The birth data were very difficult to obtain, as not all the clinics recorded them. Figures 23 - 25 show the healthy mother and baby after the intervention trial.

Figure 23: Baby from experimental group

Figure 24: Mother and baby from experimental group

Figure 25: Mother and baby from experimental group

6.3.10 Dietary diversity

Dietary diversity was measured using the nine nutritious food groups to measure food intake during a seven-day period. These food groups were recommended by the United Nations FAO, namely 1) cereals, roots and tubers, 2) dairy, 3) eggs, 4) fats and oils, 5) legumes and nuts, 6) other vegetables, 7) other fruit, 8) vitamin A-rich fruits and vegetables, and 9) flesh products (meat, poultry, fish and offal) (Steyn, Fourie & Temple 2006:38). Dietary diversity is measured by quantifying the number of individual foods, referred to as the food variety score (FVS) and the number of food groups utilised as the food group diversity score (FGDS), usually calculated for a reference period (Ruel 2003:3912s). The QFFQ was administered and analysed for dietary diversity and food variety for both experimental and control groups before and after intervention. Dietary measures, referred to as dietary variety calculated from the QFFQs, were as follows: 1) overall variety score (simple count of food items), 2) variety score between all nine food groups and 3) a variety score within every food group (Hatloy, Torheim & Oshaugh 1998:892-3; Steyn, Nel, Nantel, Kennedy & Labadarios 2006:646; Oldewage-Theron & Kruger 2008:106).

6.4 Statistical analysis

6.4.1 Questionnaires

Data from the socio-demographic, anthropometric, health and medical and sensory evaluation questionnaires were captured on an Excel spreadsheet and analysed using SPSS for Windows, version 13. Exploratory data as well as descriptive statistics were used.

The data collected by the QFFQs and 24-hour recall questionnaires were analysed by a registered dietician using the FoodFinder software program version 3.0 with the SA food composition tables (1991) as part of the calculations. Means and SDs were calculated for food and nutrient intake compared to the EAR.

6.4.2 Anthropometry

The anthropometric results were analysed by using BMI. The fieldworkers at the clinics collected this information, which was compared against the weight-for-height tables to determine who was overweight or underweight. Obese, overweight, normal and underweight were classified according to BMI (refer to Table 30 for statistical analysis).

BMI is considered a good index of body fat stores. It is best used for individuals between the ages of 20 and 65 years. A BMI score of over 18,5 is believed to signify adequate nutrition, while a BMI under 16 is a strong sign of chronic energy deficiency. Cut-off points for overweight and obesity are as follows: Overweight (BMI > 25-29,9) and obese (BMI 30 and >30) (IOM 2009, adapted from Whitney & Rolfes 2010:501).

Women who are of normal weight prior to pregnancy should aim for a weight gain in the 11,3–15,9 kg range during pregnancy. Underweight women should gain weight in the 12,7–18,1 kg range. Women who are overweight prior to pregnancy should gain between 6,8 and 11,3 kg (Mahan & Escott-Stump 2008:165).

6.4.3 Biochemical status

The results of the blood analyses were computerised and statistically analysed by a qualified statistician using SPSS, version 13. The data entry programs had a number of quality control mechanisms, including validity checks, duplicate detection and verification procedures, written in SPSS. Table 30 summarises the different statistical methods used in this study.

Biochemical analyses using means and SDs were compared to reference values. This was done by using inferential statistics and paired T-tests. Nutrient intakes and biochemical results (pre- and post-intervention), namely iron, folate and vitamin B12, were compared against each other. Cross-tabulation as well as Pearson correlations were done.

6.4.4 Dietary diversity

The data collected from the QFFQs were used to determine dietary diversification in pregnant women. FVSs and FGDSs were compared before and after intervention. Food items taken from the QFFQ were added individually and were grouped accordingly using MSExcel 97. Descriptive statistics (frequencies) were used to determine the food items consumed according to the food groups. The dietary data analyses were done using SPSS for Windows version 13.

Table 30 below summarises the statistical methods used.

Table 30: Statistical methods

Variable	Statistical methods
Demographic, health and medical questionnaires	Data captured on MSExcel 97, thereafter SPSS for Windows version 13. Exploratory data and descriptive statistics.
24-hour recall questionnaire	FoodFinder with the SA food composition tables. Means and SDs compared with EAR using descriptive statistics and cross-tabulations.
QFFQ	FoodFinder with the SA food composition tables. SD compared to EAR using descriptive statistics and cross-tabulations.
Anthropometry	SPSS for Windows version 13. Paired T-tests and independent T-tests.
Biochemical results	SPSS for Windows version 13. Inferential statistics, cross-tabulations and Pearson correlations.
Birth data	SPSS for Windows version 13. Descriptive statistics.
Dietary diversification	SPSS for Windows version 13. Descriptive statistics, paired T-tests and independent T-tests.
Compliance: Sensory evaluation questionnaire	SPSS for Windows version 13. Descriptive statistics.

6.4.5 Relationship between variables

Differences between the pre- and post-intervention and between the experimental and control groups for all variables were compared using the Levene's two-tailed test for equality of variances. Differences were considered to be significant if $p < 0,05$. The p

value in a test is the smallest value for α for which the sample results become statistically significant.

Correlations between pre- and post-intervention biochemical results were calculated and a correlation existed if $r \geq 0$ with a significance level of $p \leq 0{,}05$.

6.5 Results

6.5.1 Dropouts

The dropout rate of the pregnant women in the study was high. Reasons for this are that the women did not live within the zone of the clinics and therefore only attended the clinic for their first visitation, which was during the recruitment time of the study, and did not continue to visit the same clinic. The dropout rates for the experimental and control groups were combined as a whole group. According to Table 31, the total dropouts were 37 and the participants that remained were 49 each from the experimental and control groups. There was no statistical significance observed between the biochemical measurements of the participants and the dropouts. It can therefore be assumed that those participants who dropped out would not have influenced the results.

Table 31: Pre-intervention characteristics of participants with those lost to post-intervention and thus excluded

Pre-intervention measurement	Participants (n=49) Mean ± SD	Dropouts (n=37) Mean ± SD
Iron (µmol/l)	15,6 ± 8,2	16,2 ± 11,2
Ferritin (ng/ml)	40,4 ± 44,3	46,5 ± 38,2
Transferrin (g/L)	2,2 ± 1,2	2,1 ± 0,8
Red cell count	4,1 ± 0,5	4,0 ± 0,4
Haemoglobin (g/dl)	11,7 ± 1,6	11,8 ± 0,3
Haematocrit (%)	33,2 ± 5,6	32,6 ± 4,4
Mean cell volume (fl)	79,4 ± 9,2	80,6 ± 7,2
Folate (nmol/l)	5,2 ± 3,8	4,3 ± 3,7
Vitamin B12 (pmol/l)	357,0 ± 183,1	283,3 ± 173,6

6.5.2 Socio-demographic data of pregnant women

Table 32 gives a detailed overview of the socio-demographic data of the pregnant women who participated in this study.

Table 32: Socio-demographic data of pregnant women

Socio-demographic variable	Experimental group (n=54)	%	Control group (n=32)	%
Age distribution (years)				
Younger than 21 years	12	22,0	6	18,8
21-25	17	31,5	9	28,1
26-30	16	29,6	8	25,0
31-35	6	11,3	5	15,6
Older than 36 years	3	5,6	3	9,4
Missing	-	-	1	3,1
Pregnancy in weeks				
1-5	3	5,6	3	9,3
8	2	3,7	4	12,5
9-12	1	1,9	2	6,3
10	1	1,9	-	-
12	7	13,0	2	6,3
13	1	1,9	2	6,3
15	2	3,7	2	6,3
16	22	40,7	8	25
17-19	1	1,9	1	3,1
20	12	22,2	9	28,1
Missing	2	3,7	1	3,1
Planning to breastfeed				
Yes	50	96,2	26	81,3
No	3	2,6	4	12,5
Missing	1	1,2	2	6,2
Type of living				
Town/city	20	37,0	7	21,9
Informal settlement	12	22,2	2	6,3
Location	20	37,0	21	65,6
Township	2	3,8	1	3,1
RDP	-	-	1	3,1
Currently employed				
Yes	11	20,4	6	18,8
No	42	77,8	24	75,0
Missing	1	1,8	2	6,3
Paid employment				
Yes	32	59,2	19	59,4
No	10	18,5	5	15,6
Unsure	12	22,3	8	25,0
Total monthly household income				
R0-R500	13	24,1	4	12,5
R501-R1 000	6	11,1	6	18,8
R1 001–R1 500	4	7,4	3	9,4
R1 501–R2 000	7	13,0	4	12,5
R2 001–R2 500	3	5,6	2	6,3
R2 500 +	10	18,5	6	18,8
Insufficient funds to buy food				
Always	6	11,1	2	6,3
Often	1	1,9	-	-
Sometimes	22	40,7	9	28,1
Seldom	3	5,6	3	9,4
Never	20	37,0	15	46,8
Missing	2	3,7	3	9,4
Frequency of food purchased				

Table 32 continued ...

Socio-demographic variable	Experimental group (n=54)	%	Control group (n=32)	%
Every day	3	5,6	2	6,3
Once a week	18	33,3	11	34,4
Once a month	31	57,4	16	50,0
Twice a month	2	3,7	3	9,3
Money spent on food per week				
R0-R50	5	9,3	6	18,8
R51-R100	4	7,4	6	18,8
R101-R150	7	13,0	3	9,4
R151-R200	6	11,1	5	15,6
R201-R250	4	7,4	1	3,1
R251-R300	4	7,4	2	6,3
R300 +	19	35,2	6	18,8
Do not know	5	9,2	3	9,2
Highest education level				
Primary school	7	13,2	6	18,7
Grade 8	4	7,4	1	3,1
Grade 9	2	3,7	7	21,9
Grade 10	18	33,3	5	15,6
Grade 11	10	18,3	3	9,4
Grade 12	13	24,1	10	31,3
Language spoken				
Sotho	33	61,1	16	50,0
Xhosa	8	14,8	4	12,5
Zulu	9	16,7	7	21,9
Tsonga	2	3,6	2	6,2
Tswana	1	1,9	2	6,2
Missing	1	1,9	1	3,2
Possession of an electric stove for cooking				
Yes	30	55,6	20	62,5
No	18	33,3	7	21,9
Missing	6	11,1	5	15,6

The socio-demographic data gave a good indication of the background of the participants. According to Table 32, in both groups the majority of the participants were Sotho-speaking, younger than 30 years and ≥16 weeks pregnant. This therefore met with the inclusion criteria of the study. It was interesting to note that 96 per cent of the experimental group and 81 per cent of the control group were planning to breastfeed their babies. Seventy-eight per cent of the experimental group and 75 per cent of the control group were unemployed at the time of the study. The monthly household incomes were similarly distributed in both groups, with 55,6 per cent of the experimental group and 53,2 per cent of the control group who had a monthly household income of less than R2 000, respectively. The women in the experimental group claimed that they sometimes (22 per cent) had insufficient funds to buy food, whereas some of the women in the control group (47 per cent) claimed that they never

experienced insufficient funds. The majority of the women in both groups purchased food once a month. Thirty-five per cent of the experimental group claimed that they spent more than R300 per week on food compared to the control group of 19 per cent. The majority of the control group (62,6 per cent) spent less than R200 on food per week, whereas the majority of the experimental group (55,6 per cent) spent less than R300 on food per week. In both groups the majority of the respondents had secondary school education. All this information proved positively that the women all did fall within the inclusion criteria of the study, namely the age group between 16 to 35 years old, being pregnant either in the first or second trimester, monthly incomes of less than R3 000 and residing in the Vaal region. The majority of the women in both groups agreed that they were in possession of an electric stove; this too was a benefit to the study as the FMM had to be prepared with a cooked soup and gravy.

6.5.3 Health and medical data of pregnant women

Table 33 gives a detailed description of the health and medical condition of the pregnant women who participated in the study.

Table 33: Health and medical data of pregnant women

Health and medical variable	Experimental group (N=55)	%	Control group (N=32)	%
Skin disease				
Yes	12	21,8	7	21,9
No	43	78,2	25	78,1
Infection of the heart or circulatory system				
Yes	4	7,3	5	15,6
No	49	89,1	27	84,4
Missing	2	3,6	-	-
Infection of the digestive system				
Yes	10	18,2	10	31,3
No	45	81,8	22	68,8
Swollen feet, water retention or high blood pressure				
Yes	26	47,3	13	40,6
No	29	52,7	19	59,4
Headaches				
Yes	28	50,9	15	46,9
No	26	47,3	17	53,1
Missing	1	1,8	-	-
Level of physical activity				
Heavy/rigorous	3	5,5	5	15,6
Moderate	27	49,1	18	56,3
Light	8	14,5	6	18,8

Table 33 continued ...

Health and medical variable	Experimental group (N=55)	%	Control group (N=32)	%
None	15	27,3	2	6,3
Missing	2	3,6	1	3,1
Smoking				
Yes	2	3,6	1	3,1
No (never smoked)	46	83,6	29	90,6
No (stopped)	4	7,3	2	6,3
Missing	3	5,5	-	-
Snuff				
Yes	9	16,4	3	9,4
No (never used)	38	69,1	25	78,1
No (stopped)	6	10,9	3	9,4
Missing	2	3,6	1	3,1
Spouse/partner smoking				
Yes	23	41,8	9	28,1
No	26	47,3	23	71,9
Not applicable	1	1,8	-	-
Missing	5	9,1	-	-
Alcohol				
Yes	10	18,2	6	18,8
No	41	74,5	25	78,1
Not applicable	1	1,8	-	-
Missing	3	5,5	1	3,1
Type of alcoholic drinks				
Commercial beer/cider	7	12,7	1	3,1
Home brewed beer	3	5,5	3	9,4
Wine	2	3,6	1	3,1
Missing	43	78,2	5	15,6
***Use of supplements/medication during pregnancy**				
Yes	10	18,2	1	3,1
No	36	65,5	28	87,5
Missing	9	16,3	3	9,4
Health facility				
Private doctor	12	21,8	15	46,9
Clinic	39	70,9	15	46,9
Hospital	2	3,6	1	3,1
Missing	2	3,6	1	3,1
Travelling to health facility				
On foot	41	74,5	14	43,8
Taxi	13	23,6	16	50,0
Own transport	1	1,8	2	6,3
Death of child				
Yes	11	20,0	6	18,8
No	39	70,9	21	65,6
Missing	5	9,1	5	15,6

*** Supplementation: Supplements were mentioned by some, namely folic acid and ferrous sulphate**
***Medication names were unknown to respondents**

According to the above data in Table 33, most of the women who participated in the study were fairly healthy. There were a lot of similarities between the experimental and control groups in this part of the study:

- The majority of the women in both groups did not suffer any serious infections except for high BP (47 per cent of the experimental group and 41 per cent of the control group had a problem with swollen feet; the reason for this was that majority of the women were overweight at their onset of pregnancy).
- The women were not very active during pregnancy as 49 per cent of the experimental group and 56 per cent of the control group were only involved in moderate physical activity. Twenty-eight per cent of the experimental group reported no exercise. This was not measured, but reported only.
- Eighty-four per cent of the experimental group and 91 per cent of the control group reported that they had never smoked cigarettes nor used snuff. However, 42 per cent of the experimental and 28 per cent of the control groups mentioned that their spouses did smoke. Most of the women did not consume alcohol, but it is of concern that 18 per cent of the experimental group and 19 per cent of the control group consumed alcohol.
- Most of the women in both groups did not take supplements or medication during their pregnancies (66 per cent of the experimental and 88 per cent of the control group). Antenatal clinics supply the supplements (ferrous sulphate for iron and folic acid tablets) to pregnant women. The reason for mentioning that they did not take supplements in this survey could be that some women only realise that they are pregnant in their second or third month and visit the antenatal clinics late to collect their supplements (Bopape *et al.* 2008:335).
- Most of the women used the antennal clinics as their health facilities and travelled either on foot or by taxi to the facilities.

6.5.4 Dietary intake of pregnant women

6.5.4.1 Food consumption patterns by amount as measured by QFFQ

The tables below give an indication of the top 20 foods consumed by the participants pre- and post-intervention trial.

Table 34: Top 20 foods consumed by pregnant women pre-intervention (QFFQ)

Number	Food item	Mean quantity per day: experimental group	Food item	Mean quantity per day: control group
1	Maize meal, porridge stiff	487 g	Maize meal porridge, stiff	434 g
2	Tea, brewed	308 ml	Tea, brewed	382 ml
3	Orange raw, peeled	258 g	Milk, full cream	358 ml
4	Apple, raw	253 g	Maize meal porridge, soft	322 g
5	Bread, brown	245 g	Bread, brown	242 g
6	Maize meal porridge, soft	233 g	Apple, raw	174 g
7	Milk, full cream	232 ml	Tea, rooibos, brewed	144 g
8	Cold drink, squash	195 ml	Mabella	144 g
9	Mabella	182 g	Cold drink squash	142 ml
10	Chicken, roasted	162 g	Oats, cooked	140 g
11	Oats, cooked	148 g	Cold drink, carbonated	124 ml
12	Coffee, brewed, instant	144 ml	Rice, white, cooked	118 g
13	Rice, white, cooked	141 g	Orange, raw, peeled	114 g
14	Fruit juice	123 ml	Coffee, brewed, instant	101 ml
15	Tea, rooibos, brewed	116 ml	Vetkoek	88 g
16	Cold drink, carbonated	106 ml	Macaroni, cooked	88 g
17	Pear, raw	102 g	Fruit juice	82 ml
18	Banana, raw	97 g	Yoghurt	78 g
19	Yoghurt	71 g	Pear, raw	62 g
20	Potato, mashed	48 g	Peach, raw	62 g

According to Tables 34 and 35 (QFFQ), both experimental and control groups during pre- and post-intervention ate protein- and iron-rich foods. Chicken appeared at the bottom of the list in number 10 for the experimental group. However, for the control group no iron-rich foods appeared in the top 20 most commonly consumed foods pre-intervention. In the pre-intervention trial, the inclusion of foods of animal origin was very low. The experimental group consumed a mean portion of 232ml of milk (number 7 on the list) and 162g of chicken (10) compared to the control group, who consumed only milk (358ml portion, 3 on the list). The majority of the food items consumed by the participants were mainly carbohydrate-based. These were phytate-rich foods which inhibit iron absorption. In the experimental group these included 487g stiff maize meal porridge (1), 245g brown bread (5) and 233g soft maize meal porridge (6). In the control group these were 434g stiff maize meal (1), 322g soft maize meal (4), 242g brown bread (5) and 162g oats (10). Tea appeared second on both the lists of the experimental and control groups, and is an iron absorption inhibitor. Though vitamin C plays a role in the absorption of non-haeme iron, its intake seemed to be low as the only vitamin C-rich food item, namely oranges,

appeared on both the lists of top 20 most frequently consumed foods after tea, at 258 g (3) and 114 g (13) in the experimental and control groups, respectively. Only fruit and no vegetables appeared on the top 20 lists for both groups. These include apples (4), pears (17) and bananas (18) for the experimental group, and apples (6), oranges (13), pears (19) and peaches (20) for the control group. The dairy group included milk (7) and yoghurt (19) for the experimental group, and milk (3) and yoghurt (18) for the control group. According to the list, no legumes were consumed by either group. The only vitamin A-rich fruit that was eaten by the control group was peaches, appearing 20th on the list, but a very small mean portion size of 62 g was consumed.

Table 35: Top 20 foods consumed by pregnant women post-intervention (QFFQ)

Number	Food item	Mean quantity per day: experimental group	Food item	Mean quantity per day: control group
1	Maize meal porridge, stiff	451 g	Tea, brewed	407 ml
2	Cold drink, squash	385 ml	Malted milk beverage (Milo)	361 ml
3	Tea, brewed	379 ml	Cold drink squash	355 ml
4	*Mahewu/magou* (non-alcoholic fermented maize drink)	319 ml	Maize meal porridge stiff	268 g
5	Cold drink, carbonated	274 ml	Cold drink, carbonated	244 ml
6	Maize meal porridge, soft	251 g	Maize meal, porridge, soft	225 g
7	Coffee, brewed	220 ml	Coffee, brewed	221 ml
8	Mango, raw	160 g	Milk, full cream	217 ml
9	Orange, raw	144 g	Apple, raw	173 g
10	Mabella	143 g	Bread, brown	163 g
11	Milk, full cream	137 ml	Tea rooibos, brewed	160 ml
12	Bread, brown	124 g	Oats	139 g
13	Vetkoek	121 g	Samp	137 g
14	Tea rooibos, brewed	120 ml	Ice-cream, soft serve	131 g
15	Rice, white	117 g	Drinking yoghurt	114 ml
16	Tomato onion, stew	97 g	Custard, homemade	110 ml
17	Apple, raw	93 g	Tomato, onion stewed	100 g
18	Egg, fried	92 g	Banana, raw, peeled	82 g
19	Pear, raw	88 g	Peach, raw	69 g
20	Macaroni	61 g	Beef, loin	51 g

There were a few changes observed between the food consumption patterns of the QFFQ pre- and post-intervention. The changes were mainly the inclusion of foods of animal origin in the control group and their exclusion in the experimental group, but the inclusion of protein-rich food items was very low. The experimental group consumed a mean portion of 137ml of milk (11 on the list) and 92g of egg (18)

compared to the control group who consumed milk (217ml portion, 8), drinking yoghurt (114ml portion, 15) and 51g beef (20). The majority of the food items consumed by the participants were mainly carbohydrate-based. In the experimental group even more carbohydrate-rich foods were included compared to before the intervention. The carbohydrate-rich foods consumed by the experimental group included 451g stiff maize meal porridge (1), 251g soft maize meal porridge (6), 124g brown bread (12), 121g vetkoek (13), 117g white rice (15) and 61g macaroni (20). In the control group these foods included 268g stiff maize meal porridge (4), 225g soft maize meal porridge (6), 163g brown bread (10), 139g oats (12) and 137g samp (13). Tea appeared third and first on the lists of the experimental and control groups, respectively. The vitamin C intake still seemed to be very low. Besides the intake of oranges which appeared on the experimental group's list of the top 20 most frequently consumed foods after tea at number 9 (portion size 144g), no vitamin C-rich foods were consumed by the control group. No vegetables and only fruit still appeared on the top 20 lists for both groups. In the pre-intervention, the only vitamin A-rich fruit eaten were peaches, and in the post-intervention mangoes (8) on the experimental list and peaches (19) on the control group list. The fruit that appeared included mangoes (8), apples (17) and pears (19) for the experimental group, and apples (9), bananas (18) and peaches (19) for the control group.

Tomato and onion stew appeared at number 16 (portion size 97g) for the experimental group and 17 (100g portion size) for the control group. It is interesting that the FMM did not appear in the top 20 most frequently consumed food items of the experimental group after the intervention, but the FMM may have been included in the tomato and onion stew.

