NUTRIENT ADEQUACY AND DIETARY DIVERSITY OF WOMEN IN THE GAUTENG AND EASTERN CAPE PROVINCES, SOUTH AFRICA – FOCUS ON MICRONUTRIENTS FROM THE NATIONAL FOOD FORTIFICATION PROGRAMME.

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KEYWORDS

24-hour recall

Dietary diversity

Dietary intake

Food fortification

Fortified staple food

Household hunger

Micronutrients

Nutrient adequacy

Women of reproductive age

ABSTRACT

Background: Micronutrient deficiencies are of public health concern in South Africa. These deficiencies affect pregnancy outcomes, growth, functional and cognitive development of children and, the health and productivity of women. As an intervention, the South African government implemented the National Food Fortification Programme (NFFP), which was mandated in 2003 and according to which, the staple foods consumed by most of the population e.g. maize meal and wheat flour (and thus bread) are fortified with a premix of thiamin, niacin, riboflavin, vitamin A, folate, vitamin B6, iron and zinc. There is limited data which looks at the contribution fortified staple food to the dietary intakes and measures of nutrient assessment among South African women of reproductive age (WRA).

Aim: The aim of this study was to assess the nutrient intakes, nutrient adequacy and dietary diversity among WRA and to estimate the contribution of mandatory fortified staple foods to micronutrient intake.

Methodology: This study had a quantitative cross-sectional design. The study used data from a single 24HR to determine the dietary intake and assess nutrient adequacy. The study population was a sub-sample of WRA (18-49 years) from the Fortification Assessment Coverage Toolkit (FACT) survey, conducted in the Eastern Cape and Gauteng provinces of South Africa. Dietary intake data was converted to nutrient intakes using the South African Medical Research Council (SAMRC) food composition database. Data was analysed using the SPSS Statistics 21 Software. Nutrient adequacy was assessed using the estimated average requirement (EAR) cut-point method, nutrient adequacy and mean adequacy ratio. Nutrient contributions from fortified staple food were also assessed, as well as the associations of this with measures of nutrient adequacy. Dietary diversity scores were calculated using the minimum diet diversity for women (MDD-W) guideline. Food security status was assessed using the simplified household hunger scale (HHS). Dietary intake data was not normally distributed and non-parametric tests were applied. Differences between provinces; dietary diversity groups; consumption of fortified staple food with dietary intake, nutrient adequacy measures and socioeconomic characteristics were determined using independent t-tests or Mann-Whitney U tests for continuous data and Chi-square analysis for categorical data. Linear and binary logistic regression analysis as well as Spearman correlation (skewed data) analysis were used to explore the association of nutrient adequacy and dietary diversity with socio-economic characteristics, nutrient intakes and mean adequacy ratio (MAR).

Findings: Energy intakes for study sample was 6559 kJ (interquartile range [IQR]: 5000 kJ; 9190 kJ). Women in Gauteng had a significantly higher intake of energy, protien and fat

($p<0.05$). The mean and standard deviation (SD), percentage energy intakes for total carbohydrates, total fat and total protein were within the acceptable minimum dietary range (AMDR), except for women in Eastern Cape who had a percentage energy from total carbohydrates above the AMDR. The MAR for the total study sample was 77.8%, with a higher MAR for women in Gauteng, compared to women in the Eastern Cape, $p=0.02$. More than 50% of women had micronutrient intakes below the EAR for: vitamin B12, folate, calcium, magnesium, potassium, vitamin A and vitamin C. Fortified staple foods contributed more than 50% of the micronutrient intakes of vitamin A, iron, zinc, folate, vitamin B6, niacin and thiamin among women who consumed these fortified staple foods.

The mean dietary diversity score (SD) was 3.7 (1.3), with only 24.6% of women meeting the MDD-W. Pulses; nuts and seeds; eggs, dairy; dark green leafy vegetables; other vitamin A rich fruits and vegetables were consumed by less that 50% of the women on the day of recall. Regression analysis showed that women with a lower living standards measure (LSM) of <6 and those who received a chid support grant, were less likely to achieve the MDD-W, [OR=0.449, (95% CI 0.244-0.827)] and [OR=0.478, (95% CI 0.263-0.870), respectively. No significant associations of MAR with socioeconmic characteristics were found, $p>0.05$.