6.5.4.2 Food consumption patterns by amount as measured by 24-hour recall questionnaires

Table 36: Top 20 foods consumed by pregnant women pre-intervention (24-hour recall)

Number	Food item	Mean quantity per day: experimental group	Food item	Mean quantity per day: control group
1	Maize meal porridge, stiff	467 g	Maize meal porridge, stiff	422 g
2	Tea, brewed	280 ml	Tea, brewed	243 ml
3	Coffee, brewed, instant	275 ml	Cold drink, carbonated	243 ml
4	Milk, full cream	205 ml	Potato, boiled with skin	170 g
5	Tea, rooibos, brewed	186 ml	Coffee, brewed, instant	150 ml
6	Orange, raw, peeled	182 g	Rice, white, cooked	140 g
7	Samp	180 g	Beef, mince	140 g
8	Bread, brown	175 g	Spinach, boiled	125 g
9	Egg, poached	162 g	Oats, cooked	125 g
10	Chicken, boiled	158 g	Vetkoek	120 g
11	Oats, cooked	156 g	Bread, brown	118 g
12	Rice, white, cooked	151 g	Milk, full cream	117 ml
13	Beef, brisket	150 g	Beef, brisket	113 g
14	Cold drink squash	120 ml	Orange, raw, peeled	103 g
15	Potato, boiled	88 g	Banana, raw, peeled	94 g
16	Apple, raw	80 g	Egg, boiled	90 g
17	Banana, raw	76 g	Cabbage, fried	90 g
18	Cabbage, boiled	72 g	Chicken boiled	82 g
19	Potato chips	70 g	Apple, raw	80 g
20	Sausage, grilled	53 g	Potato chips	63 g

According to Tables 36 and 37, the food items consumed on the 24-hour recall lists differed greatly from those on the QFFQs. There was a greater consumption of foods of animal origin, namely 205 ml milk (number 4 on the list), 162 g egg (9), 158 g chicken (10) and 150 g beef brisket (13) for the pre-intervention experimental group, and 140 g beef mince (7), 113 g beef brisket (13), 90 g egg (16) and 82 g chicken (18) for the control group in Table 36. Most of the food items consumed were still carbohydrate-based for the experimental group, like 467 g stiff maize meal porridge (1), 180 g samp (7), 175 g brown bread (8), 156 g oats (11), followed by rice and potatoes. The control group's list of carbohydrate foods included 422 g stiff maize meal porridge (1), 170g potatoes (4), 140 g rice (6), 125 g oats (9), 120 g vetkoek (10), 118 g brown bread (11) and 63 g potato chips (20). Tea appeared second on the list. Fruit such as oranges (6), apples (16) and bananas (17) was consumed by the experimental group, and oranges (14), bananas (15) and apples (19) by the control group. Cabbage (82g portion) was the only vegetable consumed by the experimental

group and came in at number 18 on the list of most commonly consumed food items. The control groups included two vegetables, namely spinach at number 8 and cabbage at number 17.

Table 37: Top 20 foods consumed by pregnant women post-intervention (24-hour recall): experimental and control groups

Number	Food item	Mean quantity per day: experimental group	Food item	Mean quantity per day: control group
1	Maize meal porridge, stiff	557 g	Maize meal porridge, stiff	519 g
2	Chicken stew in tomato and onion	540 g	Maas	500 ml
3	Tea, brewed	300 ml	Milk, full cream	464 ml
4	Pumpkin, candied	297 g	Beans, dried, canned in tomato sauce	400 g
5	Beef, mince (regular)	280 g	Maize meal porridge, soft	349 g
6	Cold drink squash	275 ml	Tea rooibos, brewed	300 ml
7	Milk, full cream	271 ml	Pilchards in tomato sauce	293 g
8	Peas, split, cooked	250 g	Guava juice, sweetened	250 ml
9	Mabella	250 g	Cold drink, carbonated	250 ml
10	Potato chips	200 g	Coffee, brewed	250 ml
11	Beef, brisket	200 g	Vetkoek	240 g
12	Bread, white	168 g	Tea, brewed	231 ml
13	Chicken, roasted	163 g	Rice, white	179 g
14	Bread, brown	158 g	Potato, mashed	160 g
15	Rice, white	150 g	Apple, raw	150 g
16	Apple raw	150 g	Bread, brown	142 g
17	Egg, fried	137 g	Bread, white	135 g
18	Tomato onion stew	96 g	Spinach, boiled	125 g
19	Fried cabbage	93 g	Chicken, roasted	114 g
20	Gravy	86 ml	Cabbage, boiled	61 g

In the post-intervention trial the most commonly consumed food items remained the carbohydrate-rich foods, namely 557g stiff maize meal porridge (number 1 on the list), 250g mabella (9), 200g potato chips (10), followed by white and brown bread and white rice for the experimental group, compared to 519g stiff maize meal porridge (1), 349g soft maize meal porridge (5), 240g vetkoek (11), 179g white rice (13), followed by potatoes and brown and white bread for the control group. A bigger variety of food groups was consumed when measured by the 24-hour recall. In Table 37 it can be seen that the sample consumed more foods of animal origin. The experimental group consumed 540g chicken stew (2), 280g beef mince (5), 200g beef brisket (11), 163 g roast chicken (13) and 137g eggs (17); these were consumed by

some and not all of the respondents, compared to the control group that consumed only 293 g pilchards (7) and 114 g chicken (19). Vegetables such pumpkin (4), split peas (8) and cabbage (19) were consumed by the experimental group, and the control group consumed beans (4), spinach (18) and cabbage (20). The food items consumed by the experimental and control groups in the 24-hour recall intake had a higher iron content such as chicken, beef, fish, beans and spinach. Tea still appeared on the list (3) and (12) for the experimental and control groups, respectively. Legumes like beans appeared at number 4 on the control list. Vitamin A-rich vegetables such as pumpkin appeared at number 4 on the experimental list and spinach at 18 on the control list. Tomato and onion were again mentioned in the post-intervention as these could have been eaten with the FMM.

6.5.5 Dietary diversity

Dietary diversity is measured by quantifying the number of individual foods, referred to as the FVS and the number of food groups used as the FGDS (Ruel 2003:3912). The FVS and FGDS were calculated for the experimental and control groups pre- and post-intervention.

According to Tables 38 and 39, the total range of individual food items consumed by an individual during the one-week reporting period was 20–58 foods for the experimental group and 23–55 for the control group pre-intervention, and 27–66 foods for the experimental group and 23–49 foods for the control group post-intervention. The control group consumed less variety after the intervention as their range of foods decreased from 23-55 individual food items to 23-49 food items. One of the South African FBDGs states that it is important to eat a variety of foods. This message needs to reach the sample population.

The pre-intervention and post-intervention data were as follows:

Experimental group

The mean FVS (±SD) for the experimental group was 42,1 (±7,6) before the intervention, which improved to 46,7 (±10,3) after the intervention. Despite this improvement, the FVS indicated medium dietary diversity (30-60 food items) before and after the intervention. Before the intervention, the cereal group had the highest

mean FVS of 9,62 (±1,9), followed by the flesh foods group with a mean FVS of 6,73 (±2,0), other fruit group of 5,30 (±1,84), legumes and nuts of 4,73 (±1,04), dairy products of 4,51 (±1,4), other vegetables of 4,37 (±1,2), oils and fats of 3,80 (±1,2), vitamin A-rich foods of 2,86 (±0,9) and eggs of 1,0 (±0,0). This was similar after intervention with the three food groups showing the most diversity: the cereal group had the highest mean FVS of 9,75 (±2,3), followed by other fruit group with a mean FVS of 8,10 (±2,6) and flesh foods group of 6,60 (±1,2). The ingredients of the FMM product were added to the food groups, namely maize meal was added to the cereal group, powered milk was added to the dairy group, and peas, beans and peanuts were added to the legumes group. When studying the post-intervention for the experimental group, it can be seen that the mean FVS for the cereal group increased from 9,62 (±1,9) to 9,75 (±2,3), that of the dairy group increased from 4,51 (±1,4) to 4,9 (±1,2) and that of the legumes group increased from 4,73 (±1,04) to 5,40 (±1,3). This may have been as a result of the FMM that was consumed as the FMM included milk powder, maize meal, peas, peanuts and kidney beans. The highest number of individual food items consumed by an individual in seven days was 39 (Table 38) before the intervention and 52 after the intervention. The individual food variety improved after the intervention. The reason for this could be the inclusion of the FMM in their diets. The mean FGDS stayed the same, indicating a good food variety (–seven to nine groups). The majority of the respondents consumed eight to nine of the nutritious food groups before and after the intervention. Although the FGDS showed a good variety, this cannot be seen in isolation as FVS and food variety within the groups are also important.

The highest number of food items consumed was 52. A large number of the respondents consumed three to four food items in the cereal group. The fruit group included the most variety and this can be compared to the QFFQ in Table 34.

Although the mean number of food items consumed increased from 42,1 to 46,7, it stayed in the medium dietary diversity category. The cereal group had the highest mean FVS of 9,75 (±2,3). Table 42 shows the summary of the dietary diversity score among all nine food groups. The majority of the respondents could be classified (n = 20, 100 per cent) with high (using eight to nine) dietary diversity.

Control group

The mean FVS (±SD) for the control group was 38,9 (±10,5) before the intervention, which decreased to 35,8 (±8,39) after the intervention. No improvement in FVS was observed after the intervention, and the FVS indicated medium dietary diversity (30-60 food items). Before the intervention, the cereal group had the highest mean FVS of 9,17 (±2,71), followed by the fruit group of 6,94 (±2,5) and flesh foods of 6,22 (±1,52).

The highest number of individual food items consumed by an individual in seven days was 55 (Table 38) before the intervention and 47 after the intervention. The individual food variety decreased after the intervention. FVS decreased from 38,9 to 35,8. The majority of the respondents consumed seven to nine of the nutritious food groups before and six to nine of them after the intervention, although only one respondent consumed food items from six groups after the intervention. Although the FGDS showed a good variety, this cannot be seen in isolation as FVS and FV within the groups are also important.

The mean FVS (±SD) for the control group as shown in Table 41 was 35,8 (±8,4). This revealed as medium dietary diversity. In the post-intervention trial, the cereal group had the highest mean FVS of 7,8 (±2,1), followed by the fruit group of 6,94(±2,5), flesh foods of 6,22 (±1,52), vegetables of 4,17 (±1,8), dairy products of 3,50 (±1,5), vitamin A-rich foods of 3,28 (±1,1), oils and fats of 3,06 (±1,1), legumes of 2,46 (±0,6) and eggs of 1,0 (±0,0). Table 43 shows the summary of the dietary diversity score among all nine food groups. The majority of the respondents could be classified (n = 19, 100 per cent). Thus the dietary diversity of the control group deteriorated after the intervention.

Table 38: Food variety within food groups consumed pre-intervention trial (QFFQ)

Experimental group (n=37)										Control group (n=18)									
Cereal group n=8	Legume group n=5	Flesh foods group n=9	Egg group n=1	Dairy group n=6	Vegetable group n=7	Fruit group n=9	Vitamin A-rich group n=4	Fat group n=5	Total individual food items eaten from all groups n=54	Cereal group n=10	Legume group n=3	Flesh foods group n=6	Egg group n=1	Dairy group n=5	Vegetable group n=7	Fruit group n=10	Vitamin A-rich group n=5	Fat group n=4	Total individual food items eaten from all groups n=51
0 = 0	0 = 0	0 = 0	0 = 14	0 = 0	0 = 2	0 = 0	0 = 0	0 = 2	20 = 1	0 = 0	0 = 5	0 = 0	0 = 3	0 = 0	0 = 0	0 = 0	0 = 0	0 = 0	23 = 1
1 = 0	1 = 0	1 = 1	1 = 23	1 = 1	1 = 0	1 = 0	1 = 3	1 = 3	25 = 1	1 = 0	1 = 1	1 = 0	1 = 15	1 = 3	1 = 1	1 = 0	1 = 2	1 = 3	24 = 2
2 = 0	2 = 0	2 = 0		2 = 2	2 = 3	2 = 1	2 = 7	2 = 3	30 = 1	2 = 0	2 = 5	2 = 0		2 = 2	2 = 3	2 = 1	2 = 2	2 = 1	25 = 1
3 = 0	3 = 3	3 = 2		3 = 7	3 = 5	3 = 5	3 = 19	3 = 3	31 = 1	3 = 0	3 = 7	3 = 0		3 = 2	3 = 3	3 = 1	3 = 4	3 = 6	31 = 2
4 = 0	4 = 14	4 = 3		4 = 6	4 = 12	4 = 7	4 = 8	4 = 15	32 = 1	4 = 1		4 = 3		4 = 5	4 = 3	4 = 1	4 = 9	4 = 8	35 = 1
5 = 0	5 = 13	5 = 2		5 = 9	5 = 7	5 = 9		5 = 11	37 = 1	5 = 0		5 = 3		5 = 6	5 = 3	5 = 2	5 = 1		39 = 1
6 = 3	6 = 4	6 = 6		6 = 12	6 = 7	6 = 8			38 = 1	6 = 1		6 = 4			6 = 3	6 = 3			40 = 1
7 = 2	7 = 3	7 = 8			7 = 1	7 = 1			39 = 6	7 = 5		7 = 4			7 = 2	7 = 2			41 = 1
8 = 5		8 = 8				8 = 4			40 = 1	8 = 1		8 = 3				8 =1			43 = 1
9 = 6		9 = 6				9 = 1			41 = 1	9 = 1		9 = 1				9 =5			45 = 1
10 = 10		10 = 1				10 = 1			42 = 4	10 = 3						10 = 1			46 = 1
11 = 4									43 = 1	11 = 2						11 = 1			47 = 1
12 = 5									44 = 3	12 = 2									48 = 1
13 = 2									45 = 2	13 = 1									51 = 1
									46 = 1	14 = 1									53 = 1
									47 = 2										55 = 1
									48 = 1										
									49 = 1										
									50 = 4										
									51 = 2										
									58 = 1										

Low = 0-3 food groups or < 30 individual foods
Medium = 4-5 food groups or 30 – 60 individual foods
High = 6-9 food groups or > 60 individual foods

Table 39: Food variety within food groups consumed post-intervention trial (QFFQ)

Experimental group (n=20)										Control group (n=19)									
Cereal group n=8	Legume group n=5	Flesh foods group n=8	Egg group n=1	Dairy group n=5	Vegetable group n=7	Fruit group n=8	Vitamin A-rich group n=5	Fat group n=4	Total individual food items eaten from all groups n=51	Cereal group n=8	Legume group n=4	Flesh foods group n=8	Egg group n=1	Dairy group n=4	Vegetable group n=6	Fruit group n=9	Vitamin A-rich group n=5	Fat group n=4	Total Individual Food Items Eaten from all groups n=49
0 = 0	0 = 0	0 = 0	0 = 4	0 = 0	0 = 0	0 = 0	0 = 0	0 = 0	27 = 1	0 = 0	0 = 2	0 = 0	0 = 9	0 = 0	0 = 0	0 = 0	0 = 1	0 = 1	23 = 1
1 = 0	1 = 0	1 = 0	1 = 16	1 = 0	1 = 0	1 = 0	1 = 2	1 = 2	32 = 1	1 = 0	1 = 7	1 = 0	1 = 10	1 = 2	1 = 0	1 = 0	1 = 0	1 = 3	25 = 1
2 = 0	2 = 0	2 = 0		2 = 1	2 = 5	2 = 0	2 = 2	2 = 4	35 = 1	2 = 0	2 = 6	2 = 1		2 = 2	2 = 3	2 = 0	2 = 4	2 = 3	27 = 2
3 = 0	3 = 2	3 = 1		3 = 2	3 = 1	3 = 0	3 = 6	3 = 9	37 = 2	3 = 1	3 = 2	3 = 0		3 = 9	3 = 4	3 = 3	3 = 4	3 = 9	29 = 2
4 = 0	4 = 3	4 = 1		4 = 3	4 = 3	4 = 2	4 = 5	4 = 5	40 = 1	4 = 0	4 = 2	4 = 1		4 = 6	4 = 6	4 = 2	4 = 6	4 = 3	31 = 2
5 = 0	5 = 5	5 = 3		5 = 6	5 = 3	5 = 2	5 = 5		41 = 1	5 = 1		5 = 6			5 = 2	5 = 3	5 = 4		33 = 1
6 = 1	6 = 5	6 = 5		6 = 8	6 = 3	6 = 4			44 = 1	6 = 2		6 = 2			6 = 2	6 = 2			36 = 1
7 = 3	7 = 5	7 = 5			7 = 1	7 = 0			45 = 1	7 = 4		7 = 5			7 = 0	7 = 3			37 = 1
8 = 3		8 = 2			8 = 4	8 = 1			47 = 1	8 = 4		8 = 2			8 = 2	8 = 3			38 = 1
9 = 2		9 = 1				9 = 3			48 = 1	9 = 4		9 = 1				9 = 0			40 = 2
10 = 4		10 = 3				10 = 5			49 = 2	10 = 2		10 = 1				10 = 1			45 = 2
11 = 2						11 = 1			52 = 2	11 = 0						11 = 1			47 = 1
12 = 3						12 = 2			56 = 1	12 = 0						12 = 1			49 = 2
13 = 0									58 = 1	13 = 1									
14 =2									59 = 1										
									60 = 1										
									66 = 1										

Low = 0-3 food groups or < 30 individual foods
Medium = 4-5 food groups or 30 – 60 individual foods
High = 6-9 food groups or > 60 individual foods

Table 40: Summary of good variety within food groups pre-intervention trial

	Experimental group			Control group		
Food group	Mean	SD	Range of scores	Mean	SD	Range of scores
Flesh foods	6,73	2,02	1–10	6,22	1,52	4–9
Eggs	1,00	0,00	0–1	1,00	0,00	0–1
Dairy products	4,51	1,40	0–6	3,50	1,51	1–5
Cereals, roots and tubers	9,62	1,90	6–13	9,17	2,71	4–14
Legumes and nuts	4,73	1,04	3–7	2,46	0,66	1–3
Vitamin A-rich fruit and vegetables	2,86	0,85	1–4	3,28	1,13	1–5
Other fruit	5,30	1,84	2–10	6,94	2,51	2–11
Other vegetables	4,37	1,23	2–7	4,17	1,82	1–7
Oils and fats	3,80	1,23	1–5	3,06	1,11	1–4
Total food items	42,11	7,63	20–58	38,94	10,55	23–55

Table 41: Summary of good variety within food groups for experimental and control groups for post-intervention trial

	Experimental group			Control group		
Food group	Mean	SD	Range of scores	Mean	SD	Range of scores
Flesh foods	6,60	1,18	3–10	6,21	1,87	2–10
Eggs	1,00	0,00	0–1	1,00	0,00	0–1
Dairy products	4,90	1,21	2–6	3,00	0,94	1–4
Cereals, roots and tubers	9,75	2,31	6–14	7,84	2,14	3–13
Legumes and nuts	5,40	1,31	3–7	1,94	1,03	1–4
Vitamin A-rich fruit and vegetables	3,45	1,27	1–5	3,56	1,09	2–5
Other fruit	8,10	2,61	4–12	6,42	2,65	3–12
Other vegetables	4,85	2,23	2–8	4,21	1,78	2–8
Oils and fats	2,85	0,93	1–4	2,67	0,97	1–4
Total food items	46,70	10,26	27–66	35,84	8,39	23–49

Table 42: Summary of food group diversity pre-intervention trial

	Experimental group		Control group	
Number of food groups consumed (n=9)	Frequency	Percentage	Frequency	Percentage
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	3	8,1	1	5,6
8	12	32,4	6	33,3
9	22	59,5	11	61,1
Total	37	100	18	100

Table 43: Summary of food group diversity post-intervention trial

	Experimental group		Control group	
Number of food groups consumed (n=9)	**Frequency**	**Percentage**	**Frequency**	**Percentage**
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	1	5,3
7	0	0	1	5,3
8	4	20,0	8	42,1
9	16	80,0	9	47,4
Total	20	100	19	100

6.5.6 Nutrient intake

The main objective of this study was to improve the nutritional status of pregnant women. Tables 44 and 45 show the nutrient intake according to the QFFQ of the sample population before and after the intervention trial. The tables below will indicate if the nutritional intake improved in the food consumption patterns of the pregnant women.

The nutrients iron, vitamin B6, folate, vitamin B12, vitamin C and zinc were chosen for analysis for the following reasons:

- Iron

Iron was the main nutrient that was deficient in the sample population's diet as, can be seen in Chapter 4 where the study indicated that 41,7 per cent of the pregnant women were iron deficient and 50 per cent were suffering from IDA.

- Folate

Folate was chosen because the adequate intake of folate reduces the risk of NTDs. Megaloblastic anaemia is the latest stage of folate deficiency and may not be present until the third trimester (Mahan & Escott-Stump 2008:173).

- Vitamin B12

Vitamin B12 is needed for the activation of the folate enzyme. One of the symptoms of vitamin B12 deficiency is the anaemia of folate deficiency. The anaemia of folate deficiency is indistinguishable from that of vitamin B12 deficiency (Whitney & Rolfes 2010:332).

- Vitamin C

Vitamin C enhances iron absorption by converting it from ferric to ferrous (Whitney & Rolfes 2010:330).

- Vitamin B6

Vitamin B6 can improve the iron levels of pregnant women. Vitamin B6 deficiency is commonly associated with the high prevalence of anaemia in pregnancy (Hisano, Suzuki, Sago, Murashima & Yamaguchi 2010:223

- Zinc

According to Whitney and Rolfes (2010:436), zinc can also bind with transferrin, which binds with iron for transport in the blood.

Table 44: Nutrient intake of sample population pre-intervention (QFFQ)

		Experimental group (n=54)			Control group (n=33)			
Nutritional analysis	**Unit**	**Mean daily intake**	**Standard deviation**	**EAR< 100%**	**Mean daily intake**	**Standard deviation**	**EAR < 100%**	**#EAR for pregnant women**
Iron	Mg	13,6	7,7	87,5	13,0	5,7	94,4	22
Vitamin B6	Mg	1,7	0,9	62,5	1,8	1,3	61,1	1,6
Folate	µg	311,8	280,2	93,8	273,4	123,5	100	520
Vitamin B12	µg	8,9	13,9	18,8	5,4	3,9	11,1	2,2
Ascorbic acid	Mg	171,0	126,2	20,8	143,9	126,7	38,9	70
Zinc	Mg	10,8	5,1	42,2	11,1	6,8	44,4	9,5

Means < EAR
#EAR= Estimated average requirement (IOM 2003)

During the pre-intervention in Table 44, the QFFQ results showed that iron and folate intake was very poor among the experimental and control groups. The mean intakes were 13,6 mg (±7,7) and 311,9 µg (±280,2), respectively, for the experimental group. Although the mean vitamin B6 and zinc values showed sufficient intakes when

compared to the EAR for pregnant women, 62,5 per cent (for vitamin B6) and 42,2 per cent (for zinc) of the respondents in the experimental group showed intakes of less than 100 per cent. These results correspond to the top 20 foods that were commonly consumed as measured by the QFFQ (Table 34). Although the mean intakes for vitamins B12 and C were above the EAR, 18,8 per cent and 20,8 per cent of the respondents in the experimental group did not consume 100 per cent of the EAR for these nutrients, respectively.

The mean intakes were for iron 13,0 mg (±5,7) and folate 273,4 µg (±124), respectively, for the control group (Table 44). A greater number of respondents (94,4 per cent for iron and 100 per cent for folate) showed intakes of less than 100 per cent. Although the mean intakes for vitamin B12, vitamin B6 and zinc were above the EAR, 11,1 per cent, 61 per cent and 44 per cent of the respondents from the control group did not consume 100 per cent of the EAR of these nutrients, respectively. However, many more respondents from the control group did not meet the EAR for vitamin C (38,9 per cent) when compared to the experimental group of 20,8 per cent.

Table 45: Nutrient intake of sample population post-intervention (QFFQ)

		Experimental group (n=32)			Control group (n=24)			
Nutritional analysis	**Unit**	**Mean daily intake**	**Standard deviation**	**% of respon-dents with intake of <100% of EAR**	**Mean daily intake**	**Standard deviation**	**% of respon-dents with intake of <100% of EAR**	**#EAR for women**
Iron	Mg	29,6	15,3	35,2	32,4	14,9	33,3	22
Vitamin B6	Mg	4,1	3,0	13,0	4,4	2,3	15,2	1,6
Folate	Mg	624,3	371,3	46,3	621,7	315,4	42,4	520
Vitamin B12	Mg	19,3	37,7	3,7	24,4	36,0	3,0	2,2
Ascorbic acid	Mg	278,7	271,6	18,5	332,5	243,9	9,1	70
Zinc	Mg	24,4	15,0	7,4	31,1	21,8	3,0	9,5

#EAR= Estimated average requirement (IOM 2003)

During post-intervention there was a remarkable improvement in the iron and folate intakes (Table 45). All the nutrients measured improved after the intervention and the mean intakes for all these nutrients were above the EAR for both the experimental and control groups. Although the nutrient intakes seemed to have improved, a large

percentage of the respondents still showed deficient intakes of iron and folate for both the experimental and control groups, respectively.

There were significant changes observed between the pre- and post-intervention in the QFFQ. The percentage of respondents with intake less than 100 per cent of the EAR decreased from 87,5 per cent to 35,2 per cent for iron, 93,8 per cent to 46,3 per cent for folate in the experimental group, and from 94,4 per cent to 33,3 per cent for iron and 100 per cent to 42,4 per cent for folate in the control group. The reason for this could be the inclusion of the FMM for the experimental group and the soup powder for the control group.

Tables 46 and 47 show the nutrient intake according to the 24-hour recall questionnaires of the sample before and after the intervention trial.

Table 46: Nutrient intake of sample population pre-intervention (24-hour recall questionnaires)

		Experimental group (n=54)			Control group (n=33)			
Nutritional analysis	**Unit**	**Mean daily intake**	**Standard deviation**	**% of respon-dents with intake of <100% of EAR**	**Mean daily intake**	**Standard deviation**	**% of respon-dents with intake of <100% of EAR**	**#EAR for pregnant women**
Iron	Mg	6,9	5,2	97,8	7,3	3,6	100	22
Vitamin B6	Mg	0,8	0,6	89,1	1,01	0,5	76,5	1,6
Folic acid	µg	183,4	213,8	95,7	185,4	189,1	94,1	520
Vitamin B12	µg	2,7	4,5	54,3	3,2	4,5	41,2	2,2
Ascorbic acid	Mg	63,0	78,0	60,9	51,3	70,4	88,2	70
Zinc	Mg	6,9	4,3	74,4	7,6	3,7	76,3	9,5

Means < EAR
#EAR= Estimated average requirement (IOM 2003)

During the pre-intervention the results in Table 46 as measured by the 24-hour recall questionnaire showed that iron, vitamin B6, folate, vitamin C and zinc intake was poor among the experimental and control groups (table 46). The mean intakes were iron 6,9 mg (±5,2), folate 183,4 µg (±214), vitamin B6 0,8 mg (±0,6), vitamin C 63,0 mg (±78) and zinc 6,9 mg (±4,3). Ninety-eight per cent of the respondents in the experimental group and 100 per cent of the control group had an intake of less than

100 per cent of the EAR for iron compared to 96 per cent of the respondents in the experimental group and 94,1 per cent of the control group who had an intake of less than 100 per cent of the EAR for folate. The mean intakes for the control group were iron 7,3 mg (±3,6), folate 185,4 µg (±189,1), vitamin B6 1,01 mg (±0,5), vitamin C 51,3 mg (±70,4) and zinc 7,6 mg (±3,7). Although the mean vitamin B12 intakes were normal for both the experimental and control groups when compared to EAR, 54,4 per cent of the experimental group showed deficient intakes compared with 2,2 per cent in the control group.

Table 47: Nutrient intake of sample population post-intervention (24-hour recall questionnaires)

		Experimental group (n=32)			Control group (n=24)			
Nutritional analysis	**Unit**	**Mean daily intake**	**Standard deviation**	**% of respon-dents with intake of <100% of EAR**	**Mean daily intake**	**Standard deviation**	**% of respon-dents with intake of <100% of EAR**	**#EAR for women**
Iron	Mg	9,8	5,3	94,2	15,4	9,1	84,4	22
Vitamin B6	Mg	1,3	0,8	67,3	1,5	0,9	56,3	1,6
Folate	Mg	219,8	135,6	98,1	314,7	200,8	87,5	520
Vitamin B12	Mg	2,4	2,4	53,8	6,0	10,4	40,6	2,2
Ascorbic acid	Mg	37,5	36,0	75,0	42,6	68,2	78,1	70
Zinc	Mg	9,1	6,4	57,6	10,7	5,4	46,8	9,5

Means < EAR
#EAR= Estimated average requirement (IOM 2003)

When comparing the results it can be clearly seen that the mean daily intakes of all the nutrients increased in the QFFQ post-intervention results in Table 47. The iron and folate intakes improved according to the EAR for pregnant women. This was not the case in the results of the 24-hour recall questionnaire. The mean daily intake improved from 6,9 mg (±5,2) to 9,8 mg (±5,3) for iron from 183,4 µg (±213,8) to 219,8 µg (±135,6) for folate, but the mean intakes for vitamin C at 37,5 mg (±36,0) and zinc at 9,1 mg (± 6.4) still showed insufficient intakes of 75 per cent and 58 per cent when compared to the EARs. In the control group the mean daily intake also improved from 7,3 mg (±3,6) to 15,4 mg (±9,1) for iron and from 185,4 µg (±189) to 314,7 µg (±201). Although vitamin B12 was the only nutrient showing a mean intake

greater than the EAR before the intervention for both groups, after the intervention the mean vitamin B12 intake decreased from 2,7 mg (±4,5) to 2,4 mg (±2,4) in the experimental group. The mean intakes for vitamin B12 stayed the same before and after the intervention in the control group. The percentage of respondents with a deficient vitamin B12 intake, however, improved from 54,3 per cent to 53,8 per cent before and after the intervention in the experimental group. The following nutrients showed an improvement in the EAR after intervention: iron in the experimental and control group, vitamin B6 in both groups, folate in the control group, vitamin B12 in both groups, vitamin C in the control group and zinc in both groups.

It is acknowledged that the results of the 24-hour recall questionnaire differed greatly from the QFFQ. No tests were done to test for statistically significant differences between the results of the two dietary intake methods. The QFFQ measured usual intakes and the 24-hour recall measured only the intake during the previous day.

6.5.7 Anthropometry of pregnant women

The following anthropometric measurements were recorded for the experimental and control groups before, during and after the intervention programme:

- Height
- MUAC
- Pre-pregnancy weight
- Weight
- Waist measurement
- Hip measurement
- Age

Before the intervention the height and pre-pregnancy weight and age of the experimental and control groups were recorded.

According to Figure 26 and the BMI cut-off point of 24,9, 70 per cent of the experimental group were overweight (BMI 25-29,9) or obese (BMI >30) before falling pregnant.

Figure 26 shows that a large percentage of the respondents in the experimental group was overweight (39 per cent) and obese (31 per cent), respectively, whereas 26 per cent were in the normal weight (BMI -24,9) category. The control group showed a similar trend, but 25 per cent were overweight, 50 per cent were between overweight and obese, and 25 per cent were underweight (BMI <18,5) before the intervention.

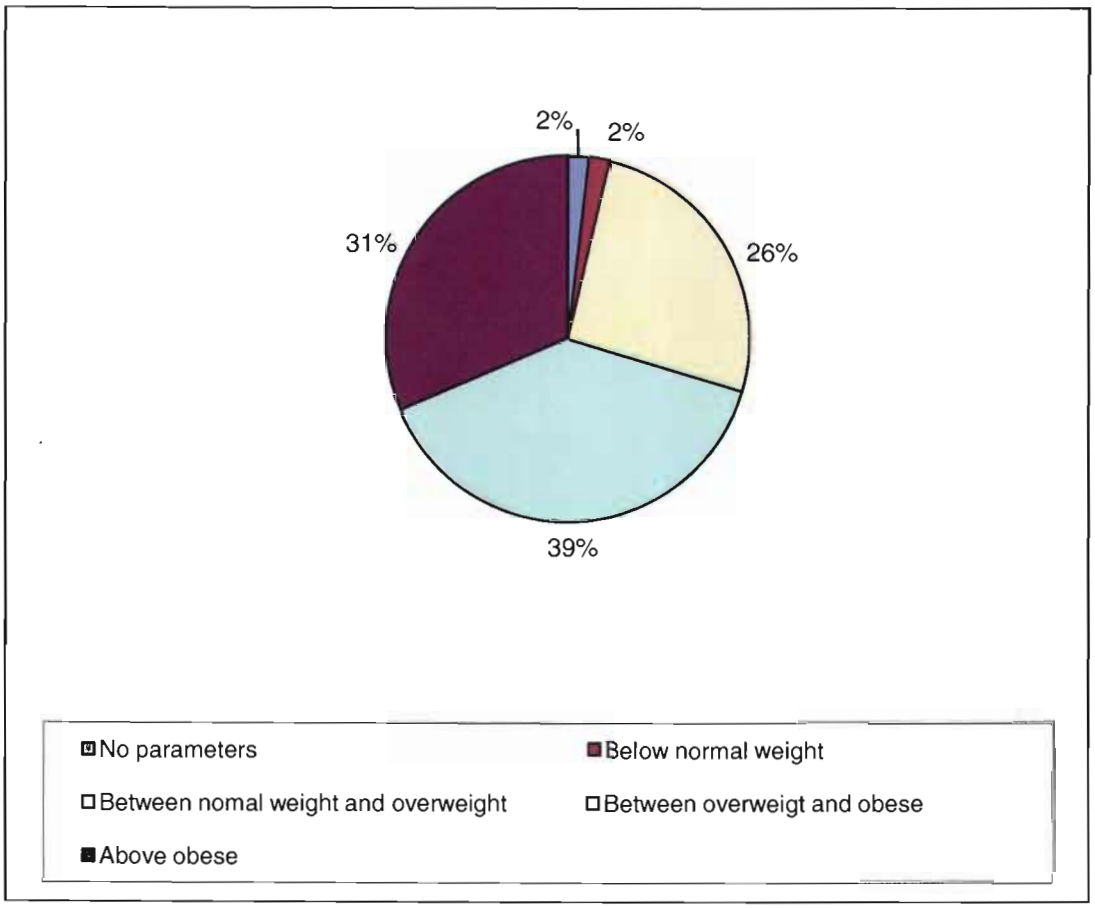

Figure 26: Weight distribution of pregnant women in experimental group

According to Figure 27 and the BMI cut-off point of 25, 75 per cent of the control group was overweight or obese before falling pregnant.

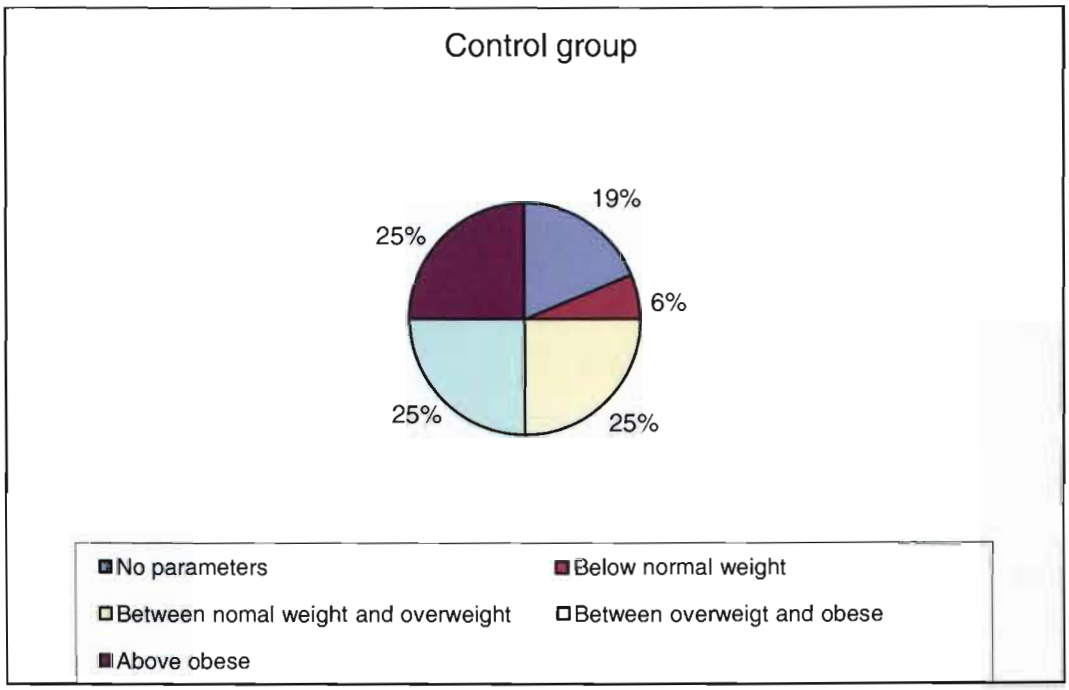

Figure 27: Weight distribution of pregnant women in control group

According to Mahan and Escott-Stump (2008: 163), women who are of normal weight prior to pregnancy should aim for a weight gain in the 11,3–15,9 kg range during pregnancy. Underweight women should gain weight in the 12,7–18,1 kg range. Women who are overweight prior to pregnancy should gain between 6,8 and 11,3 kg.

Healthy weight falls between a BMI of 18,5 and 24,9, with underweight below 18,5, overweight above 25 to 29,9, and obese above 30 (Whitney & Rolfes 2010:252).

Recommended weight gains for pregnant women based on pre-pregnancy BMI (Mahan & Escott-Stump 2008:165) are as follows:

- Underweight women should gain 2,3 kg in the first trimester and 0,49 kg in the second and third trimesters (weekly gain).
- Normal weight women should gain 1,6 kg in the first trimester and 0,44 kg in the second and third trimester (weekly gain).

- Overweight women should gain 0,9 kg in the first trimester and 0,3 kg in the second and third trimester (weekly gain).

Table 48: Anthropometric measurements of pregnant women, pre-, during and post-intervention trial

	Experimental group		Control group	
Variable	**Mean**	**SD**	**Mean**	**SD**
Weight (kg)				
Before intervention	71,2	19,5	70,6	20,3
During intervention	77,4	18,1	73,5	13,7
After intervention	84,5	23,5	75,4	13,6
MUAC (cm)				
Before intervention	28,5	6,9	26,6	7,3
During intervention	30,3	4,1	27,2	2,8
After intervention	35	20,2	28,6	2,4
Waist (cm)				
Before intervention	83,5	26,2	82,7	27,0
During intervention	103	9,1	99,8	7,5
After intervention	105	10,1	102	8,9
Hip (cm)				
Before intervention	106,1	24,9	92,3	38,6
During intervention	110,7	12,5	108,8	6,2
After intervention	111	11,9	110,9	7,5

According to Figures 26 and 27, the BMI of 70 per cent of the experimental group was between overweight and obese, and the BMI of 75 per cent of the control group was between overweight and obese. According to Table 48, the experimental group gained a mean of 6,2 kg in their first trimester and 7,1 kg between the second and third trimester. This is too high according to the recommended weight gain for pregnant women as per their pre-pregnancy weight.

The control group gained 2,9 kg in their first trimester and 1,9 kg between the second and third trimester. The weight gain was less than the experimental group but still high according to the recommended weight gain for pregnant women.

A person's waist circumference is a good indicator of fat distribution and central obesity. According to Whitney and Rolfes (2010:509), women with a waist circumference of greater than 88 cm have a high risk of central obesity-related health problems. The waist circumference of both the experimental and control groups was under the cut-off point of 88 cm.

There was a gradual increase in the MUAC and hip measurements. The experimental group's anthropometric measurement increased between pre- and post-intervention by 13,3kg in weight, 6,5cm in MUAC, 21,5cm in waist and 5cm in hip measurements. Those of the control group increased by 4,8kg in weight, 2cm in MUAC, 19,3cm in waist and 18,6cm in hip measurements. The experimental group gained more weight and centimetres in MUAC and waist measurements. The control group's hip measurement was greater than that of the experimental group. The pre-pregnancy BMI results showed that 70 per cent of the experimental group were overweight before pregnancy and 75 per cent of the control group were overweight before pregnancy. Women who are overweight prior to pregnancy should gain between 6,8 and 11,3kg. In this case the experimental group gained above the range and the control group below.

6.5.8 Biochemical status of pregnant women

The biochemical data is summarised in Table 49. Only the participants for whom the data were available at the end of the study were included, as post-intervention results for the dropouts were not included.

Table 49 shows the biochemical data for the experimental and control groups pre- and post-intervention. The data indicate that most of the biochemical values were within the normal range for both the experimental and control groups before the intervention, for red blood cell count, Hct and folate, but the experimental group also showed low MCV levels (<80-92 fl). The data shows that there was an improvement in the clinical levels of the experimental group, post-intervention in the following variables: iron, transferrin, Hb, Hct, MCV, folate and vitamin B12 and in the control group the following variables: iron, transferrin, red cell count, Hb, Hct, folate and vitamin B12. However, the MCV (76,5 ±5,6) and folate (4,8 ±5,6) levels were still low in both groups when compared with the normal ranges and after the intervention.

The results also show that the FMM had a positive impact on the iron status of pregnant women as the experimental group showed that 24,1 per cent of the respondents had low serum iron values (below the normal range) before intervention and 6,9 per cent after intervention. Fourteen per cent had low ferritin values (<12-160

ng/ml) before intervention and 5,2 per cent after intervention. Sixty-seven per cent had low transferrin values before intervention and 1,7 per cent after intervention. Nineteen per cent had low red cell count values (<4,5-6,5) before intervention and 10,3 per cent after intervention. Forty per cent had low haemoglobin values (<11,5-15,5 g/dl) before intervention and 20,7 per cent after intervention. Seventy-eight per cent had low haematocrit (<36-48 per cent) values before intervention and 13,8 per cent after intervention. Fifty-two per cent had low MCVs before intervention and 31 per cent after intervention. Sixty-seven per cent had low folate values before intervention and 60 per cent after intervention.

In the control group 16,6 per cent had low serum iron values before the intervention and 5,4 per cent after the intervention. Eight per cent had low ferritin values before intervention and none had low values after intervention. There was a big improvement in ferritin. Fifty-seven per cent had low transferrin values before intervention and none had low values after intervention. There was a big improvement in transferrin as well. Twenty-two per cent had low values of red cell count before intervention and 13,5 per cent after intervention. Forty-nine per cent had low haemoglobin values before intervention and 32,4 per cent after intervention. Thirty per cent had low haematocrit values before intervention and 13,5 per cent after intervention. Fourteen per cent had low mean cell volumes values before intervention and this remained the same after intervention. Seventy-one per cent had low folate values before intervention and 68,2 per cent after intervention. The respondents in both groups had normal vitamin B12 values during pre- and-post-intervention.

The experimental group showed statistically significant differences ($p \leq 0,05$) between pre- and post-intervention measurements in transferrin and haematocrit levels. The mean transferrin level before intervention was 2,05 g/L (±0,5) and 3,8 g/L (0,7) after intervention, and haematocrit before intervention was 30,9 per cent (±5,2) and 36,8 per cent (±4,3) after intervention. These are very favourable as transferrin circulates the iron in the blood through the body and this shows that the extra iron intake as contributed by the FMM may still have been in circulation to be further absorbed by the participants (Whitney & Rolfes 2010:428). The increase in haematocrit shows a

complete haemoglobin formation within the red blood cells (Whitney & Rolfes 2010:E18).

The control group showed a statistically significant difference ($p \leq 0,05$) between pre- and post-intervention measurements in the haematocrit levels. With the normal range being 36-48 per cent, the levels improved from 35,6 per cent (±4,9) to 40,5 per cent (±5,3).

The mean of the haematocrit levels of the experimental group pre-intervention at 30,9 per cent (±5,2) showed that the participants were anaemic and became normal post-intervention at 36,8 per cent (±4,3). The mean of the control group was borderline pre-intervention and became normal post-intervention. A possible reason for this could also be that some of the participants took supplements during pregnancy (Table 52), although Table 33 showed that majority of the women were not taking their supplements pre-intervention. During the pre-intervention period most of the women (66 per cent of the experimental and 88 per cent of the control group) mentioned that they were not taking supplements during that time, but it was only during that time that the women discovered that they were pregnant and could have started with their supplements in conjunction with the FMM. This could be the reason for the improvement in both groups.

Table 49: Biochemical results of experimental and control groups (pre- and post-intervention)

		Experimental group (n =54)				Control group (n = 33)			
		Before intervention		After intervention		Before intervention		After intervention	
Variable	**Normal range**	**Mean ± SD**	**% of partici-pants with low values**	**Mean ± SD**	**% of partici-pants with low values**	**Mean ± SD**	**% of partici-pants with low values**	**Mean ± SD**	**% of partici-pants with low values**
Iron (Fe) #	9,0–30,4 µmol/l	15,3 ± 7,1	24,1	16,9 ± 7,6	6,9	18,9 ± 14,2	16,2	31,6 ± 44,5	5,4
Ferritin (FER) #	12–160 ng/ml	51,8 ± 52,5	13,8	33,2 ± 21,7	5,2	34,5 ± 29,8	8,1	27,9 ± 20,8	-
Transferrin (Trf) #	2,0–3,6 g/L	2,05 ± 0,5[a]	67,2	3,8 ± 0,7[a]	1,7	2,4 ± 1,7	56,8	3,8 ± 0,7	-
Red cell count (RCC) #	4,5–6,5	4,1 ± 0,5	19,0	4,1 ± 0,4	10,3	4,0 ± 0,4	21,6	4,2 ± 0,5	13,5
Haemoglobin (Hb) #	11,5–15,5 g/dl	11,9 ± 1,9	39,7	12,0 ± 1,6	20,7	11,4 ± 1,5	48,6	12,4 ± 1,7	32,4
Haematocrit (Hct) #	36–48%	30,9 ± 5,2[a]	77,6	36,8 ± 4,3[a]	13,8	35,6 ± 4,9[a]	29,7	40,5 ± 5,3[a]	13,5
Mean cell volume (MCV) #	80–95 fl	74,7 ± 7,5	51,7	76,5 ± 5,6	31,0	84,7 ± 8,5	13,5	84,4 ± 7,0	13,5
Folate #	7–36 nmol/l	4,7 ± 3,4	67,3	4,8 ± 5,6	60,2	4,8 ± 4,3	71,1	5,2 ± 5,2	68,2
Vitamin B12 #	74–517 pmol/l	340,3 ± 204,2	-	426,5 ± 245,8	-	287,9 ± 141,3	-	372,1 ± 183,7	-

SD – Standard deviation

Brutis & Ashwood (2001)

[a] Statistically significant difference ($p \leq 0,05$) between pre- and post-intervention measurements

Biochemical status versus nutrient intake

Tables 50–51 below provide the summary of associations using Pearson's correlations. Correlation was considered to be present if r≥ 0 with a significance level of p≤ 0,05.