Conclusion: This study demonstrates that micronutrient adequacy and adequate dietary diversity remains a challenge for WRA, especailly those from more impoverished and vulnerable households. The NFFP contributes a signifcantly to the micronutrients intakes of WRA, and together with intervetions aimed at imporving nutrient adequacy, it provides a complimentary approach to addressing the micronutrient deficiencies among South African WRA.

DECLARATION

I, Roxanne Fisher, student number: 3111911, hereby declare that the dissertation titled "Nutrient adequacy and dietary diversity of women in the Gauteng and Eastern Cape provinces, South Africa – focus on micronutrients from the National Food Fortification Programme", is my own independent work and that it has not been submitted for any degree or examination in any other university, and that all sources I have used or quoted have been acknowledged.

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R. Fisher

9 September 2021

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ACRONYMS AND ABBREVATIONS

%TE	Percentage Total Energy
24HR	24 Hour-recall
AMDR	Acceptable Minimum Dietary Range
BMI	Body Mass Index
DBM	Double Buren of Malnutrition
DDS	Diet Diversity Score
DRI	Dietary Reference Intakes
EA	Enumeration Area
EAR	Estimated Average Requirement
EER	Estimated Energy Requirement
FACT	Fortification Assessments Coverage Toolkit
FAO	Food and Agriculture Organization
GAIN	Global Alliance for Integrated Nutrition
HHFS	Household Food Security
HHS	Household Hunger Scale
LMIC	Low-and-middle Income Countries
LSFF	Large Scale Food Fortification
LSM	Living Standards Measure
MAR	Mean Adequacy Ratio
MDD-W	Minimum Diet Diversity for Women of Reproductive Age
MND	Micronutrient Deficiencies
MNM	Micronutrient Malnutrition
MUIC	Median Urinary Iodine Concentration
NAR	Nutrient Adequacy Ratio
NFCS	National Food Consumption Survey
NFFP	National Food Fortification Programme
PSU	Primary Sampling Units
SAARF	South African Audience Research Foundation
SADHS	South African Demographic and Health Survey
SAMRC	South African Medical Research Council
SANHANES	South African National Health and Nutrition Examination Survey

UIC	Urinary Iodine Concentration
UNICEF	United Nations Children's Fund
VAD	Vitamin A Deficiency
VAS	Vitamin A Supplementation
WRA	Women of Reproductive Age

DEFINITION OF TERMS/GLOSSARY

24 hour recall (24HR): A structured interview which captures detailed information about all dietary intake from the respondent in the past 24 hours. The respondent is asked to recall all foods and beverages in the past 24 hours (Thompson and Subar 2013).

Adequate dietary diversity: Dietary intake of 5 or more food groups out of 10 defined food groups for MDD-W (FAO and FHI 360 2016).

Food groups: Foods which have similar amounts of keys nutrients that are grouped together. For this study 10 predefined food groups were use which are : (1) grains, white roots, tubers and plantains; (2) pulses: beans, peas and lentils; (3) nuts and seeds; (4) dairy; (5) meat, poultry and fish; (6) eggs; (7) dark green leafy vegetables; (8) other vitamin A-rich fruits and vegetables; (9) other vegetables and (10) other fruits (FAO and FHI 360 2016).

Fortificant nutrient: Micronutrients which are added to maize meal and wheat bread flour as per the South African legislation (Department of Health 2003).

Fortified staple food: A food which is widely consumed by a population to which micronutrients are added (Allen *et al.* 2006). In South Africa, maize meal and wheat bread flour are the staple foods which are fortified with 8 micronutrients.

Living standards measure (LSM): A maketing and research tool used to classify standard of living. This tool assesses 29 variables which are household assets and facilities. The LSM is comprised of ten groups, where households with a LSM of 1 is classified as being the most impoverished and households with LSM of 10 being less impoverished with more household assets (Haupt 2006).

Micronutrient adequacy: Dietary intake level of a micronutrient which meets the specified nutrient reference value, to reduce risk of deficiency or excess levels (Tabacchi *et al.* 2009).

Poor dietary diversity: Dietary intake of 4 or less food groups out of 10 defined food groups for MDD-W (FAO and FHI 360 2016).

Women of reproductive age (WRA): Women aged 18-49 years.

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CHAPTER 1: INTRODUCTION

South Africa experiences a double burden of malnutrition (DBM), which is the coexistence of undernutrition (micronutrient deficiencies and underweight), overweight, obesity or diet-related non-communicable diseases (Popkin *et al.* 2020). The increase in the prevalence of chronic diseases is largely attributed to changes in lifestyle such as unhealthy diet, tobacco use, risky drinking and sedentary lifestyles associated with globalisation and urbanisation (WHO 2014). Similarly, unhealthy diet, lifestyle changes and urbanization are some of the main causes of overweight and obesity which, in turn, are major risk factors for hypertension and type 2 diabetes in South Africa (Nojilana *et al.* 2016)**.** The micronutrient status of women in South Africa has seen an improvement, with many micronutrient deficiency statuses moving from a severe public health issue to a moderate or low public health issue (Shisana *et al.* 2014, Harika *et al.* 2017). The data on the micronutrient adequacy shows an increase but seems to have slowed down. This is the same for the dietary diversity of women, which calls for investigation on the underlying factors that are associated with these measures of nutrient assesment. Many food based approaches have been employed over the last 2 decades to address malnutrition. In particular, food fortification of staple foods was made mandatory in many countries, including South Africa, as an intervention strategy to address the multiple micronutrient deficiencies at national level (Allen *et al.* 2006, Department of Health SA *et al.* 2007, Steyn *et al.* 2008).

1.1 Research problem

Fortification of maize meal and wheat flour became mandatory in October 2003 in South Africa. A reflection report on the mandatory food fortification programme revealed that the programme has reached many of its objectives but did, however, have challenges (Department of Health SA *et al.* 2007). A baseline survey assessing the micronutrient status of the South African population in 2005, led by the University of Stellenbosch was conducted to benchmark monitoring and evaluation of the National Food Fortification Programme. This was compromised mainly due to the survey being conducted more than a year after the legislation became mandatory. In addition several millers already started fortifying maize meal and wheat flour before the legislation became mandatory. There have been a few studies, since the implementation of mandatory fortification, which estimated the effect of fortification on micronutrient intake of women of reproductive age (WRA). A theoretical estimation of potential contribution of mandatory fortification to micronutrient intake by Steyn *et al,* 2008,

suggests that the consumption of fortified staple foods (maize meal and wheat flour/bread) has the potential to improve mean vitamin B6, thiamin, riboflavin, niacin, folate and iron intakes of South African adults (Steyn *et al.* 2008). A cohort study that assessed dietary intake and micronutrient status in South African lactating women in 2002 and 2004 showed that the mandatory food fortification improved the micronutrient intakes by more than 70%, but the Estimated Average Requirement (EAR) for zinc, vitamin A, riboflavin and B6 were not met and although iron intake after fortification was adequate, the iron status (based on plasma ferritin concentration) did not improve (Papathakis and Pearson 2012). A recent survey known as the FACT (Fortification Assessment Coverage Toolkit) Survey, assessed the coverage of the mandatory food fortification program in two of the nine South African provinces and showed that within these households, 16% had fortified wheat-flour and more than 75% had fortified maize flour in their household (Aaron *et al.* 2017). The FACT survey forms the base of the current study and the individual intake of nutrients are assessed by means of 24HR nutrient intake analysis, nutrient adequacy methods and dietary diversity.

1.2 Problem statement

The FACT survey provides evidence that the South African population are consuming fortified staple foods (maize meal and wheat flour/bread) within their households (Aaron *et al.* 2017, Friesen *et al.* 2017). The survey does not reflect the fortified staple food intake at individual level, or the contribution of these foods to the actual dietary micronutrient intake of WRA. Few studies have investigated the actual dietary intake to assess the contribution of consumed fortified staple foods. This study aims to assess nutrient adequacy and dietary diversity of WRA with a focus on the micronutrient contribution of fortified staple foods.