Table 50: QFFQ intake vs biochemical status

	Pre-intervention				Post- intervention			
	Experimental group		Control group		Experimental group		Control group	
Variable	R value	P value	R value	P value	R value	P value	R value	P value
Iron status# vs iron intake	-0,067	0,670	0,037	0,885	-0,332	0,084	0,412	0,183
Vit B12 status vs vit B12 intake	0,124	0,446	-0,051	0,840	-0,104	0,612	0,340	0,306
Folate status vs folate intake	0,281	0,079	-0,007	0,977	-0,138	0,503	-0,300	0,370

As measured by serum iron and Hb

Table 50 shows that there is no statistically significant association between dietary intake of iron, vitamin B12 and folate as measured by the QFFQ and the serum levels of these nutrients, respectively. Therefore no relationship between the dietary intake and blood results was found in this sample of pregnant women.

Table 51: 24-hour recall intake vs biochemical status

	Pre-intervention				Post-intervention			
	Experimental group		Control group		Experimental group		Control group	
Variable	R value	P value	R value	P value	R value	P value	R value	P value
Iron status# vs iron intake	-0,158	0,325	0,197	0,466	-0,055	0,770	0,336	0,286
Vit B12 status vs vit B12 intake	-0,007	0,969	0,286	0,321	-0,295	0,143	-0,631	0,037*
Folate status vs folate intake	-0,024	0,885	0,027	0,920	0,082	0,686	-0,194	0,568

As measured by serum iron and Hb

* Statistically significant association (p≤ 0,05) between nutrient intake and biochemical status

Table 51 shows that there is no statistical significance between dietary intake of iron, vitamin B12 and folate as measured by the 24-hour recall and the serum levels of these

nutrients, respectively, in both the experimental and control groups. However, there was a strong significant negative relationship between dietary intake of vitamin B12 and serum vitamin B12 levels in the control group after the intervention.

Table 52: Supplements taken by experimental and control groups

Experimental group			Control group	
Supplement/dose	FMM	Total*	Supplement/dose	Total
Ferrous sulphate: 30 mg per day	6,2 mg x 2 =12,4 mg	42,4 mg	Ferrous sulphate: 30 mg per day	30 mg
Folic acid tablets: 0,5 µg	76,5 µg	77 µg	Folic acid tablets: 0,5 µg	0,5 µg

* Supplement plus FMM = Total
*Folic acid plus FMM = Total

According to Table 52, both groups received iron and folic acid supplementation from the antenatal clinics. The supplementation levels were the same, but the dietary intakes of the experimental group were higher due to the iron and folic acid content of the FMM.

- **Blood pressure measurements**

Table 53 shows the percentages of the categories in which the respondents' BP fell. Low BP ranges from 90/60 mm Hg (low) to 140/90 mm Hg (high) and normal is 120/80 mm Hg (Mahan & Escott-Stump 2008:184). High BP is defined as high arterial BP which is the force exerted per unit area on the walls of the arteries. To be defined as hypertension, the systolic blood pressure, the blood pressure during the contraction phase of the cardiac cycle, has to be 140 mm Hg or higher, or the diastolic blood pressure, the pressure during the relaxation phase of the cardiac cycle, has to be 90 mm Hg or higher (Chobanian 2003:2560).

Table 53: Blood pressure measurements

	Experimental group		Control group	
Blood pressure	**Before intervention %**	**After intervention %**	**Before intervention %**	**After intervention %**
Below (<120/80 mm Hg)	61.8	40.0	54.8	68.8
High (>140/90 mm Hg)	14.5	12.0	19.4	18.8
Normal (120/80 mm Hg)	23.6	48.0	25.8	12.5

According to Table 53, the prevalence of respondents with high BP among both the groups dropped after the intervention, i.e. 14,5 per cent to 12,0 per cent in the experimental group compared with 19,4 to 18,8 per cent in the control group. Forty-eight per cent of the respondents in the experimental group had normal BP after the intervention compared to 23,6 per cent before the intervention. The opposite was observed in the control group where the percentage of respondents with normal BP decreased from 25,8 per cent to 12,5 per cent after the intervention. More respondents presented with low BP in both groups after the intervention.

6.5.9 Compliance

6.5.9.1 Number of packets

As discussed in 6.3.7, compliance was measured by counting the number of FMM bags left for the week, as well as the completion of the sensory evaluation questionnaire, which was completed by the pregnant women after the intervention programme to ensure that they had consumed the FMM.

The respondents in the experimental group each received 30 brown bags per month, but were given a two-week supply at a time (i.e. 15 brown bags). Each brown bag consisted of two 100 g packets of the FMM. The respondents in the control group each received 30 brown bags per month and were also given a two-week supply at a time (i.e. 15 brown bags). Each brown bag consisted of one packet of soup powder.

During the home visit at the beginning of the two-week cycle, the number of brown bags left, including the new supply of 15 bags, was recorded to test for compliance. The

results showed that the experimental group had an average number of 19 brown bags of the FMM, leaving them with an extra four brown bags, and the control group had an average of 17 brown bags of the soup powder, leaving them with an extra two brown bags. The women were questioned about the leftovers and also how they were preparing the powders. They claimed that they were definitely consuming the powders but sometimes ate the leftover food from the previous day and therefore had some powders left. They all claimed that they were following the preparation methods according to the recipe leaflets. The results show that the pregnant women were consuming the products and there was a control in the consumption of the FMM.

6.5.9.2 Sensory evaluation questionnaire (post-intervention)

Figures 28-32 illustrate the responses of the pregnant (experimental and control) respondents after the intervention programme (120 days).

Figure 28 shows that 75 per cent of the experimental group did not find the FMM in the soup form very appealing in appearance compared to 60 per cent in the control group.

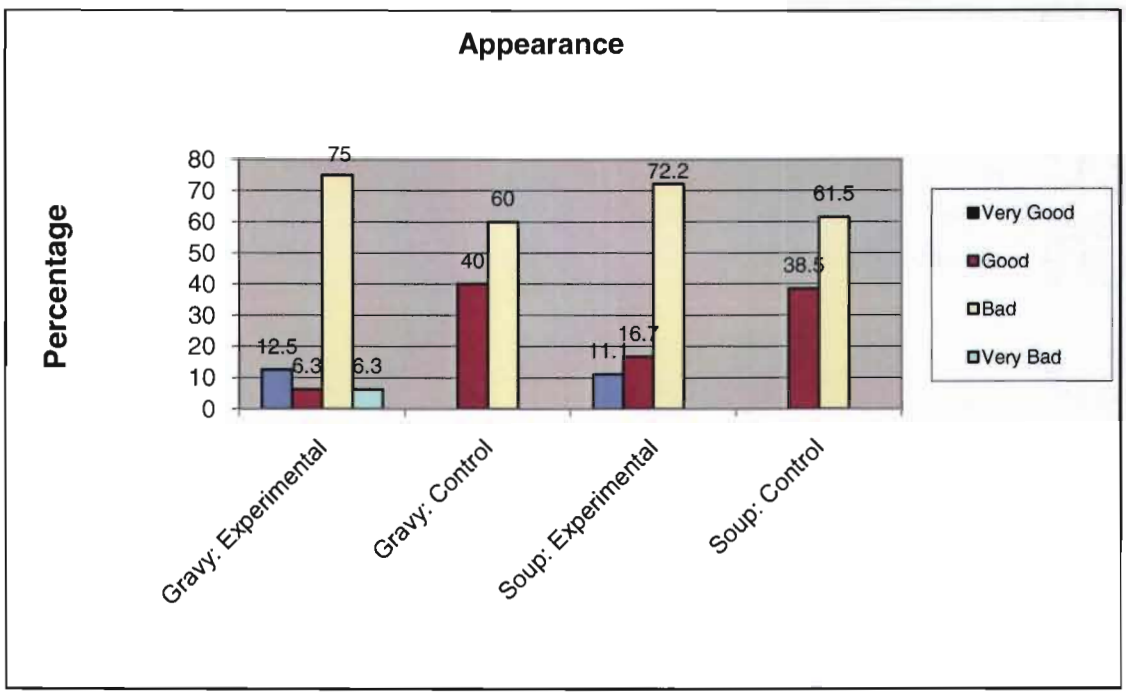

Figure 28: Appearance of FMM and soup powder post-intervention trial

Figure 29 shows that 66,7 per cent of the control group did not like the flavour of the soup powder in a gravy form.

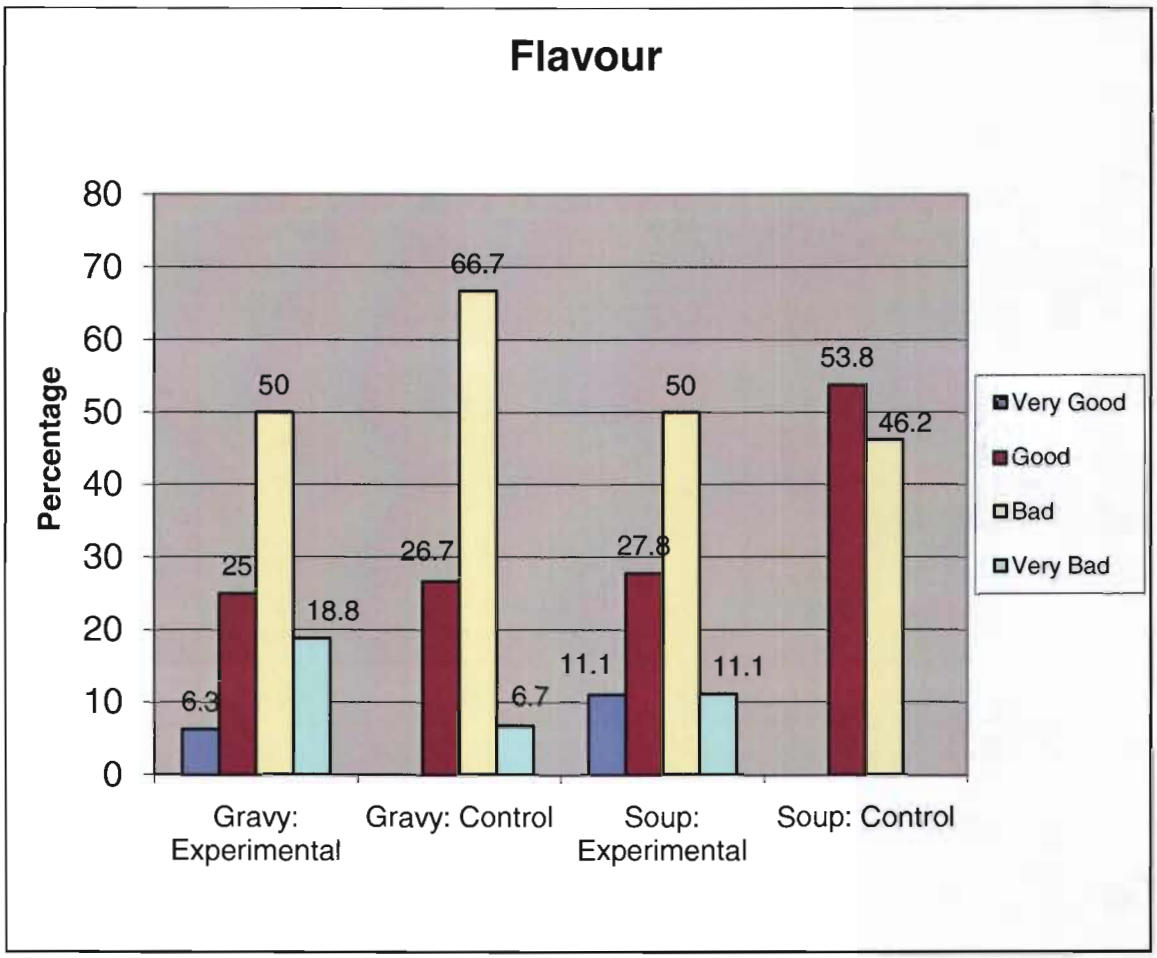

Figure 29: Flavour of FMM and soup powder post-intervention trial

Figure 30 shows that majority of the control group did not like the taste of the soup powder in either form, i.e. gravy (66,7 per cent) and soup (61,5 per cent). However, 31,3 per cent of the experimental group also disliked the taste of the FMM in the gravy (31,3 per cent) and soup (50 per cent) form.

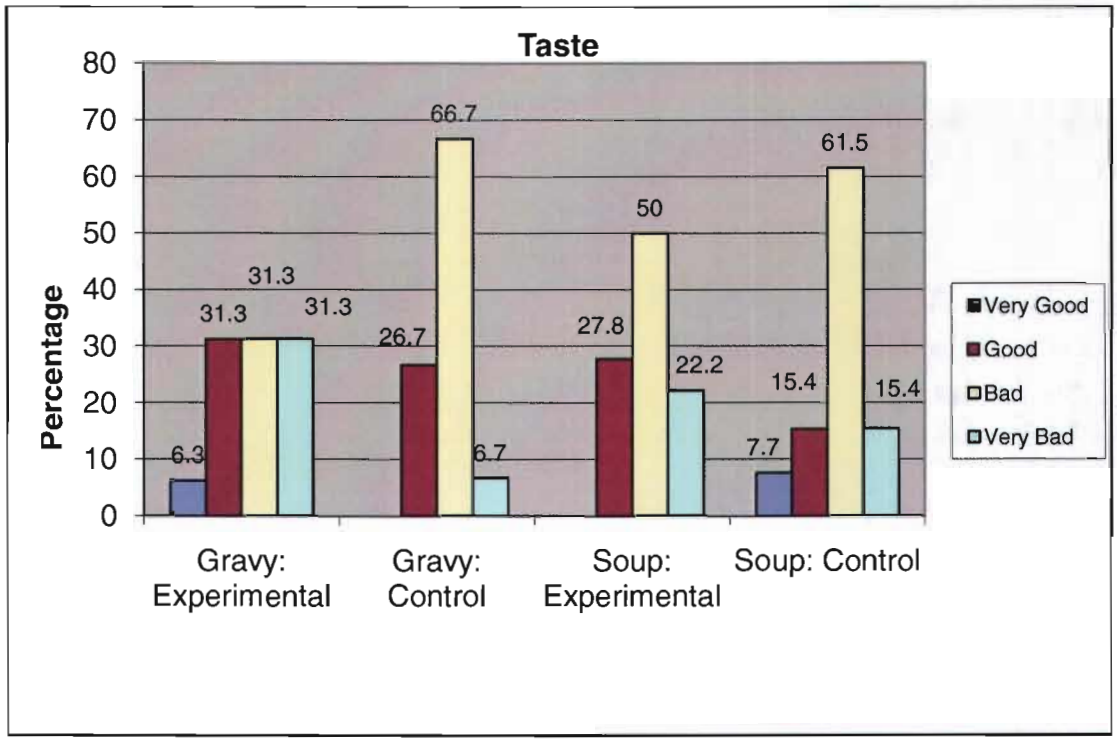

Figure 30: Taste of FMM and soup powder post-intervention trial

Figure 31 again shows that 73 per cent of the control group did not like the mouth feel of the soup powder in the gravy format. The experimental group did not like the feel of the FMM in the form of soup or gravy either.

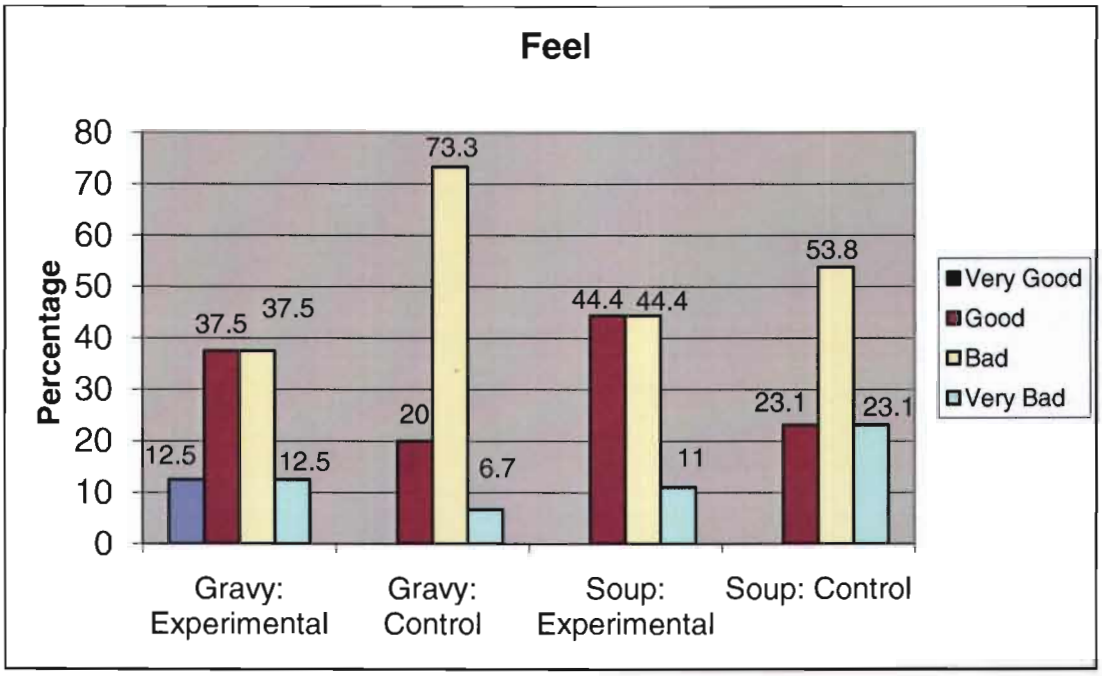

Figure 31: Feel of FMM and soup powder post-intervention trial

Figure 32 shows that neither the experimental group (50 per cent for the gravy and 22,2 per cent for the soup) nor control group (57 per cent for the gravy and 53 per cent for the soup) liked the smell of the products.

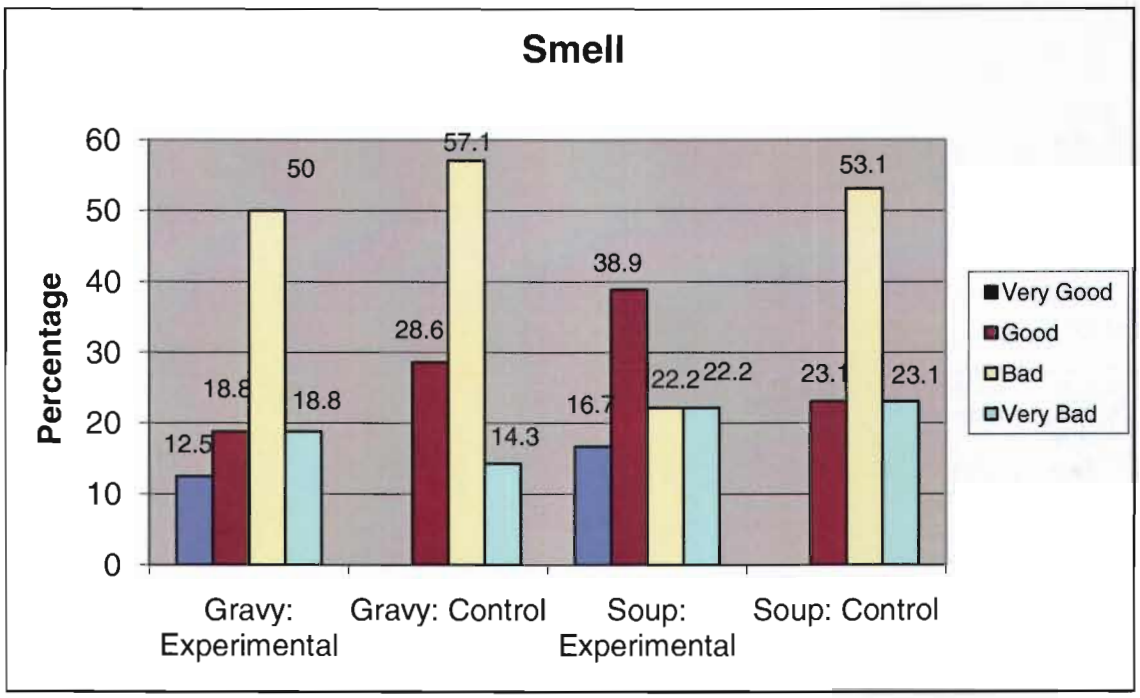

Figure 32: Smell of FMM and soup powder post-intervention trial

In general, the FMM was not very acceptable to the experimental group. Similarly, the soup powder was not acceptable to the control group in both the gravy and soup format. The results of the sensory analysis when compared to the results in section 5.4.7 clearly show that before intervention when the products were tasted for the first time they were easily accepted by the respondents and that eating the products daily for 120 days led to menu fatigue. This gives an indication that the respondents consumed the FMM and therefore could respond honestly about the FMM, be it positive or negative.

6.5.10 Birth data

Table 54 below gives an indication of the birth data available at the clinics of the experimental and control groups.

Twenty women from the experimental group and 19 women from the control group had given birth by the end of the intervention period. The data below were taken from the clinic records. Table 54 indicates that 75 per cent of the experimental group had given birth to girls and 53 per cent of the control group had boys. The majority of the participants from both groups had a normal delivery. The clinic sisters indicated that all the women had carried their babies to full term (38-40 weeks).

According to the data below, the babies' Apgar scores were relatively good as their scores ranged between 8 and 10. The majority of the placenta weights of the participants (79 per cent) showed average weights (500-700 g). Mothers of bigger babies had heavier placentas. Table 54 indicates the weight of the babies, the majority of whom weighed between 3,0 kg and 3,9 kg, which is a healthy weight and therefore a placenta weight of 500–700 g is appropriate.

Table 54: Birth data

	Experimental group		Control group	
Birth data variable	**N=20**	**%**	**N=19**	**%**
Gender of baby				
Boy	5	25	10	52,6
Girl	15	75	9	47,3
Delivery				
Normal	19	95	17	89,4
Caesarean	1	5	2	10,5
Apgar score (1 min)				
7	2	10	5	26,3
9	18	90	15	78,9
Apgar score (5 min)				
9	6	30	8	42,1
10	14	70	11	52,6
Placenta (g)				
500–700	11	55	15	79,0
750	1	5	-	-
Missing	8	40	4	21,0
Physical status at discharge (mother)				
Good	11	55	10	52,6
Missing	9	45	9	47,3

Birth measurements of babies from both the experimental and control groups, including the weight, length of babies and head circumference of babies, are given in Table 55 below. According to the data, the measurements of the babies were all good and healthy. The average weight of a newborn baby is 3,4 kg. Anything between 2,5 kg and 4 kg is considered as normal weight. The average length of the babies was 50 cm. The results of the experimental and control groups were very similar.

Table 55: Birth measurements of babies

	Experimental group		Control group	
Variable	**Mean**	**SD**	**Mean**	**SD**
Weight (kg)	3,0	0,401	3,9	2,7
Length (cm)	50	3,9	50	4,4
Head circumference (cm)	33,1	1,5	34,1	1,2
Mother's weight after birth (kg)	76,6	20,7	75,9	12,9

6.6 Discussion

A recent study conducted by Oldewage-Theron and Slabbert (2010) described the Vaal as a region in which 48 per cent of the population are unemployed and 46 per cent of the

households live in poverty. This description fits in well with the socio-demographic data of this study, where most of the pregnant women who participated in this study were unemployed (78 per cent of the experimental group and 75 per cent of the control group) and the majority of the respondents in both groups had a household monthly income of less than R2 000. Sixty-one per cent of the experimental and 53 per cent of the control group were between the ages of 21 and 30 years. According to Bretherick *et al.* (2010:2167), babies born to women older than 35 are at increased risk of preterm births and LBWs. This was also found by Mamabolo *et al.* (2006:120), who state that the increase in the risk of premature delivery and IUGR is associated with women who are younger than 20 and older than 35 years of age. In the present study only 6 per cent of the experimental group and 9 per cent of the control group were older than 36 years of age. The majority of the experimental group had Grade 10 and the majority of the control group had a Grade 12 as their highest qualification and most were Sotho speaking. In the present study, the fact that the women had secondary education and were Sotho speaking was of great benefit to the study because they were able to understand the need for and benefit of the study. The fieldworkers being mostly Sotho speaking helped in communicating with the respondents. The respondents all fell within the inclusion criteria of the study, namely the age group between 16 and 35 years old, being pregnant either in the first or second trimester, monthly income of less than R3 000 and residing in the Vaal region.

The sample chosen for this study was relatively healthy from the onset of the intervention trial. They did not suffer from any chronic diseases. Eighty-four per cent of the experimental group and 91 per cent of the control group never smoked. This proved positive for the respondents as smoking during pregnancy is related to LBW and IUGR, as well as childhood asthma (Grazuleviciene *et al.* 2009:1286; Moshammer *et al.* 2006:1260). The majority of the respondents did not consume alcohol, which was a good thing as a study conducted by Ervalahti (2007:2920) shows that foetal alcohol syndrome and lower Apgar scores are associated with maternal alcohol consumption. The BP measurements improved among the experimental group and 48 per cent of the respondents' BP became normal. The percentage of low BP improved as well. The

control group showed an increase (12,5 per cent) in normal BP post-intervention and an increase in low BP (68,8 per cent) as well. These results are positive because there was a drop in the percentage of high BP among the respondents as only 12 per cent of the experimental group and 19 per cent of the control group respondents suffered from high BP. In the current study none of the respondents suffered from gestational diabetes and this again was good as, according to Hedderson and Ferrara (2008) who conducted a study in Northern California, women who suffer from gestational diabetes have a greater risk of hypertension and preterm delivery.

According to the nutrient intakes of the QFFQ, indicating usual dietary intakes, the dietary iron intake levels of 87,5 per cent of the experimental group and 94 per cent of the control group fell below the EAR before intervention. After intervention this improved in that the iron intakes of 35,2 per cent of the experimental group and 33,3 per cent of the control group fell below the EAR. This can be compared to the top ten items consumed by the experimental group during pre- and post-intervention which consisted mostly of carbohydrates. Food containing iron absorption inhibitors such as tannin in tea and phytates in maize meal and bread were among the top ten foods listed. Chicken appeared at the lower end of the top ten list in the experimental and control groups. According to Whitney and Rolfes (2010), meat, fish and poultry contain not only the well-absorbed haeme iron, but also a peptide (called the MFP factor) that promotes the absorption of non-haeme iron from other foods eaten at the same meal. Vitamin C also enhances non-haeme iron absorption from foods eaten in the same meal by capturing the iron and keeping it in the reduced ferrous form, ready for absorption. Oranges were seen as number 3 on the pre-intervention list and number 9 on the post-intervention top 10 list. The vitamin C intake of 21 per cent of the experimental group and for 39 per cent of the control group fell below the EAR during pre-intervention. This improved the most by intervention in that the vitamin C intake fell below the EAR for pregnant women for 18,5 per cent of the experimental group and 9,1 per cent of the control group. Vitamin C consumption as well as the inclusion of the FMM could also be the reason for the improvement in the iron levels. During post-intervention, in both the QFFQ and 24-hour recall questionnaires the respondents consumed tomato and onion stew which could be

consumed with the FMM. According to the nutrient intake analysis, the iron and folate intakes improved in the post-intervention data of the experimental and control groups.

Optimal nutrition promotes good health status and dietary diversity and variety of foods promote enjoyment and adequate nutrition (Clausen *et al.* 2005). The highest number of individual food items consumed by an individual in seven days was 39 before the intervention and 52 after the intervention among the experimental group. The individual food variety improved after the intervention. The reason for this could be the inclusion of the FMM in their diets. The mean FGDS stayed the same, indicating a good food variety (seven to nine groups). The majority of the respondents consumed eight to nine of the nutritious food groups before and after the intervention. The mean FVS (±SD) for the control group was 38,9 (±10,5) before the intervention, which decreased to 35,8 (±8,39) after the intervention. No improvement in FVS was observed after the intervention, as the FVS indicated medium dietary diversity (30-60 food items). Pregnant women need variety in their diets because what a woman consumes during her pregnancy has a huge impact on the formation of the baby. Dietary diversity is very important before and during pregnancy. Ensuring good nutrition during pregnancy like eating a variety and a combination of healthy foods will result in a nutrient-dense diet, leading to a positive birth outcome (Whitney & Rolfes 2010:504).

During pre-intervention, according to the anthropometric results, 70 per cent of the experimental group and 75 per cent of the control group fell between the range of being overweight and obese prior to pregnancy. The experimental group gained 6,2 kg in their first trimester and 7,1 kg between the second and third trimester. This is too much according to the recommended weight gain for pregnant women. The control group gained 2,9 kg in their first trimester and 1,9 kg between the second and third trimester. The weight gain was lower than the experimental group but still high according to the recommended weight gain for pregnant women. Ward *et al.* (2007:116) found in their study conducted at the Potchefstroom Primary Health Care Clinic that pre-pregnancy BMI was associated with hypertension, and being overweight and obesity were both associated with hypertensive complications, induced labour and macrosomia. Another study conducted in South Africa by Puoane, Fourie, Shapiro, Rosling, Tshaka and

Oelofse (2005:10) has shown that among women, being overweight is often perceived to be attractive by the black community and is associated with respect, dignity and affluence. In the current study, although the respondents were overweight or obese during the onset of their pregnancies, the birth outcomes were positive. There were no reports of hypertensive complications, induced labour or macrosomia.

The pilot study in Chapter 4 confirmed that ID was prevalent within pregnant women in the Vaal region and the pre-intervention biochemical measurement in the current study also showed that the sample population was iron deficient. The post-intervention shows that there was an improvement in most of the iron variables. The experimental group showed statistically significant differences ($p \leq 0,05$) between pre- and post-intervention measurements in transferrin and haematocrit levels. The control group showed a statistically significant difference ($p \leq 0,05$) between pre- and post-intervention measurements in the haematocrit levels. A study conducted by Bopape *et al.* (2008:332) found that maternal mortality, preterm delivery and LBWs are associated with ID. Another study conducted by Lee *et al.* (2006) reported on the prevalence of IDA in Korean pregnant women. The study concluded that women with low Hb levels had babies with lower birthweight, height and Apgar scores. Even though in the current study 21 per cent of the experimental group and 32 per cent of the control group had Hb levels below the normal range of 11,5–15,5 g/dl post-intervention, none of the respondents experienced any negative birth outcomes.

Forty per cent of the experimental group had low haemoglobin values before intervention and 21 per cent after intervention. Sixty-seven per cent had low folate values before intervention and 60 per cent after intervention. Forty-nine per cent of the control group had low haemoglobin values before intervention and 32,4 per cent after intervention. Seventy-one percent had low folate values before intervention and 68.2 per cent after intervention. Folate deficiency is associated with NTDs and spina bifida. Grewal *et al.* (2009:117) also report that congenital birth defects such as cleft lip and palate are associated with folate deficiencies during pregnancy. The current study reported that during post-intervention 60 per cent of the experimental group and 68.2 per cent of the control group were folate deficient. Although none of the above defects were

reported in the study, this deficiency is of concern because some of these defects are only diagnosed later in infancy.

The improvement in the iron and folate status was evident for both the experimental and control groups, but even more so with the experimental group that consumed the FMM. The reasons for the improvement could be as follows:

- The correct form of consumption of the FMM by the pregnant women, which was ensured by the compliance tests, i.e. the sensory evaluation forms and home visits. A study conducted by Seck and Jackson (2009: 486) also found that providing free iron/folic acid tablets to pregnant women improves compliance. In this study because of incorrect street addresses and to avoid home visits, the women were asked to bring their bottle of tablets to the clinics for counting.
- More iron is normally absorbed when stores are empty and less is absorbed when stores are full (Whitney & Rolfes 2009:425).
- Iron and folic acid supplements were given to the women by the clinics but the majority claimed that they had not taken them before intervention. The reason for this could be that the women had just found out that they were pregnant during that time and took their supplements afterwards. Patterson *et al.* (2001:653) found higher ferritin and Hb levels among Australian women who were taking supplements compared to those who were not.

No relationship between dietary intake and blood results was found in the experimental sample of pregnant women, except for a strong significant negative relationship between dietary intake of vitamin B12 and serum vitamin B12 levels in the control group after the intervention. The respondents in both groups had normal vitamin B12 values at pre- and post-intervention. Kruger *et al.* (1994) reported in their study that the prevalence of vitamin B12 deficiency was not common among pregnant women in the Cape Peninsula. They also reported that it takes about five to six years for the deficiency in vitamin B12 to appear after restriction of vitamin B12 dietary intake. Patel, Lamparelli, Sacks, Breeds, MacPhail and Bothwell (1992:31) also found a lower prevalence of biochemical vitamin B12 deficiency among pregnant women attending antenatal care at Baragwanath Hospital.

All the babies born to the mothers of both the experimental and control groups were healthy and all measurements fell within the normal range. Lee *et al.* (2006:1134) report the association between low maternal Hb level and Apgar score as less than 5 at 1 minute, which is an index of the health status of newborn babies. This was not the case in the present study. Although the pregnant women's Hb results showed that 39,7 per cent fell below the normal range before intervention and 20,7 per cent after intervention, the babies' Apgar scores were mainly between 7 and 9 at 1 minute and 9 and 10 at 5 minutes.

6.7 Conclusion

ID is the most common nutrient deficiency and IDA affects more than 1.6 billion people worldwide. Almost half of these sufferers are pregnant women and school children. ID is also common amongst overweight people (Brown 2009:23).

The results of the pilot study and intervention study show that the pregnant women in the Vaal region are iron deficient and also overweight. One of the main reasons for obesity is their high carbohydrate-based diet and lack of physical activity: 49 per cent of the experimental and 56 per cent of the control group reported doing moderate levels of physical activity before pregnancy. This study showed that food insecurity still exists in their households as most of the pregnant women were unemployed and came from lower income households. A study conducted by Malhotra, Hoyo, Ostbyte, Hughes, Schwartz, Tsolekile, Zulu and Puoane (2008:316) on the determinants of obesity in Cape Town also found that 51 per cent of the women who were found to be obese in their study were unemployed and 72 per cent of the households earned less than R1 600 per month. This could also be an explanation of the weight problem experienced by the respondents in this current study.

The objective of this study was to determine the impact of dietary diversification on the nutritional status of pregnant women in the Vaal region. The experimental group consuming the FMM showed an improvement in the FVS scores as well as biochemical status, specifically the transferrin and haematocrit levels when compared to the control

group. It can thus be concluded that the nutritional status of the pregnant women did improve with consumption of the FMM and that this also had an impact on dietary diversity. There was also an improvement in the control group's nutritional status and their babies were born healthy. The reason for this could be their inclusion in the research project and the attention given to these women by the clinic sisters and researchers. The placebo effect of the soup powder could have also been a reason as this made the women more conscious of taking care of themselves during pregnancy. Though the nutritional status of the control group improved, the soup powder still had a high salt content which would not be suitable for consumption by pregnant women for longer periods.

Chapter 7

Discussion, conclusions and recommendations

7.1 Discussion

7.1.1 Objectives

The major objectives of this study were to:

- Determine the socio-demographic status, nutritional status, dietary intake, food consumption patterns and biochemical and haematological measurements of pregnant women in the Vaal region

- Formulate an FMM which would address micronutrient deficiencies and to develop recipes including the mix in the diet of the women

- Assess the impact of consumption of the multimix on nutritional status of pregnant women and the outcomes of their pregnancy in an intervention study

- Assess the impact of the consumption of the multimix on the dietary diversity of the pregnant women participating in this study

This study was motivated by the high prevalence of ID within pregnant women in the Vaal region.

7.1.2 Limitations of the study

The first limitation of this study was in the formulation of the FMM. The criteria for the formulation were to meet 20 per cent of the RDA (Food and Nutrition Board 1989) for iron, folate and protein. The chemical analysis showed that the FMM developed contained 21 g of protein (35 per cent of the RDA). The 20 per cent RDA criterion for protein was thus met. The nutritive value for iron was 4,2 mg, thus only meeting 14 per cent of the RDA. The folate content was 40 μg, therefore meeting 10 per cent of the RDA. It was very difficult to meet the 20 per cent criterion for both macronutrients and

micronutrients. The RDA for iron and folate was not met in the multimix. This was due to the fact that re-analysis was done theoretically, but chemically the optimisation of the FMM could not be done because of the cost factor and the fact that the VUT chemical analysis equipment (AAS machine) broke down during analysis and the FMM had to be sent to ARC for chemical analysis, which was too costly.

The second limitation was the dropout rate of 36 per cent in the study. The main reason for this was the incorrect addresses given by the women. The clinics are zoned for a specific area and therefore women had to live in that area to qualify to visit that clinic. The given addresses belonged to other people so that the women could visit those particular clinics, and this problem also affected the home visits for compliance tests. The post-intervention groups were small, but there were still a few statistically significant clinical results.

The third limitation was in the completion of the post-intervention QFFQ and 24-hour recall questionnaires where there was no mention of the consumption of the FMM, as the questionnaires did not contain information on the FMM. It was therefore assumed that the FMM was consumed in the form of soup or gravy.

The fourth limitation was menu fatigue. In the post-intervention sensory analysis the women claimed that they disliked the taste of the soup and gravy made from the FMM. This information showed that the women did consume the FMM until the end, but more recipes could have been developed to prevent menu fatigue.

7.1.3 Main findings

The significant findings of this study are presented below:

The South African Health Review (Health Systems Trust 2006:114) estimates that the maternal mortality ratio is 150 per 100 000 live births for South African women. Severe anaemia during pregnancy increases the risk of maternal mortality. According to Engmann *et al.* (2008:62), ID is prevalent in low-income countries and poverty is the

biggest problem. Lack of purchasing power to afford foods containing haeme iron or to afford transport costs for pregnant women to access antenatal services all co-exist in poor households where there is anaemia. The cause of anaemia is associated with nutritional deficiencies of iron, folate and vitamin B12 (Abdelrahim *et al.* 2009:495).

According to Heleigh (2006:3), a strategy designed to reduce exposure to risk by combining a variety of investments is food diversification. A practical and long-term measure to eliminate and prevent micronutrient deficiencies is diversification in the diet. Activities that improve production, availability and access to micronutrient-rich and locally produced foods are a major focus of this type of intervention. The inclusion of an FMM is a theoretical strategy that can be implemented as part of food diversity.

The pilot study in 2001 found that ID was prevalent in the Vaal region with 50 per cent of pregnant women suffering from IDA. The majority of the women were unemployed and came from low-income households where food insecurity existed. Therefore in this study a cost-effective, culturally acceptable and nutrient-dense FMM was developed based on the local food staples.

The formulation criteria for the FMM were as follows: The first criterion was to develop a nutrient-dense FMM that would meet 20 per cent of the RDA for protein, iron and folate for pregnant women. The second criterion was that the amount that pregnant women were prepared to spend on extra food, snacks or supplements was R1,75 per day (Kesa 2001) and this amount was used as the cost criterion. The third criterion was that the FMM had to be culturally acceptable to the pregnant women. The affordability criterion was met as the FMM cost R0,82 per 100 g. The cultural acceptability criterion was also met as most of the ingredients chosen for the FMM were available in the households of the pregnant women and the pre-intervention sensory analyses showed that the FMM and the recipes were acceptable to the pregnant women for consumption. However, the 20 per cent of the RDA for iron and folate could not be met; the iron content met 14 per cent of the RDA and folate met 10 per cent of the RDA. The study proved that it is very difficult to meet the 20 per cent criterion for both macronutrients

and micronutrients. Optimisation was done to try and improve the folate content, but as stated in the limitations of this study, this could not be re-analysed chemically.

The socio-demographic data proved positively that the women all met the inclusion criteria of the study, namely the age group between 16 to 35 years old, being pregnant either in the first or second trimester, monthly incomes of less than R3 000 and residing in the Vaal region. The income earned contributed to the household food insecurity that resulted in a malnourished sample population. Food was purchased once a month and the majority said that sometimes they had insufficient funds to purchase food.

Being overweight or obesity was found to be a problem in the study as 70 per cent of the experimental group and 75 per cent of the control group fell between the overweight and obese range before falling pregnant. The reason for this could be the lack of physical activity as the majority of the women did only moderate exercise. The diet, however, could have played a big role in this, as the top 10 food items consumed by the sample were mostly carbohydrate-based foods. The pre-intervention micronutrient intakes were low, but showed an improvement in the experimental group: iron (16 mg), folate (312,5 µg) and vitamin B12 (10,2 mg), and in the control group: iron (19,4 mg), folate (348,3 µg) and vitamin B12 (19 mg). The study showed a high dietary diversity score for the experimental group pre- and post-intervention of seven to nine and a medium FVS of 42,1 and 46,7, and for the control group a high dietary diversity score of six to nine and a medium FVS of 38,9 and 35,8.

According to the biochemical and haematological results, the iron status of the sample improved and showed slightly statistically significant improvements. The results also show that the haematocrit levels of the experimental and control groups were very similar. The mean of the haematocrit levels of the experimental group pre-intervention suggested that the participants were anaemic and became normal post-intervention. The mean of the control group was borderline pre-intervention and normalised post-intervention. Supplementation by means of iron and folic acid tablets at the clinics could be a possibility for this although 66 per cent of the experimental group and 88 per cent

of the control group claimed that they were not taking any supplements during pregnancy.

Although the mothers were overweight or obese, the birth data showed that all the babies were born with good and healthy measurements. Their Apgar scores showed a good range between 8 and 10. The average weight of the babies was above 2,5 kg.

7.2 Conclusions

The following conclusions can be drawn from the results of this study:

- The pilot study in 2001 indicated that 41,6 per cent of pregnant women were iron deficient and 50 per cent were suffering from IDA. The present study indicated that there had been an improvement in the nutritional status of the pregnant women as the intake of iron and folate improved from pre- to post-intervention and the serum iron status improved from 24 per cent of the respondents with low values to 6,9 per cent, and haemoglobin improved from 40 per cent of the respondents with low values to 21 per cent. Folate intake improved from 67 per cent of the respondents with low values to 60 per cent with low values. Although the nutritional status improved, the problem of iron and folate deficiency still persists among pregnant women in the Vaal region.

- This research project provided the opportunity to develop a novel food product, namely FMM, for pregnant women. This FMM is culturally acceptable and affordable. It was one the first multimixes developed in South Africa and was easy to prepare using local food staples. If 20 per cent of the RDAs can be met, this product and the FMM concept can be developed using other recipes. In order to sustain this FMM concept, women can be taught to prepare the FMM for themselves.

- Compliance with the intake of the FMM was good as shown in the acceptability of the FMM by the pregnant women and by the number of packets that were left during the home visits.

- Although few differences were observed between the groups with regard to the dietary intake patterns, anthropometric parameters and biochemical iron and folate status, positive changes were observed in both the experimental and control groups, indicating that any intervention may be beneficial to pregnant women. In this study, however, the inclusion of the developed FMM could have had a positive impact on the iron status and dietary diversity of pregnant women as an improved mean serum iron, transferrin, red cell count, haemoglobin and mean cell volume levels as well as FVS and dietary diversification were observed in the experimental group only.

- This was the first time that an intervention study of this nature had been conducted among pregnant women in the Vaal region. This study shows that is it possible to develop a novel food product, namely the FMM, for pregnant women to improve the nutritional status by using low-cost ingredients that are available in the majority of households.

7.3 Recommendations for future research

The results of this study indicate that further research is needed in the following areas:

- The sustainability of this product or similar FMM products for pregnant women to improve their nutritional status should be investigated.
- More recipes need to be developed for FMMs to avoid menu fatigue.
- A long-term intervention trial to measure the impact of the FMM concept to improve the nutritional status of pregnant women should be conducted.
- NEPs need to be implemented in order to ensure that pregnant women make the correct purchasing and food consumption choices.
- Obesity needs to be addressed among pregnant women in the Vaal region in order for women to be healthier during their pregnancies.
- Clinic sisters in the Vaal region need to receive training on nutrition education and healthy food preparation methods for pregnant women.

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Annexure A

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Anthropometric indications and nutritional intake of women in the Vaal Triangle, South Africa☆

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Summary *Objectives.* The main purpose of this study was to determine the anthropometric indications and nutritional intake of pregnant and lactating women in the Vaal Triangle ($n=431$).

Design and methods. A validated quantitative food frequency questionnaire was used in this study. Trained fieldworkers conducted interviews with the help of food models to estimate portion sizes. The anthropometric measurements included weight, height and body mass index (BMI). Blood samples were collected for determining iron status parameters.

Results. The 10 items consumed most frequently by pregnant women were, in descending order: fresh milk; tea; coffee; cold drinks; maize meal; fruit juice; bread; magou (non-alcoholic fermented maize drink); rice and sugar. For lactating women, the results were: fresh milk; tea; coffee; maize meal; cold drinks; magou; bread; yoghurt; rice and sugar. Daily intakes (mean $\pm$ SD) for pregnant women were 8425.71 $\pm$ 2279 kJ, 73.18 $\pm$ 23 g protein, 62.29 $\pm$ 23.7 g fat, 292.45 $\pm$ 72.2 g carbohydrate and 9.74 $\pm$ 3.8 mg iron. For lactating women, the intakes were 8511.94 $\pm$ 2047 kJ, 76.24 $\pm$ 25 g protein, 61.95 $\pm$ 22.3 g fat, 294.37 $\pm$ 64.2 g carbohydrate and 10.50 $\pm$ 4.0 mg iron. The results of this study showed that most of the women (98%) resided in towns and 79.3% were unemployed. The majority of the sample population was overweight or obese (BMI $\geqq$ 25).

Conclusions. The diets of the subjects consisted primarily of plant-based foods. Animal foods were scarce except for milk. Most of the items consumed were low in iron.