1.3 Aim and objectives of study

1.3.1 Aim of the study

The aim of this study was to assess the nutrient adequacy and dietary diversity among WRA in South Africa using a 24 hour-recall (24HR) and to estimate the contribution of fortified staple foods to their nutrient intake.

1.3.2 Research objectives

The objectives of this study were:

- To determine the estimated energy and nutrient intakes and determine nutrient adequacy.
- To determine the energy and selected micronutrients intakes from fortified maize meal, wheat flour and bread.
- To assess dietary diversity and percentage of women consuming a diet of low variety.
- To determine the association between each of these measures of nutrient intake and dietary diversity with household hunger, socio-economic factors, fortification logo awareness and its influence on the purchase of fortified staples.

1.3.3 Research questions

1. Are the nutrient intakes of WRA adequate?
2. What is the contribution of fortified staple foods to total nutrient intakes of WRA?
3. Does the study sample meet the minimum dietary diversity for women?
4. Are nutrient intake, nutrient adequacy and dietary diversity associated with the socio-economic factors?

CHAPTER 2: LITERATURE REVIEW

2.1 Nutritional status of women

Global malnutrition in all its forms continues to be high and is the leading cause of poor health outcomes (Development Initiatives 2018). Many low- and middle-income countries (LMIC) are faced with a DBM which is the coexistence of undernutrition (micronutrient deficiencies and underweight), overweight, obesity or diet-related non-communicable diseases (Popkin *et al.* 2020). Women carry a higher burden to certain forms of malnutrition which include anaemia, overweight, obesity and underweight. The Global Nutrition report of 2018, which analyzed data from 2000-2016, showed an increase in the prevalence of anaemia (31.6% to 32.8%), overweight and obesity (31.7% to 39.2%) among women. The report also stated that, for the same period, the prevalence of underweight decreased from 11.6% to 9.7% (Development Initiatives 2018). The consequences of malnutrition in WRA include increased risk of pregnancy and childbirth complications such as intrauterine growth retardation and low birth weight infants (UNICEF 2013, Wells *et al.* 2020). The risk factors associated with maternal malnutrition can affect the fetal and infant development which can hinder the cognitive development of the child later in life (UNICEF 2013).

Additionally, undernutrition during early childhood resulting in stunting and micronutrient deficiencies increases the risk for overweight and obesity later in the life cycle i.e. during adolescences and adulthood (UNICEF 2013). The long-term consequences of malnutrition throughout women's life cycle has been described as a vicious cycle and is shown in ***Figure 1,*** (ACC/SCN 2000)**.**