Implications. Iron deficiency is partly induced by plant-based diets containing low levels of poorly bio-available iron. An assessment of dietary intake is required to aid in the development of relevant dietary guidelines for the sample population.
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Introduction

Iron deficiency is among the most common nutritional disorders in the world. It is a serious threat to the health and wellbeing of women and young children. It is estimated that 2150 million people

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are iron deficient and 1200 million of these are anaemic.[1] Risk factors for iron deficiency include low income, poor diet, pregnancy, heavy menstrual losses and bleeding from other causes.[2]

The most commonly used indices of iron status in pregnancy are haemoglobin (Hb) and serum ferritin. Due to haemodilution during the second trimester, cutoff values (g/l) for anaemia for pregnant women in the first, second and third trimesters, respectively, are: Hb, 110, 105 and 110; and haematocrit (Hct), 33, 32 and 33. Even in iron-supplemented women, the Hb concentration falls by an average of 20 g/l in the second trimester to a mean of 116 g/l. The World Health Organization (WHO) cutoff is 110 g/l throughout pregnancy and 120 g/l for non-pregnant women.[3]

Anaemia is a major cause of postpartum maternal mortality, and the anaemic pregnant woman is at greater risk of death during the perinatal period. A recent review of 21 studies in Africa and Asia concluded that a reasonable estimate of the risk of maternal mortality attributable to anaemia is 20.0% in Africa and 22.6% in Asia.[4] The risk of preterm delivery, inadequate gestational weight gain and increased perinatal mortality are all directly related to anaemia.[5]

The association between anaemia and both preterm delivery and growth retardation is strongest during the early months of pregnancy. It is suggested that prepregnancy improvement in iron status is warranted. A US study showed that iron-depleted non-anaemic women were also found to have reduced levels of oxygen consumption compared with a matched iron-sufficient group. The reduction associated with iron depletion was related to reduced body storage and was not related to decreased oxygen transport capacity of the blood.[2]

Dietary assessment is an aid in the interpretation of anthropometric, clinical and laboratory findings that provide a foundation for dietary counselling. Dietary assessment is also an important aspect of surveys of nutritional status of population groups. Different methods are used to obtain food consumption patterns at the individual level, for example, weighed record, estimated record, 24-h recall, food diary, quantitative food frequency questionnaire (QFFQ) and diet history.[6]

It is difficult for mothers to meet their very high iron requirements by means of diet alone. This problem is compounded by the high prevalence of insufficient dietary iron intakes among pregnant and lactating women in developing and developed countries, as well as the low absorption of non-haem iron from cereal-based diets. If the iron stores are depleted, dietary iron requirements during the second half of pregnancy can be double those of a non-pregnant woman.[7]

The aim of this study was to determine the association between food consumption patterns and iron status by means of biochemical and anthropometric (weight/height) status, and to describe the related demographic background of pregnant and lactating women in the Vaal Triangle, which is approximately 80 km south of Johannesburg and is a semi-industrial, low-income area consisting of formal and informal settlements. The Vaal Triangle was chosen for research because it is a disadvantaged area with a high prevalence of malnutrition amongst the low-income households.

Subjects and methods

The study population consisted of 431 females, of which 116 were lactating and 315 were pregnant, aged between 16 and 35 years. A sample of the clinics in Vereeniging, Meyerton and Vanderbijlpark was drawn at random, and all pregnant and lactating women visiting these clinics were included on a list. Stratified random sampling was performed because it was necessary to have a full list of individuals in each stratum, and also to determine the demographic profile such as age groups, geographical areas and social class categories.[6]

The inclusion criteria for participation in the project were: female, age between 16 and 35 years, pregnant and/or lactating, and monthly income less than R1000 per household (1US$ = R6.40).

A total of 19 clinics were used in this project. These clinics provided antenatal and postnatal care on different days for pregnant and lactating women. The survey was conducted between November 1999 and April 2000.

We were advised by the various clinic sisters that a sample size of 30 volunteers at 19 clinics should be used. This was due to the fact that most pregnant and lactating women are anaemic or iron deficient, and if too much blood is drawn, this could affect the mother and the baby. The sample size of blood specimens was therefore chosen according to the availability of pregnant and lactating women who were willing to have their blood drawn.[7,8]

A consent form for the drawing of blood was approved by the ethics committee from the Vaal Triangle Technikon. The consent form included information explaining the purpose of the study as well as the procedures to be followed. All subjects gave their written consent to participate in the project, and were told that they could leave

the study at any time. All the clinics were given copies of the form because the clinic sisters performed the actual drawing of blood. Thirty blood samples were drawn for the determination of Hb, Hct, red blood cell count (RBC), mean corpuscular volume (MCV), iron, ferritin and transferrin.

All the fieldworkers chosen for this study were Sotho speaking and were given extensive training and detailed instructions on administration of the QFFQs and demographic questionnaires, use of food models, anthropometric measurements and food diaries.

The demographic questionnaire included questions on age, race group, present employment, main earner in the family, geographical area and, if lactating, the age of the baby. A validated QFFQ was used as a test measure in this study to obtain habitual food consumption patterns. The QFFQs were administered by the fieldworkers. Food models were used simultaneously to determine portion sizes and to explain and describe the food items to the subjects. Food diaries were kept for 1 weekday as a cross-check for items reported in the QFFQ. The food diaries included a list of foods with a very high iron content in order to determine if the pregnant and lactating women were consuming iron-rich foods. The Dietary Manager® programme of the Medical Research Council's South African food composition tables (1991) was used to determine the nutrient intake of the sample population.[9] The frequency of consumption of food was examined and the standard deviations were determined.

Laboratory assessment is important as it provides information on nutritional status. The subjects were required to fast overnight (12 h). Venous blood samples were collected by the nursing sisters using a 21-gauge scalp vein infusion set. All blood samples were drawn with minimal stasis between 0700 and 1000 h to avoid the effects of diurnal variation.

The following samples were collected from each subject:

- 5 ml EDTA (whole blood) for the full blood count and measurement of haematological markers: Hct, MCV, RBC and Hb; and
- 10 ml serum for the analysis of ferritin and transferrin.

All the samples were collected and analysed by a haematologist under controlled, standardized conditions. The assessment of the iron status of the sample population was important in order to determine whether the sample population was iron deficient or anaemic. The assessment was also important to determine the association between nutrient intake and iron status of the pregnant and lactating women in the Vaal Triangle.

At the clinics, the fieldworkers recorded the subjects' anthropometric measurements [i.e. weight, height and body mass index (BMI)]. BMI was compared against the BMI tables to determine over- and underweight. All subjects were weighed in light clothes without shoes on a portable electronic scale. Height was measured with an upright stadiometer placed against a perpendicular wall. Two measurements were made that did not differ by more than 0.5 kg (weight) or 0.5 cm (height).

The results were computerized and analysed by a qualified statistician using SPSS, Version 8. The data entry programmes had a number of quality control mechanisms, including validity checks, duplicate detection and verification procedures, written in SPSS. Differences between the pregnant and lactating groups for all variables were compared using Levene's two-tailed test for equality of variances. Differences were considered to be significant if $P \leq 0.05$. Chi-square and Fisher's Exact test (two-tail) correlation coefficients were used to test for associations between BMI and macronutrient and iron intake. Correlation was considered to be present if $r \geqq 0$ with a significance level of $P \leq 0.05$.

Results

Twenty-seven percent of the study population were lactating and 73% were pregnant. According to the demographic data, most of the women were black and between the ages of 21 and 30 years, 98% of them resided in towns and 79.3% were unemployed. The average monthly income of the majority of the lactating women (61%) and pregnant women (52%) was between R0 and R500 (1US$ = R6.40) per month. Fifty-eight percent of the babies of the lactating women were between 0 and 3 months old.

The mean intake of all QFFQs per subject represented the consumption patterns and nutritional intake. The diets of the subjects consisted primarily of plant-based foods, and animal foods were scarce except for milk. Most of the items consumed were low in iron.

The iron status was evaluated by concentrations of serum iron, ferritin, transferrin, Hb, Hct, MCV and RBC. According to the results, 50% of the pregnant women and 83.33% of the lactating

Table 1 Interpretation of iron status from blood samples.

	% Pregnant	% Lactating
Normal	4.17	16.6
Iron deficient	41.6	0.00
Iron-deficient anaemia	50.0	83.3
Missing	4.17	0.00
Total	100.0	100.0

Summary table of cut-off points.

women suffered from iron-deficient anaemia (IDA) (Table 1).

The Fisher exact test correlation coefficient was used to test the association between iron intake, macronutrients and BMI. There was a strong association between iron intake and macronutrients, especially for lactating women. The correlations for pregnant women were not as strong and not as statistically significant as those of lactating women. No correlations were found between BMI/weight and nutrient intakes for either pregnant or lactating women (Table 2).

The following cut-off points were used to determine iron intake:[7]

- first trimester of pregnancy: 13 mg
- second trimester of pregnancy: 18 mg
- third trimester of pregnancy: 23 mg
- lactation: 13 mg

Discussion

In African societies, both rural and urban, the number of single mother households is increasing. Rural women deserted by their husbands are forced to go out and work. Although this is very much part of the African life style, it often puts a greater strain on rural families and communities. According to the demographic data of this study, most of the subjects were black, residing in towns and their monthly earnings were between R0 and R500 (1US$ = R6.40).

Table 2 Summary of the associations using Fisher's Exact test, $P=0.05$.

Variable	Pregnant (correlation r^2)	Lactating (correlation r^2)
Energy vs iron	0.4715	0.9862*
Protein vs iron	0.3291	0.9235*
Carbohydrates vs iron	0.4221	0.9064*
Fat vs iron	0.2884	0.9027*
BMI vs iron	0.0007	0.0199
BMI vs energy	0.008	0.0226
BMI vs protein	0.0014	0.0611
BMI vs carbohydrates	0.0211	0.0025
BMI vs fat	0.0028	0.0408

*Statistically significant. BMI, body mass index.

Their way of living affects their food consumption patterns. Our results found that the food items consumed most frequently by the subjects contained very little iron. According to Barasi,[3] many factors influence iron absorption. Nutrients that may enhance iron absorption include vitamin C (ascorbic acid), sugar (fructose) and citric acid. The addition of a serving of a vitamin-C-rich food at every meal will significantly enhance the absorption of dietary iron. Factors enhancing absorption are: animal protein; human milk; acid medium; calcium; intrinsic factors and physiological state. The 10 items consumed most frequently by the subjects contained very little vitamin C and animal protein. The 10 items consumed most frequently by the pregnant women were, in descending order: fresh milk; tea; coffee; cold drinks; maize meal; fruit juice; bread; magou (non-alcoholic fermented maize drink); rice and sugar. Results for the lactating women were: fresh milk; tea; coffee; maize meal; cold drinks; magou; bread; yoghurt; rice and sugar. Daily intakes (mean ± SD) for pregnant women were 8425.71 ± 2279 kJ, 73.18 ± 23 g protein, 62.29 ± 23.7 g fat, 292.45 ± 72.2 g carbohydrate and 9.74 ± 3.8 mg iron. Daily intakes for lactating women were 8511.94 ± 2047 kJ, 76.24 ± 25 g protein, 61.95 ± 22.3 g fat, 294.37 ± 64.2 g carbohydrate and 10.50 ± 4.0 mg iron.

The mean total iron intake for pregnant (9.74 mg/day) and lactating (10.50 mg/day) women fell below the recommended daily allowances (RDAs); 18 mg/day for pregnant women[10] and 13 mg/day for lactating women. The reason for the low intake may be due to the types of foods consumed, since most of the subjects were from low-income households and could not afford the more expensive iron-containing foods such as meat, poultry and seafood. Cereal-based food items are cheaper and more filling.

There are two major sources of food iron: haem iron and non-haem iron. The two forms of iron in the diet are absorbed with different efficiency. Haem iron is readily bio-available, since it is absorbed intact within the porphyrin ring and is not influenced by most inhibitory factors in the diet. The non-haem iron in food enters an exchangeable pool that is markedly affected by inhibitory iron-binding ligands. Some forms of non-haem iron, such as ferritin and hemosiderin, only

partially enter the exchangeable pool and are poorly absorbed. Organic (haem) iron must be hydrolysed from any protein to which it is attached and it is then absorbed relatively easily but slowly. The overall absorption of iron from meat may be 20-25%. The most efficient absorption takes place in the duodenum, and is inversely related to the iron store level.[3]

Non-haem iron must be solubilized and hydrolysed before absorption is possible. Hydrochloric acid in the stomach performs this function and also converts any ferric iron in food to its absorbable ferrous state. This reaction is facilitated by ascorbic acid (vitamin C). Other factors enhancing the absorption of inorganic iron include citric acid, lactic acid, fructose and peptides derived from meat. All of these form ligands with the ferrous iron, maintaining its solubility and thus facilitating absorption.[3]

The three most important factors that determine the amount of iron absorbed from the diet are the amount of iron ingested, its bio-availability and the iron status of the individual. Low dietary intake and the lack of iron supplements was the main reasons for iron deficiency in the present study. Low bio-availability of dietary iron was also a factor due the high intake of plant sources, for example, maize meal porridge and bread, together with a low intake of haem iron sources such as meat, fish and chicken. The availability of iron from non-haem foods could also be decreased by the high intake of tea and coffee with meals. Tea and coffee were amongst the top 10 foods consumed by the participants. Ascorbic acid is considered to be the most potent enhancer of non-haem absorption. The effect of ascorbic acid on iron absorption is so pronounced that it has been recommended that each meal should contain 25-50 mg of ascorbic acid. The more inhibitors present in a meal, the more ascorbic acid is necessary to achieve the same increase in absorption.[11] In the present study, the iron statuses of the pregnant women were 4.17% normal, 41.67% iron-deficient erythropoiesis and 50% IDA. For lactating women, the iron status was 16.67% normal and 83.33% IDA.

In the same way as simple food dislikes may develop into disgust aversions, food preferences can be elevated to the rank of intense longing or craving under some circumstances. Foods eaten by pregnant women are often associated with the physiological status of pregnancy. It has been suggested that pica, the craving for substances with little or no nutritional value, may be associated with iron deficiency. Studies have shown that the most common substances eaten are dirt, clay, starch and ice. Some pica substances such as starch are high in calories and may contribute to obesity. Many studies of pica have focused on low-income blacks, and pica appears to be prevalent among this group.[12] The aetiology of pica is poorly understood. One theory suggests that a deficiency of an essential nutrient, such as calcium or iron, results in the eating of non-food substances that contain these nutrients.[13] However, Karimi et al. did not find any correlation between pica of any kind and low serum ferritin levels in pregnant women of Southern Iran.[14] According to another theory, pica may be practiced for cultural reasons.[15] These authors found that 38% of socially disadvantaged pregnant women in their study practiced pica, and most of them were African-American women. Some recent evidence has linked pica with the obsessive-compulsive spectrum of disorders.[16]

According to the BMI cut-off point of 25, 79.12% of pregnant women and 80.39% of lactating women were found to be overweight or obese. In a study performed in Kenya, Mexico and Egypt, it was found that women who were heavier and fatter at conception had retained substantially less weight and fat 2-4 weeks post partum, reflecting the lower weight gain of fatter women during pregnancy.

The prevalence of anaemia in this study was 50% for pregnant women and 83.33% for lactating women. This compares unfavourably with studies performed in other parts of South Africa. In a study on black pregnant women at Baragwanath Hospital, Johannesburg, the prevalence of anaemia (Hb $<$ 11 g/dl) was found to be 20.5%, and in a study on pregnant women at the antenatal clinic at Pelonomi Hospital, Bloemfontein, the prevalence of anaemia was found to be 26.2%. Higher prevalences have been reported for pregnant women in sub-Saharan Africa (50%) and South Asia (64%).[17]

The reason for the high prevalence of anaemia in the present study may be because most of the subjects were from towns, unemployed and from low-income households and, therefore, they were not consuming iron-rich food. MacIntyre et al.[18] recently described the effects of urbanization on the food consumption of an African population of the North West Province. Intake of the staple, maize meal, was still high in the urban middle and upper class strata, but was replaced to some extent by animal protein and fat. Increased intakes of vegetables and fruit appeared to be taking place to a lesser extent, primarily in the upper class urban stratum, resulting in somewhat better miconutrient intakes than in the rural and informal settlement

subjects. Seventy-six percent of women in the informal settlement stratum aged 16-24.6 years had iron intakes below 67% of the RDA, and 67% of the women aged 25-44 years had intakes below 67% of the RDA.

Conclusion and recommendations

Dietary improvement by means of food fortification, food diversity and iron supplementation is essential. Fortification of suitable food vehicles with absorbable forms of iron is a cost-effective approach to controlling iron deficiency. Food fortification with iron is an important strategy for improving iron nutrition on a sustainable basis. In developing countries, most diets are plant based. Although they may contain high levels of iron, the iron is not readily bio-available because of the presence of inhibitory substances such as phytates and polyphenols. Most developing countries do not practice iron fortification. As industries become established and the processing of food becomes centralized, opportunities for fortification can be developed. There have been notable successes in countries such as Chile, Venezuela and the USA where iron has been added to staple foods. If a fortifiable food exists and is consumed by many people at risk of iron deficiency, fortification is likely to be the most cost-effective strategy. There are many possible strategies for iron fortification. One approach is to fortify staple food that is consumed in significant quantities by most of the population. Fortification of wheat flour with iron is technically relatively simple and this has been implemented successfully in several countries in South America, North America, Great Britain and, as recently as 2003, in South Africa (maize as well as wheat flour). Another approach is to fortify a widely consumed condiment that women from low-income households can afford.

Iron supplementation refers to the distribution of iron in medicinal form (tablets, liquid form or parenteral injection) and is often the only way to improve iron status. The WHO considers pregnant women to be a priority group for iron supplementation. The subjects in the present study did not take any iron supplements as they did not understand the need for it. Blanket supplementation need not be expensive because preventative rather than therapeutic doses of supplementation can be used. Side-effects of iron supplementation, which are usually minor (constipation, diarrhoea and nausea), will be less with lower iron doses and can be improved by counselling about diet and supplement use. Motivation of the patient, explaining why and how the tablets should be taken, and the reduction of side-effects are some of the essential recommendations for iron supplementation programmes. It is recommended that all women in low socio-economic communities should be supplemented with iron during the second half of pregnancy when iron requirements are increased. Part of their daily iron requirement can be supplied as iron-fortified food, which will reduce the dose of iron to be taken in tablet form. Information on the importance of iron to pregnant and lactating women and the unborn child, how to take the iron supplements and how to handle side-effects will improve compliance and effectiveness of the supplements.[11]

No nutrition education was given at these clinics; therefore an intervention programme is recommended that includes iron supplementation with a nutrition education programme. The nutrition education programme should include proper dietary guidelines within a limited budget, and ways to increase iron intake during pregnancy and lactation. To increase dietary iron, more iron-rich foods like organ meat, meat, poultry, fish, legumes, whole wheat, green leafy vegetables and nuts should be included. If possible, the intake of the highly absorbable haem iron should be increased by increasing meat, poultry or fish intake. Tinned sardines in tomato sauce is very popular amongst South African blacks and is reasonably priced. The absorption of non-haem iron can be increased by including ascorbic-acid-rich food, such as citrus fruit or tomatoes, in the same meal. On the other hand, tea and coffee, which are known to decrease the absorption of non-haem iron, should be avoided during and after meals. Further research on iron supplementation and nutrition education programmes in this population of pregnant and lactating women is recommended.

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Annexure B

FIELD WORKER MANUAL

Why am I here?

Hema Kesa is conducting a research study on women, who are pregnant in their first trimester, to in the Vaal Triangle (Vanderbijlpark, Vereeniging and Meyerton), aged between 20 and 30 years. The main focus of the study is to improve their nutritional status during pregnancy in order to have healthier pregnancy outcomes. To help improve their nutritional status, a cost effective, culturally acceptable, nutrient-dense food multimix based on local food staples for household consumption for pregnant women in the Vaal Triangle is being developed and tested as part of the research project.

The main objectives of the project are as follows:

a. To determine the food consumption patterns and dietary intake of pregnant women in the Vaal Triangle by quantitative food frequency questionnaire (QFFQ) and 24-hour recall questionnaire.
b. Determine the nutritional status of pregnant women in the Vaal Triangle by anthropometric, biochemical and hematological measurements.
c. Formulation of the multimix.
d. Recipe development once the formulation of the multimix is complete.
e. Intervention study to assess the impact of multimix consumption on nutritional status of the pregnant women.
f. To assure compliance during the intervention study and to improve basic nutrition knowledge, nutrition education will form an important part of this study.
g. Evaluation and reporting of results.

What is a Field Worker?

The field worker is an extremely important person in this project. In fact, this research would not be possible without the field workers. The field workers are the people who must interview the subjects (the people chosen to take part in the research) and get correct and accurate information from them. The subjects must feel at ease with the field worker so that they will not feel threatened or intimidated and will willingly answer the questions to the best of his or her ability.

How should I behave?

In order to be a successful interviewer, a field worker must have (or develop) the following characteristics:

1. Friendliness: the field worker must be able to make each subject feel relaxed and not threatened in any way. The subject must feel that the field worker sees him or her as a person, not just another number that must be dealt with.

2. Respect: the subject must be treated with respect at all times. For example, he must be greeted politely, thanked for his time and co-operation; he must not be forced to answer a question that he is not willing to answer. The field worker must never show if she disagrees with something the subject has said.

3. Patience: each subject has to be asked the same questions in the same way. This means that the field worker must ask the same questions over and over, which can be very tiring and irritating.

However, the field worker may never show that she is impatient or irritated even when the subjects are slow to answer or when they do not understand the questions. She must be able to control her own feelings and hide them when necessary.

4. Reliability: the field worker must be reliable, she must pay attention to detail, record all answers accurately, not skip over questions or make up answers herself.

5. Enthusiastic and Motivated: the field worker must be enthusiastic about the research. She should be doing it because she really wants to and not just because it's just a job.

6. Flexible: a good field worker is able to adapt to circumstances. She is aware that things do not always work out as planned and sometimes she will have to work under difficult and uncomfortable conditions.

8. Neat Appearance: the field worker must always look neat and well groomed, but never overdressed. The following guidelines for dress should be followed:
   - wear neat, simple and comfortable clothes
   - do not wear badges or emblems of organisations, churches, etc. as these may influence the way subjects answer.
   - dress so that the subject will concentrate on the interview and not on the way you are dressed.

How do I interview the subject?

The "subject" in this project is the pregnant woman in the Vaal Triangel.

1. How do I begin?

- ✘ Greet the subject politely and introduce yourself.
- ✘ Ask what language the subject would prefer to speak.
- ✘ Explain what the interview is about. Let the subject ask questions about the research. Reassure the subject that the answers are confidential and that neither the subject nor his or her address will be identified.
- ✘ Put the subject at ease. Be flexible and sensitive to the subject. Some subjects may be tense or apprehensive. In such cases, talking about something general, e.g. the weather may put the subject at ease.

2. How do I conduct the interview?

- ✘ Ask the questions exactly as they are written on the questionnaire. Try even to keep your tone of voice the same for each subject so as not to lead the subject or to give him an idea of how you want him to answer. You may have to explain a question or use different wording if the subject cannot understand it.
- ✘ Ask the questions in the order that they appear on the questionnaire. If the subject refuses to answer the question, record the lack of response and go on to the next question.
- ✘ Follow the instructions on the questionnaire. Sometimes it may seem that a subject has already answered a question when he answered a previous one, but the interviewer must still answer the question. For example, the questions about polony and atchaar. Start the question: "We have already mentioned this, but...".
- ✘ Do not lead the respondents. Do not try to influence the way the subject answers. Keep your facial expression friendly, but neutral. Never show surprise or shock or approval to the subject's answers. Try to avoid unconscious reactions such as nodding the head, frowning, raising the eyebrows. Never give your own opinions.

- Keep the tone of the interview conversational. Be friendly and courteous. Do not make the subject feel as if he or she is taking an examination or is on trial Be familiar with the questionnaire so that you can ask questions conversationally rather than reading them stiffly. The questionnaire is designed to keep the amount of writing to a minimum. However, if a subject gives a long response to an 'other' question, say, 'excuse me while I write that down'. Don't make the subject feel as though you have forgotten he is there.
- Keep control of the interview. Do not let the subject go off into irrelevant conversation. If he or she does, bring him or her gently back to the interview.
- Allow the subject time to think; do not hurry him to answer. However, if he is silent for too long, repeat the question, or 'prompt' him. For example, say ' you have told me how you cook cabbage; now please tell me how you cook pumpkin.
- Follow the instructions on the questionnaire for recording the responses. Record all responses, including negative responses or refusals to answer.
- Make sure that you have written in the subject's number.

3. How do I end the interview?

- Tell the subject that you have finished the interview.
- Reassure him that everything he has told you is confidential.
- Thank him for his time and cooperation. Direct him to the next stage. Greet him.

Interview for the Quantitative Food Frequency Questionnaire.

Quantitative = amounts of food
Frequency = number of times food is eaten

1. Part I

Part I of the QFFQ is aimed at finding out the eating pattern of the subject, that is, how many times a day he eats, at about what times he eats, where he eats and does he consume snacks or drinks between his main meals (and also what does he think of as a snack). We need this information to be able to compare the eating habits of people in different areas and to be able to give people relevant advice.

We start by asking the number of meals the subject ate 'yesterday' because it is easy to remember what you ate yesterday. ('What is a meal? Discuss this with field workers). Put a circle around the day, which was 'yesterday'. Then ask at about the times at which he ate each meal. The number of questions to ask next will depend on the subject's answer to question 1. So, if the subject answered that he ate 2 meals yesterday ask questions 2.1.1-2.2.2.

We then ask if this is the number of meals he usually eats (2.5). If the answer is YES do not ask questions 2.5.1. We also ask if he eats at these times usually. If the answer is YES do not ask questions 2.6.1-2.6.7.

2. Part 2

We now come to the main part of the QFFQ. It is very important that this information be filled in as accurately as possible. All that the subject tells us will be put onto a computer and analysed to tell use how much energy, protein, fat, vitamins and minerals the subject is eating and whether it is too little or too much to be healthy or whether it is the correct amount.

The subject must answer about what he has eaten or drunk in the last few months. Anything, which he has not eaten in this time, must be marked with an X under 'Seldom/Never'.

2.1 Filling in the amounts and frequencies.

For the direct questions, e.g. "Do you eat maize-meal?", circle the number next to the subject's answer.

To fill in the amount: estimate the portion size of the food using the food samples or crockery and utensils available, i.e. cups, spoons, bowls, etc. Write this amount in the column under 'AMOUNT'. If the subject describes the amount as spoons or teaspoons, ask him which size of spoon and whether it is level or heaped. Use L for level and H for heaped. For example: If a subject takes one small, heaped teaspoon of sugar in a cup of tea write *1 x small heaped tsp* under 'AMOUNT' or if he takes 2 level 5 ml teaspoons of sugar per cup of tea write *2 x level tsp* under 'AMOUNT'. Use the sizes of the cups and glasses in the sample pack for amounts of drinks, or the sizes of cans or bottles.

Remember that amount of most foods should be the cooked amount and not the raw amount.

To fill in the frequency: ask the subject how many times he has the food per day; how many times he has it per week or how many times per month. Write the number under the column 'Per day' 'per week' or 'Per month' For example, a subject has 500g stiff porridge in the morning and evening every day. It will be filled in as follows:

Example 1: The subject eats a medium size dish of maize-meal porridge once every day, except on Sundays.

FOOD	DESCRIPTION	Amount	TIMES EATEN				CODE	AMOUNT/DAY
			Per day	Per week	Per month	Seldom Never		
Maize-meal porridge	Stiff	*2 cups*	2	7				

Interviewer: How do you like your maize-meal porridge?
Subject: I eat it stiff
Interviewer:(*Circle 'Stiff'*) How much do you eat at a time? (*Show the cup and let the subject tell you how many at a time))*
Subject: About 1 of those cups.
Interviewer: How many times a day do you eat this amount of stiff porridge?
Subject: I eat it once every day.
Interviewer: (*Write 1 under the column Per Day).*
Do you eat stiff porridge every day?
Subject: No, I do not eat it on Sunday.
Interviewer: So you eat stiff maize-meal porridge six times a week (*Write 6 under the column Per Week*)

FOOD	DESCRIPTION	Amount	TIMES EATEN				CODE	AMOUNT/DAY
			Per	Per	Per	Seldom		

			day	week	month	Never		
Maize-meal porridge	**Stiff**	***1 cup***	**1**	**6**				

Example 2.The subject eats a large dish of ting twice a month

I: Do you eat ting?
S: Yes
I: How much do you eat (*Show the cup and let the subject tell you how much would fit in the cup*)
S: About 2 of those cups.
I: How many times a day do you eat ting?
S: I don't eat ting every day.
I: How many times a week do you eat ting?
S: I eat it less than once a week
I: How many times a month do you eat it?
S: I eat it twice a month.
I: (*Write 2 under the 'per month' column*)

FOOD	DESCRIPTION	Amount	TIMES EATEN Per day	Per week	Per month	Seldom Never	CODE	AMOUNT/DAY
Ting		***2 cups***	**1**		**2**			

2.2 Brand names.

In some sections, the subject is asked what brand he uses. This is so that we can be sure to use the correct item for nutrient analyses. For example, some maize-meals have vitamins added, others do not. The subject may not know whether the maize-meal he uses has added vitamins or not, but he should know the brand name. We can then check if that brand has added vitamins or not. The same applies to margarines, milk powders, fruit juices, and breakfast cereals.

2.3 Preparation methods (meat and vegetables).

Do not read out the list of all the possible preparation methods to the subject. Ask 'How do you prepare your beef?' Then circle the option closest to the subject's answer. If the answer does not fit one of the options, circle 'other' and write in the description.

Also, check if the subject cooks the food in more than one way.

If the subject does not know the preparation method (men or if eaten away from home), help him by reading the list. If he still does not know, circle 'Don't know' and fill in the amounts and frequency next to 'Don't know'.

Example: The subject sometimes cooks cabbage with potato and onions and sometimes fries it.

I: How do you cook cabbage?
S: I cook it with potato and onion.
I: *(Circle boiled with potato, onion and fat).*

Do you cook it any other way?

S: Sometimes I fry it.

I: *(circle Fried, nothing added)*
What is the amount you eat if it is cooked with potato and onion? (*Show the samples, cutlery or crockery available*)

S: This one (*Subject points to ladle*)

I: *(Write 1 ladle under 'Amount' next to boiled, potato, onions and fat).*
How often do you eat it?

S: About three times a week.

I: (*Write 3 under 'per week'*)
What is the amount you eat when you fry cabbage?
(*Show the samples, cutlery or crockery available*)

S: This one (*Subject points to ladle*)

I: *(Write 1 ladle under 'Amount' next to fried, nothing added).*
How often do you eat it?

S: I only fry it if I haven't got any potatoes?

I: How many times per month is that?

S: Usually at month end, when the potatoes are finished.

I: So, how may times a month?

S: Say twice a month.

I: (*Write 2 under 'per month')* Can I check that I have got this right? You eat cabbage with potato and onion three times a week and fried cabbage with nothing added twice a month.

S: That is right.

FOOD	DESCRIPTION	Amount	TIMES EATEN				CODE	AMOUNT/DAY
			Per day	Per week	Per month	Seldom Never		
Cabbage	**How do you cook cabbage?**							
	Boiled nothing added							
	Boiled with potato, onion and fat	30	1	3				
	Fried nothing added	30	1		2			
	Boiled then fried with potato onion							
	Other describe Don't know							

2.4 Other foods.

- **Vegetables and fruit:** Ask the subject which vegetables and fruits he eats and mark them on the questionnaire, then go back to each answer and ask about the preparation, amount and frequency. Do not read the list to the subject.

- **Tomato and onion gravy:** Use the ladle to help the subject judge the amount of gravy used with the porridge.

- **Canned fruit with custard:** Custard is included under fruit as it is usually eaten with canned fruit. This is also a control question, as canned fruit and custard is also included under puddings. The answers to both questions must be the same. If not, make sure the subject has understood the question.
- **Bread and spreads:** Ask the subject if he spreads anything on his bread. If he answers **YES** ask him what he spreads and mark them on the questionnaire, then go back to each answer and ask about the amount and frequency. Do not read the list to the subject. (Remember not to ask how much is put on per slice of bread, but how much is used every day or every week or every month).

- **Atchar:** Atchar is included here as a spread on bread, it is also asked about later under 'condiments' for when it is used as sesebo.

- **Polony:** Polony is asked about here again (it was included with cold meat) as something put on bread, whereas previously it was asked about as cold meat. Make sure with the subject whether he uses polony only on bread (e.g. with atchar) or if he also eats it on its own.

- **Margarine:** There is a difference between the type of fat in soft (tub) margarines and hard (brick) margarines. When you ask about the brand also ask whether it is the hard or soft type and write the answer with the brand e.g. *'Rama - soft'* or *'Rama - hard'*.

- **Fats, drinks and snacks:** As for vegetables, fruit and spreads. Ask the subject what he uses and mark them on the questionnaire, then go back to each answer and ask about the preparation, amount and frequency. Do not read the list to the subject.

- **Fats:** Most people will add fat to vegetables or other food while it is being cooked. So to try to find out how much fat one person is getting, we need to ask how much fat is used for the whole amount of food and then how many people will eat the food. These are also checking questions for the cooking methods of vegetables.

- **Alcoholic drinks:** Some questions are asked in the first general questionnaire about the use of alcohol. The subject may want to know why he is being asked again. The first questionnaire is to assess the general state of health of the subject and alcohol is a part of this. In our questionnaire we want to find out the amounts used as alcoholic drinks are 'food' and contribute energy and some nutrients to the diet.

- **Repetition:** Some questions are repeated e.g. custard, atchar, polony. This has been done as a double check to make sure that everything is included. For example, atchar may be spread on bread or eaten as 'sesebo'. The subject may only think of it as sesebo, if it was not also included under spreads.

- **Storing food:** Keeping food can affect its nutritional value and other properties of the food. If food is regularly stored, it could have an important effect on the quality of the diet.

- **Salt:** Separate questions are asked about the use of salt, as it is very difficult to estimate the amount of salt used.

Interview for the 24-Hour Recall Questionnaire.

The 24-hour recall is a questionnaire on what the subject has eaten the day before over a 24 hour period. Often the 24-hour recall is used to establish whether the QFFQ is valid or not. It is important to think of the 24-hour recall questionnaire as being a totally separate questionnaire and not a cross-reference to the QFFQ. Therefore, the answers to the questionnaire need to be very detailed. You will need to ask what is eaten and drunk, what type of food or drink is consumed, the brand name, the preparation method and the quantity consumed. Remember to include spreads, sugar and milk to tea / coffee, snacks, sweets, juices, sauces, salts and other condiments. In other words, Be Specific.

Example: The subject is asked what she has in the morning on waking up.

I: What do you have in the morning when you wake up?
S: I drink tea and then have porridge.
I: How do you take your tea?
S: With 2 sugars and a little milk.
I: How big is the spoon and is it level or heaped? (*Showing the teaspoon*).
S: It is like that spoon and I also have it heaped.
I: What type of porridge did you eat and how much did you have? (*Showing a bowl or cup*).
S: I had soft mealie meal porridge and I had about 2 of those cups to the fill in a bowl.
I: Do you put anything else in the porridge?
S: Yes, 2 spoons of sugar, like my tea, and a little margarine about 1 spoon.
I: At about what time was this meal?
S: At 6 am.
I: Where did you have this meal?
S: At home.

Time (approximately)	Place (Home, school, etc)	Description of food and preparation method.	Amount	Amount in g (office use Only)	**Code (office use only)**
From waking up to going to work, or starting day's activities					
6 am	**Home**	**Tea**	**1x**		
		With milk	**little milk**		
		And sugar	**2 heaped tsp**		
		Soft mealie meal porridge	**2 cups**		
		With sugar	**2 heaped tsp**		
		And margarine	**1 tsp**		

Good luck and enjoy yourself!

RESEARCH SURVEY PACKAGE

Fieldworker name:

Clinic name:

Clinic address:

Clinic telephone number:

Visiting days:

Contact person:

Researcher telephone number: 082 6879200

FIELDWORKER TRAINING

Make sure you receive the following from the researcher in your package:

1. Training document (This document)
2. Claim form (To claim for transport and the correctly completed questionnaires)
3. Conformation letter (To be presented to the head of the clinic when you visit)
4. Information letter for each pregnant woman (15)
5. Quantitative Food Frequency questionnaires (15)
6. 24- Hour Recall questionnaires (15)
7. Antropometric, health and medical questionnaires (15)
8. Socio-demographic questionnaires (15)
9. A letter of commitment.
10. A detailed list of clinics.
11. A thank you gift for each pregnant woman.
12. A thank you card for the sister in charge.
13. A pencil.

You will be visiting the specific clinics from **10/06/04 till 26/07/04** from 9h00 to 16h00 according to the days stipulated on your list.

The clinic that you will be visiting is already informed of your visit.
Please introduce yourself on arrival at the clinic.
Ask to speak to the head sister at the clinic.
Explain to her the purpose of your visit and ask her to show you the weighing scale and measuring tape that you will be using. If you don't know how to use it ask her to show you.

You must interview, weigh and measure every pregnant woman between the ages of 16 to 35 that is visiting the clinic during the time that you are there. If the women are literate explain each question to them and allow them under your supervision to fill in the questionnaire correctly. If the women

are illiterate you must read and explain each question to them and you must write down each answer on the questionnaire.
Please explain to them what the questionnaire is about and its purpose.
Write down their address in the given space, this is only for control purposes and will not be used in the future.

The person must sign the questionnaire even if they can't write.
When the questionnaires are completed or your days of visits are over please thank them for allowing us to use their facilities and their participation.

Please hand in the questionnaires to the researcher as soon as possible.

Please make sure that the questionnaires are completed and handed in by **26th of July 2004.**

Thank you for your assistance and co-operation

Mrs. H. Kesa
Snr. Lecturer
Department: Hospitality and Tourism

Annexure C

Socio-Demographic Questionnaire

DIETARY DIVERSIFICATION: PREGNANT WOMEN

VAAL UNIVERSITY OF TECHNOLOGY

FACULTY: HUMANITIES

DEPARTMENT: HOSPITALITY AND TOURISM

SOCIO-DEMOGRAPHIC QUESTIONNAIRE

This questionnaire covers certain aspects of your life, including work and personal details, health and illness, lifestyle and social life that is relevant to health. The answers to these questions will be kept strictly confidential and the information will not be identifiable from any reports or publications.

1. GENERAL INFORMATION

Date : .....
Name : .....
ID Number : .....
Address : .....
.....
.....

Please answer all questions by marking the correct answer with **X,** except where otherwise indicated.

Example: In what town do you live?

Johannesburg	Bloemfontein	Cape Town	Vanderbijlpark	Durban

2. PERSONAL INFORMATION

2.1 Your role in the family

Mother	Grandmother	Caregiver	Other, specify.....

2.2 When were you born? Year: Month: Day:

2.3 How old are you? _____ years

2.4 How far pregnant are you? _____ weeks

2.5 Are you planning to breastfeed your baby? Yes ❑ No ❑

2.6 How many children do you have? _____

2.7 How old are your children?

AGE	DATE OF BIRTH

3. ACCOMMODATION AND FAMILY COMPOSITION

3.1 Where do you live and in which area?

Town/City	Farm	Informal settlement	Rural village	Hostel	Other, specify.....

Vereeniging	Meyerton	Vanderderbijlpark

3.2 Do other people live in your house?

Yes
No

3.3 How many people are living in your house?

1	2	3	4	5	6	7	8	9	10	10+

3.4. Please **complete** the table below on all members of the household

Name of household member	Age (yrs)	Gender M / F	Family relationship	Does this person eat and sleep in this house at least 4 days a week?

3.5 Are all members permanent residents in this house?

Yes	No

3.6 If yes, how long have you been staying permanent in this house?

< 1 year	1-5 years	>5 years

3.7 Do you have another home outside the Vaal Triangle?

Yes	No

3.8 In what type of house are you staying and indicate the number of rooms?

Brick	Clay	Grass	Zinc/shack	< 2 rooms	3-4 rooms	> 4 rooms

3.9. Are there other houses/shacks within the same yard of the main house?

Yes	No

3.10 How would you describe the place where you are currently living?

Homeless	
Living with parents	
Living with relatives	
Living with friends	
Hostel accommodation	
Squatter home	
Rented house	
Rented flat	
Own house	
Own flat	
Other, specify.....	

3.11 Do you have the following facilities at home?

3.11.1 Water

Tap in the house	
Tap outside the house (in yard)	
Borehole	
Spring / river / dam water	
Fetch water from elsewhere	

3.11.2 Toilet facilities

None	
Pit latrine	
Flush / sewage	
Bucket system	
Other, specify.....	

3.11.3	Waste removal	Yes	No

3.11.4	Tarred road in front of house	Yes	No
	Gravel road in front of house	Yes	No

3.12 To what extent do you have problems with your housing (e.g. too small, repairs, damp, etc.)?

.....
.....

3.13. Do you have problems with the following?

Mice / Rats	Cockroaches	Ants	Other pests, specify.....

4. WORK STATUS AND INCOME

4.1. Are you currently employed?

Yes	No

If YES, go to Question 4.5.

4.2. If NO, how would you describe your current status (tick one box only)?

Unemployed	Retired	Housewife	Student	Other, specify.....

4.3. Are you actively looking for paid employment at the moment?

Yes	No

4.4. How long have you been unemployed?

< 6 months	6-12 months	1-3 years	> 3 years

4.5. If YES (question 4.1) is your current job a:

Permanent position	Temporary position	Fixed term contract	Other, specify.....

4.6. Is your job?

Full time	< 25 hours per week

4.7 What is the exact title of your current job?
(Including self-employed)

4.8 Do you have a second job for extra cash?

Yes	No

If YES, go to Question 4.10.

4.9 If NO, is your spouse (partner) in paid employment at present?

Yes, full time, permanent	
Yes, part-time, permanent (< 25 hours p w)	
Yes, temporary	
No, unemployed	
No, retired	
No, other, specify.....	

4.10. If YES, what is your spouse (partner)'s occupation or job?

4.11. What is the total income in the household per month?

< R500	R501-R1000	R1001-R1500	R1501-R2000	R2001-R2500	> R2500

4.12. How often does it happen that you do not have enough money to buy food for you or your family?

Always	Often	Sometimes	Seldom	Never

4.13 How many people e.g. partner, relatives & others (including yourself) contributed to your household income from any source, (including wages/salary from paid employment, money from second or odd jobs income from savings investments, pension, rent or property, benefits and or maintenance etc.) in the last 12 months?

People	0	1	2	3	4	5	6	7	8	9

4.14 How often do you buy food?

Every day	Once a week	Once a month	Other, specify.....

4.15 Where do you buy food?

Spaza shop	Street vendor	Supermarket	Other, specify.....

4.16. How much money is spent on food PER WEEK? (Tick only one box)

R 0 – R 50	R 51 – R 100	R 101 – R 150	R 151 – R 200	R 201 – R 250	R 251 – R 300	> R 300	I do not know

4.17 How much money do you give to each child to take to school for buying food / snacks PER WEEK?

50 c	R 1 – 2	R 2- 3	R 3 - 4	R 4 - 5	> R 5

5 EDUCATION AND LANGUAGE

5.1. What is the highest education you have?

None	Primary School	Grade 10	Grade 12	College	Other post school

5.2 What language is spoken mostly in the house?

Sotho	Xhosa	Zulu	Pedi	Other, specify.....

5.3 How many children (in the household) 5 years and under have birth certificates?

None	1	2	3	4	5	6	7	8	All

5.4 How many children 5 years and under have completed their immunisation schedule?

None	1	2	3	4	5	6	7	8	All

5.5 Number of children attending school

None	1	2	3	4	5	6	7	8	All

5.6 How do the children get to school?

Walk	Bus	Taxi	Lift	Other, specify.....

6 ASSETS

Tick one block for every question:	Father	Mother	Sibling	Grandma	Grandpa	Aunt	Uncle	Cousin	Friend	Other
6.1 Who is mainly responsible for food preparation in the house?										
6.2 Who decides on what types of food are bought for the household?										
6.3 Who is mainly responsible for feeding/serving the child?										
6.4 Who is the head of this household?										
6.5 Who decides how much is spent on food?										

6.6 How many meals do you eat at per day?

0	1	2	3	> 3

6.7 Where do you eat most of your meals?

Home	Friends	Work	Buy	Other, specify.....

6.8 Where do your children eat most of their meals?

Home	Friends	School	Buy	Other, specify.....

6.9 Does your home have the following and how many?

	Yes	**No**	**Quantity**
Electrical stove			
Gas stove			
Primus or paraffin stove			
Microwave			
Hot plate			
Radio			
Television			
Refrigerator			
Freezer			
Bed with mattress			
Mattress only			
Lounge suite			
Dining room suite			

Annexure D

Quantitative Food Frequency Questionnaire

QUANTITATIVE FOOD FREQUENCY QUESTIONNAIRE

SUBJECT DATE OF BIRTH: ..... AGE:.....

SUBJECT NUMBER: .....

NAME: .....

INTERVIEWER: .....

ADDRESS: .....

INTRODUCTION:

Greeting

Thank you for giving up your time to participate in this study. Here we want to find out what people living in this area eat and drink. This information is important to know as it will tell us if people are eating enough and if they are healthy.

Please think carefully about the food and drink you have consumed during the past few months. I will now go through a list of foods and drinks with you and I would like you to tell me

- If you eat the food,
- how the food is prepared,
- how much of the food you eat at a time,
- how many times a day you eat it and if you do not eat it every day, how many times a week or a month do you eat it.

To help you to describe the amount of a food you eat, I will show you pictures/examples of different amounts of the food. Please say which picture/example is the closest to the amount that is eaten, or if it is smaller, between sizes or bigger than the pictures.

I will also ask some questions about where you get your food and where you shop. This information is important because it will tell us which foods are easy to obtain and which are not and how the food is prepared and served.

THERE ARE NO RIGHT OR WRONG ANSWERS.

EVERYTHING YOU TELL ME IS CONFIDENTIAL. ONLY YOUR SUBJECT NUMBER APPEARS ON THE FORM.

IS THERE ANYTHING you WANT TO ASK NOW?
ARE YOU WILLING TO GO ON WITH THE QUESTIONS?

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

SUBJECT DATE OF BIRTH: .....

I shall now ask you about the type and the amount of food your child has been eating in the last few months. Please tell me 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 you 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	Maize/mabela							
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								
	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								
	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). How many times per week do you eat chicken?								
	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 Not coated						1634 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								
Chicken feet	How do you cook it?						1609	
Chicken offal	How do you cook it?						1610	
Where do you get your MEAT from? (May answer more than 1). How many times per week do you eat meat?								
	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							
	Stewed – without bone							
	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 Grilled						1526	
Bacon							1501	
Cold meats	Polony						1514	
	Ham						1564	
	Viennas						1531	
	Other specify:							
Canned meat	Bully beef						1535	
	Other specify:							
Meat pie	Home made Bought						1548	
Hamburger	Home made Bought							
Dried beans, peas, lentils (10)	How do you prepare them?							
Soya products e.g. Toppers	Brands at home now Don't know..... Show examples						3527	
Pilchards in tomato chilli brine	Whole						2557	
	Mashed with fried onion							
Fried fish	With batter/ crumbs						2523	
	Without batter/crumbs						2509	
Other canned fish	Tuna							
	Pickled fish Other:						2562	
Fish cakes	Home made (describe) Frozen Bought						2531	

FOOD	DESCRIPTION	Amount	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom Never		
Eggs	Boiled poached Scrambled Fried						1001 1025 1003	
WE NOW COME TO VEGETABLES AND FRUIT How many times per week do you eat vegetables? ..... Where do you get your vegetables from? (May answer more than 1) Own vegetable garden Employer's farm Own farm Shops, supermarket, greengrocer Hawker Veld (e.g. morogo) Gifts Other specify								1 2 3 4 5 6 7 8
Cabbage	How do you cook cabbage?							
	Boiled, nothing added						8066	
	Boiled with potato and onion and fat							
	Fried, nothing added							
	Boiled, then fried with potato, onion							
	Other:							
	Don't know							
Spinach / morogo / other green leafy	How do you cook spinach?							
	Boiled, nothing added						8071	
	Boiled fat added						8209	
	Boiled with – onion, tomato & fat							
	-onion, tomato & potato						8212	
	- with peanuts							
	Other:							
	Don't know							
Tomato and onion 'gravy'	Home made - with fat - without fat							
	Canned (Is this the amount of pap you eat? How much more or less?)						8221	
Pumpkin	How do you cook pumpkin?							
	Cooked in fat & sugar							
	Boiled, little sugar and fat							
	Other:							
	Don't know							

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							
	Raw, salad Chakalaka						8015	
	Other:							
	Don't know							
Mealies / Sweet corn	How do you eat mealies? On cob –with fat -without fat						8033	
	Off cob –with fat -without fat						8261	
Beetroot salad	Home made Bought						8005	
Potatoes	How do you cook potatoes?							
	Boiled/baked - with skin						8046	
	- without skin						8045	
	Mashed						8187	
	Roasted						8189	
	French fries						8048	
	Salad						8236	
	Other:							
Sweet potatoes	How do you cook sweet potatoes?							
	Boiled/baked - with skin						8057	
	- 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 How many times per week do you eat fruit in winter? ...../ in summer? .....

Where do you get your fruit from?

Own fruit trees	1
Farm – employer	2
Farm – own	3
Supermarket/greengrocer	4
Hawker	5
Veld	6
Gifts	7
Other	8

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

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 Niknaks etc.							4067	
Peanuts	Raw Roasted						6001 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 Samoosas Biscuits e.g. Bacon kips Other						1534 4196 4162	
PUDDINGS:								
Canned fruit	Type							
Jelly							9004	
Custard	Homemade Ultramel						0004	
Baked pudding							4181	
Instant pudding							4066	
Ice cream Sorbet							6507 6516	
Other: specify								
SAUCES / GRAVIES / CONDIMENTS:								
Atchar							3004	
Tomato sauce Worcester sauce							3027	
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:								

SALT USE:

The next few questions are to find out if you use salt, where you use it and how much you use.

Do you add salt to food while it is being cooked?

Always	Sometimes	Never	Don't know
1	2	3	4

Do you add salt to food after it has been cooked?

Always	Sometimes	Never	Don't know
1	2	3	4

Do you like salty foods e.g. salted peanuts, crisps?

Very much	Like	Not at all
1	2	3

KEEPING FOOD:

Do you keep food from one meal to eat at the next meal?

Always	Sometimes	Never	Don't know
1	2	3	4

If ALWAYS OR SOMETIMES, what foods do you keep?
Do you eat kept food cold or do you reheat it?

FOOD	Reheated	Eaten cold

Do you use any of the following?

	Name of product	Amount/day
Vitamins/vitamins & minerals		
Tonics		
Health foods		
Body building preparations		
Dietary fibre supplement		
Other: specify		

THANK YOU FOR YOUR COOPERATION AND PATIENCE

GOOD-BYE!

Annexure E

Food Diary

Dear Friend,
The purpose of this survey is to obtain information on the food that you have eaten for the last 24 hours, especially those that are rich in Iron. Please tick on the appropriate column to indicate if you eat some of the foods listed below.
Please be as honest as possible.
Thank you for your co-operation.

TIME :		
PLACE :		
LIST OF FOODS	**YES**	**NO**
Meat:		
Minced meat		
Ham		
Steaks		
Lamb		
Other		
Fish:		
Clams		
Crabs		
Mackerel		
Oysters		
Shrimps		
Soles		
Trout		
Tuna		
Other		
Poultry:		
Chicken with skin		
Chicken without skin		
Other		
Liver		
Whole grains		
Enriched cereals and breads		
Rice		
Pasta		
Green leafy vegetables		
Eggs		
Dried fruits		
Fresh fruits		
Dry beans		
Nuts		
Miscellaneous:		

Private Bag X021, Vanderbijlpark 1900, South Africa Privaatsak X021, Vanderbijlpark 1900, Suid Afrika

Annexure F

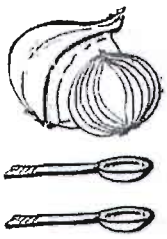
Gravy Mix

multimix

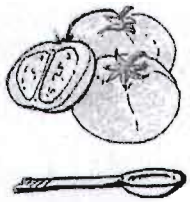
Pinch of salt

2 tablespoons oil

2 full cups water



2 tablespoons chopped onion



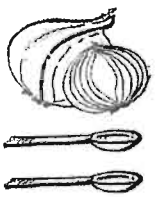
1 tablespoon chopped tomatoes

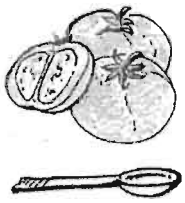
---

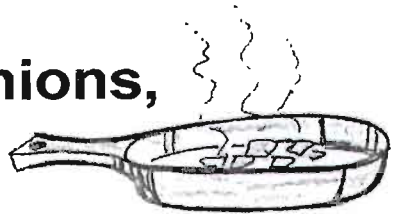
1. Add mix

+ 1 cup water +

2. And mix together to form paste

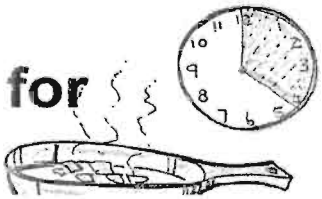
3.  +

+ 

Heat oil and fry onions, then tomatoes 

4. Add multimix paste and stir

5. Add 1/2 cup water. Keep stirring

6. Allow to cook for 20 minutes 

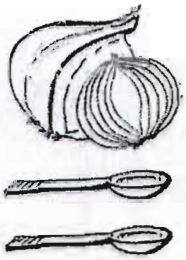
Soup Mix

multimix

Pinch of salt

2 tablespoons oil

2 full cups water

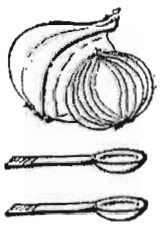


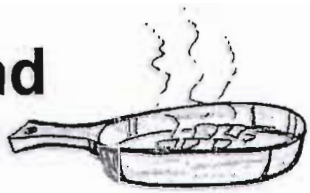
2 tablespoons chopped onion

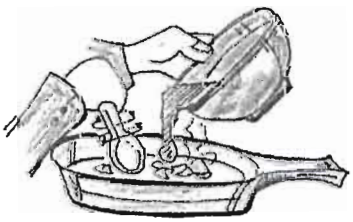
---

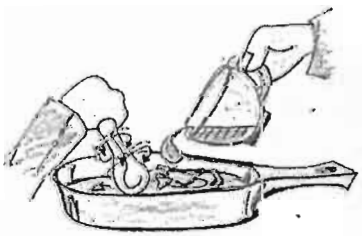
1. Add mix + 1 cup water +

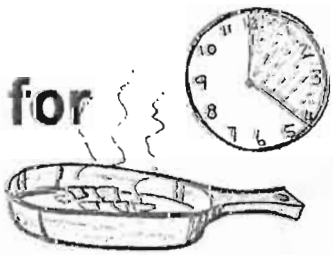
2. And mix together to form paste

3.  +

Heat oil and fry onions 

4. Add multimix paste and stir 

5. Add 1 cup water. Keep stirring 

6. Allow to cook for 20 minutes 

Annexure G

SENSORY EVALUATION FORM

NAME:.....
RATINGS:
.....
.....

Very good (4/4) **Good (3/4)** **Bad (2/4)** **Very bad (1/4)**

Please mark with a cross (X) on the face which best describes your feelings about the following:
RECIPE:.....

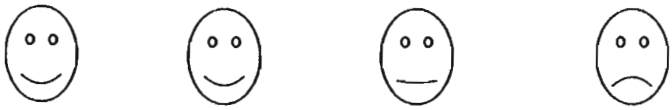
1. APPEARANCE

2. FLAVOUR

3. TASTE

4. FEEL

5. SMELL



COMMENTS:
.....
.....

.....

.....

Annexure H

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Kesa

CLEARANCE CERTIFICATE **PROTOCOL NUMBER M040110**

PROJECT The impack of dietary diversification on nutritional status of pregnant women in the Vaal triangle region.

INVESTIGATORS Ms H Kesa

DEPARTMENT Faculty of Humanities

DATE CONSIDERED 30:01:04

DECISION OF THE COMMITTEE* Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 04.03.23 **CHAIRPERSON** .....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Professor W Oldewage-Theron

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10005, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Annexure I

Vaal University of Technology
Department: Hospitality and Tourism

Department Tel: (016) 950 9279
Fax: (016) 950 9788

20 April 2004

Sister D Magagula
Acting Executive Manager - Social Services
Sedibeng District
Fax No: 422-6939

Research Project for D-Studies

A research project was undertaken during 1999 by the Hospitality and Tourism Department to determine the eating habits and nutritional status of pregnant and lactating women between the ages of sixteen and thirty in the Vaal Triangle. The results of that research project have helped the department to establish and plan intervention programs.

The title of the project is: The impact of dietary diversification on the nutritional status pregnant women in the Vaal Triangle region.

This study is a continuation of the previous study. The main focus of this study will thus be on women who are pregnant in their first trimester, to improve their nutritional status during pregnancy in order to have healthier pregnancy outcomes. (Healthy babies, fewer miscarriages and prevent stillborn babies).

The main objective of the project is to develop a cheap, tasty, nutritious and acceptable food product based on local food staples (called a multimix) for household consumption for pregnant women in the Vaal Triangle. (E.g. maize meal, dried beans, vegetables, etc).

However we cannot do it without your assistance.

I would appreciate it if I could meet with the clinic sisters and yourself to discuss the project with you in detail and to also share with you the results of the previous study. The areas of interest are Vanderbijlpark, Vereeniging and Meyerton.

I appreciate your co-operation in this matter. The results of the project will be furnished to you after completion.

I wait for your response in anticipation

Kind Regards

Hema Kesa
Snr. Lecturer
Department: Hospitality and Tourism

Annexure J

Information Letter
Dietary Diversification: Pregnant Women

1. **Researcher: Hema Kesa (Action: Introduction and explain the purpose of the meeting).**

Good day, I am currently working at the Vaal University of Technology, Department: Hospitality and Tourism as a Senior Lecturer. I am currently busy with my D-Tech studies and will therefore need your co-operation and assistance in doing so.

2. **Background**

A study was conducted in 2001 on the dietary intake and iron status of pregnant and lactating women in the Vaal Triangle. The results showed that the women were not eating properly and therefore were not healthy during their pregnancy and therefore this had affected their pregnancy outcomes. (babies)

3. **Project title (Action: Explain and translate key concepts).**

The impact of dietary diversification on nutritional status of pregnant women in the Vaal Triangle region.

Duration of study: August 2003 – September 2006

The main focus of this study will thus be on women who are pregnant in their first trimester, to improve their nutritional status during pregnancy in order to have healthier pregnancy outcomes. (Healthy babies, fewer miscarriages and prevent stillborn babies).

The main objective of the project is to develop a cheap, tasty, nutritious and acceptable food product based on local food staples for household consumption for pregnant women in the Vaal Triangle region. (E.g. maize meal, dried beans, vegetables, etc).

4. **Benefits to participants**

- The participants will benefit by this study by receiving a multimix powder to improve their nutritional status;

- Babies will be born healthier
- Nutritional status during pregnancy will improve resulting in a healthier pregnancy;
- Education on food preparation skills.

5. Disadvantages

The subjects may experience some discomfort in the form of pain with a prick of a needle in the drawing of blood. Provision will be made if medical treatment is needed.

6. What is expected from participants?

Tasks for participants	**Time (Dicuss with participant- day most suitable according to clinic visit).**	**Responsible person**
1. Completion of questionnaires; 2. Have anthropometric measurements taken i.e. weight, height, waist and hip circumference and mid upper arm; 3. Clinical examinations; 4. Drawing of blood	Every 3-6 months before during pregnancy at the clinics.	1. Fieldworkers (may not always be the same). 2. Fieldworkers and researcher (when available). 3. Fieldworkers and researcher (when available). 4. Nursing sisters.
5. Participate in food preparation skills.	After completion of tasks 1-4 (At the Vaal University of Technology, Dept: Hospitality and Tourism)	Fieldworkers and researcher
6. Use of developed product in staple foods	During task 5 (At individual homes)	Participants

7. Who are eligible to participate?

Study will include:

- Females
- Aged between 20-30
- Low income
- Pregnant in their first trimester.

- Geographical area – Vaal Triangle region.

8. Details of research project

Specific objectives of the study are to:

1. Determine the food consumption patterns and dietary intake of pregnant women in Vaal Triangle;

2. Determine the nutritional status of pregnant women in the Vaal Triangle;

3. Formulation of the multimix;

4. Recipe development and sensory evaluation

5. Intervention study to assess the impact of the multimix consumption on nutritional status (2005) of pregnant women, (2006);

6. To assure compliance during the intervention study sensory evaluation will form part at the end of this study, (2006);

7. Evaluation and reporting of results.

However participation in this project will be on voluntary basis, and refusal to participate will involve no penalty or loss of benefits, you may also discontinue participation at any time without penalty or loss of benefits.

Thank you,

Hema Kesa
Vaal University of Technology

Annexure K

INFORMED CONSENT: DIETARY DIVERSIFICATION FOR PREGNANT WOMEN IN THE VAAL TRIANGLE REGION.

I, the undersigned.....(full names in print) have read the details of the project, or have listened to the oral explanation thereof, and hereby state that I understand it. I have had the opportunity to discuss all my queries with the researcher and understand that I voluntarily participate in the project. I hereby agree to participate in the project and for blood samples to be taken from me. I realise that I may withdraw from this study at anytime that I decide not to continue.

.....
Signature of volunteer

Signed at ..... on .....

Witnesses

Name ..... Name .....

Signature ..... Signature .....

Signed at ..... on .....

For subjects under the age of 21 years, signed consent of a parent or legal guardian is essential.

I, ...(full names), the parent/legal guardian of the person named above, hereby agree that she may participate in this research project and that blood samples may be taken from my child.

Signature ..... Relationship.....

Signed at ..... on .....

Address of volunteer: .....
.....
.....

Telephone number : .....

Annexure M

DIETARY DIVERSIFICATION: PREGNANT WOMEN

VAAL UNIVERSITY OF TECHNOLOGY

DEPARTMENT: HOSPITALITY AND TOURISM

Researcher: H. Kesa

ANTHROPOMETRIC QUESTIONNAIRE

Surname		ID number (if applicable)	
First Names		Age	
Subject No		Name of Clinic/ Hospital for giving birth?	
Height	, m	Current Weight	, kg
Blood pressure	mmHg	Weight before pregnancy	, kg
Mid upper arm circumference	, cm	Waist circumference	, cm
		Hip circumference	, cm

Supplements during pregnancy: Yes/No (underline)

Name of supplement: .....

Reason for taking supplement: .....

Thank you

Annexure L

From: hema kesa
Sent: Wednesday, June 02, 2004 9:25 AM
To: babsie jacobs
Subject: FW: clinics offering ANC services

SEDIBENG DISTRICT
CLINIC ALLOCATION.doc

Please print message and attachment.

Hema
-----Original Message-----
From: Dolphin Magagula [mailto:DolphinM@sedibeng.gov.za]
Sent: Tuesday, June 01, 2004 2:12 PM
To: hema kesa
Cc: HiteshK@siemens.co.za
Subject: Re: clinics offering ANC services

Hi Hema,
Herwith the list of clinics offering Antenatal services. The Lesedi clinics were included for your information ; these clinics are in Heidelburg .All the managers have been informed about the research. You can be assured of their support.

Thanx
Dolphin Magagula
----- Original Message -----

From: hema kesa
To: 'Dolphinm (E-mail)
Sent: Monday, May 17, 2004 12:12 PM
Subject: Copy of letter and new proposal

Dear Mrs Magagula

Please find attached a copy of the letter we discussed this morning and a copy of my proposal with changes.

<<letter-permissions clinic2.doc>> <<D-STUDIES PROPOSAL(2)L.EDJan 2004.doc>>

I will fax the ethics letter and this letter ASAP.

Thank you

Hema

Annexure N

Health and Medical Questionnaire

DIETARY DIVERSIFICATION: PREGNANT WOMEN

VAAL UNIVERSITY OF TECHNOLOGY

FACULTY: HUMANITIES

DEPARTMENT: HOSPITALITY AND TOURISM

ANTHROPOMETRIC, HEALTH AND MEDICAL QUESTIONNAIRE

Section A:

1.

Surname		ID number (if applicable)	
First Names		Age	
Height	, m	Current Weight	, kg
Blood pressure	mmHg	Weight before pregnancy	, kg
Mid upper arm	, cm	Waist circumference	, cm
		Hip circumference	, cm

Section B:

HEALTH QUESTIONNAIRE:

2.

ARE YOU SUFFERING OR HAVE YOU SUFFERED FROM	YES	NO	IF ANY ANSWER IS YES, GIVE DETAILS OF THE NATURE, SEVERITY AND DURATION OF ILLNESS
1. Any skin disease?			
2. Any affection of the skeleton and/or joints?			
3. Any affection of the eyes, ears, nose or teeth?			
4. Any affection of the heart or circulatory system?			
5. Any swollen feet/ water retention or high blood pressure?			
6. Any affection of the chest or respiratory system?			
7. Any affection of the digestive system?			
8. Any affection of the urinary system and/or genital organs?			

9. Any nervous affection or mental abnormality?			
10. Any headaches			
11. Any other illness?			

3.

Would you say your usual level of physical activity is:	**Tick the correct block**
1. Heavy/ rigorous (running, playing tennis, swimming, doing heavy gardening, etc., at least three times per week)	
2. Moderate (Taking rigorous exercise once or twice a week, or steady walking, or other moderate activities at least three times per week)	
3. Light (playing golf, taking a stroll, or doing none rigorous activities occasionally)	
4. None (No exercise whatsoever)	

4.

	YES	**NO**
1. Do you suffer from any defect of hearing, speech or sight?		
2. Are you physically disabled and do you use artificial limbs?		
GIVE DETAILS OF THE NATURE AND SEVERITY OF THE DISABILITY		

5.

Do you smoke at this moment?	**Tick the correct block**
1. Yes	
2. No (Never smoked	
3. No (Stopped)	

6.

Do you make use of snuff at this moment?	**Tick the correct block**
1. Yes	
2. No (Never used)	
3. No (Stopped)	

7.

Does you're spouse or partner smoke at this moment?	**Tick the correct block**
1. Yes	
2. No	
3. Not applicable	

8.

Do you use alcohol on a regular basis ?	**Tick the correct block**
1. Yes	
2. No	
3. Not applicable	

9.

If you use alcohol, How often?	**Tick the correct block**
1. Every day	
2. Once a week	
3. Occasionally	

10.

What type of alcoholic drinks do you drink?	**Tick the correct block**
1. Commercial beer / cider	
2. Home brewed beer	
3. Strong liquor ex. Whiskey, brandy, Vodka etc.	
4. Wine	

11.

	YES	**NO**
Have you undergone any operations?		
GIVE DETAILS OF THE NATURE AND DATE OF THE OPERATION/S		

Section C:

MEDICATION QUESTIONNAIRE:

1.

1. Do you use any medication?	**Yes**	**No**
2. If no, go to the next block.		
3. If yes, what for/why?		
4. What is the name of the medication you are taking?		
5. What is the dosage and how often do you take this medication?.	**Dosage**	**How often?**

2.

Which health facility is commonly used by the household?	**Tick the correct block**
1. Private Doctor	
2. Clinic	
3. Hospital	
4. Traditional Healer	
5. Other (please state)	

3.

How does the household travel to the health facility?	**Tick the correct block**
1. On foot	
2. Taxi	
3. Bus	
4. Own transport	
5. Other (please state)	

4.

Has there been a death of a child under 5 years within the family?	**Tick the correct block**
1. Yes	
2. No	

If yes answer the next two questions

5.

How old was the child?	**Tick the correct block**
1. Still born	
2. Miscarriage	
3. 0-7 days	
4. 0-3 Months	
5. 4-12 Months	
6. 13 – 24 Months	
7. 2-5 years	

6.

Do you know the cause of death	**Tick the correct block**
1. Yes	
2. No	

7. If yes please specify:

_____

_____

I declare that the above-mentioned information is true and correct and that I have not withheld any information.
Signature.....Date.....

Annexure O

24 – Hours Recall Questionnaire

24 – HOURS RECALL

Subject ID number: _____ Interviewer: _____

Name: _____ Date: _____ / _____ / 2005

Address: _____

Tick what the day was yesterday:

Monday	Tuesday	Wednesday	Thursday	Friday

Would you describe the food that you ate yesterday as typical of your habitual food intake?

Yes	1	No	2

If not, why? _____

I want to find out about everything you ate or drank yesterday, including food you pick from the veld. Please tell me everything you ate from the time you woke up to the time you went to sleep. I will also ask you where you ate the food and how much you ate.

Time (approximately)	Place (Home, school, etc)	Description of food and preparation method.	Amount	Amount in g (office use Only)	Code (office use only)
From waking up to going to work, or starting day's activities					
During the morning at work or at home					

Time (approximately	Place (Home, school, etc)	Description of food and Preparation method.	Amount	Amount in g (office use Only)	Code (office use only)
Middle of the day (Lunch time)					
During the afternoon					
At night (dinner time)					

Time (approximately	Place (Home, school, etc)	Description of food and preparation method.	Amount	Amount in g (office use Only)	Code (office use only)
After dinner, before going to sleep					

* Do you take any vitamins (tablets or syrup)	Yes	1	No	2
Give the brand name and dose of the vitamin/tonic:				
* Do you receive a mealie meal mix (PVM) at the clinic?	Yes	1	No	2
How often do you eat this?		Daily	Weekly	Monthly
How much do you eat at a time?				
* Do you receive PVM drink mix at the clinic?	Yes	1	No	2
How often do you eat this?		Daily	Weekly	Monthly
How much do you eat at a time?				

Annexure P

Dietary Diversification for Pregnant Women
Vaal University of Technology
Researcher: Hema Kesa

Birth data

Subject name: ..... Subject number: .....

Place of Delivery: .....

Baby Boy/Baby Girl (underline)

Gestational age of baby: ..... Weeks

Delivery: Normal/ Caesarean

Baby

Weight: (kg)	Length: (cm)
Apgar score: (1 min)	Head circumference: (cm)
Apgar score: (5 min)	

Placenta: Weight: .....g

Mother

Weight before birth: (kg)	Weight after birth: (kg)
Weight at dismissal: (kg)	Health Status:

Date of dismissal: .....

Annexure Q

11 June 2010

TO WHOM IT MAY CONCERN

I hereby declare that I have edited the thesis entitled "The impact of dietary diversification on the nutritional status of pregnant women in the Vaal region" by Hema Kesa.

It remains the author's responsibility to make the changes suggested.

Glenda Buncombe
BA(Translation) (Rhodes University)
(cell) 083 391 2806