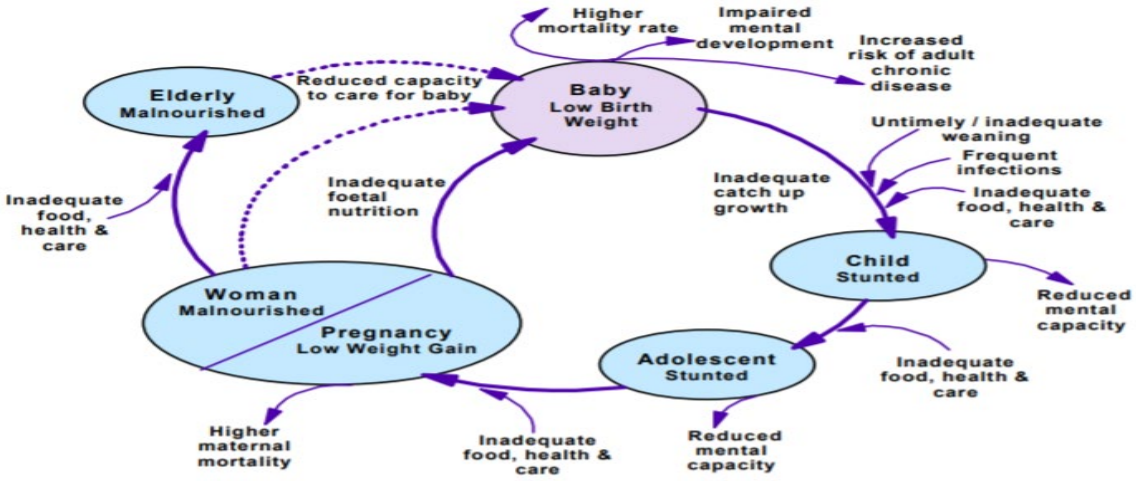

Figure 1: Nutrition throughout the life cycle

Source: Commission on the Nutrition Challenges of the 21st Century (2000) Final report to the ACC/SCN (ACC/SCN 2000).

2.2 Nutritional status of South African women

South Africa is undergoing an epidemiological transition which has resulted in the increased prevalence of overweight and obesity (Micklesfield *et al.* 2013). South African women are now facing an increasing burden of non-communicable diseases where there is a decline in underweight and increase in overweight and obesity. According to the South African Demographic and Health survey (SADHS) of 2003 and 2016, for women aged 15 years and older, there was a decrease in underweight prevalence from 6.2% to 2.6 and an increase in overweight and obesity (55% to 67.6%), (Department of Health and Medical Research Council 2003, NDoH *et al.* 2017). A recent report of the malnutrition burden faced by women indicated that 25.8% of WRA had anaemia, 12.6% had diabetes and 39.6% had obesity (UNICEF *et al.* 2019).

2.2.1 Micronutrient status of women

Micronutrient deficiencies (MND), a form of under nutrition, continues to be a public health concern with a focus on deficiencies of vitamin A, iron, folate, zinc and iodine. These MND are associated with increased risk of maternal and perinatal mortality, birth defects, growth and delays in functional and cognitive development (Labadarios *et al.* 2008, Shisana *et al.* 2014).

Vitamin A deficiency (VAD) has been associated with increased risk of infection, morbidity and mortality and causes xerophthalmia (WHO 2009). A review article which reviewed data from 4 African countries among WRA, between 2005-2015, reported a weighted by sample size (WAVG) prevalence of 22% VAD for South Africa, which was the highest prevalence for the four countries included in the review. The South African National Health and Nutrition Examination Survey (SANHANES) 2012, showed that, among females of reproductive age, the rates of VAD decreased from 27.2% in 2005 (Labadarios *et al.* 2008) to 13.3% in 2012 (Shisana *et al.* 2014). This reduction can be due to the implemented vitamin A supplementation (VAS) program (National Department of Health 2002) for women postpartum and the mandatory fortification of staple foods (Department of Health 2003) which includes vitamin A. The VAS for women post-partum was later stopped by the National Department of Health as the VAD prevalence shifted from a severe to a moderate public health problem according to WHO recommendations of serum retinol levels (WHO 2011a, 2011b).

A diet deficient in iron is probably the most common cause of anaemia. Iron deficiency adversly effects cognative development, behaviour and growth of infants; immune status, morbity related to infections and physical use of energy in all age groups (WHO 2001). WRA are at a higher risk of anaemia due to iron losses during menstruation (Shisana *et al.* 2014). Additionally, the SANHANES 2012, reported that the prevalence of anaemia in women aged 16-35 years was 23.1%, 15.3% of women were iron deficient (low serum ferritin) and 9.7% had iron deficiency anaemia (IDA); all of which were lower when compared to the National Food Consumption Survey in 2005, (Labadarios *et al.* 2005, Shisana *et al.* 2014). A systematic review which assessed the micronutrient status and intake of WRA, reported anaemia in 23%, iron deficiency in 16% and iron deficiency anaemia in 10% of South African women (Harika *et al.* 2017). Additionally, a recent study conducted in healthy adults from the Western Cape province found that the prevalence of anaemia among women was 12.6%, iron deficiency was 39.8% and IDA 9.8%. This study also found the prevalence of anaemia and iron deficiency to be higher in females compared to males (Phatlhane *et al.* 2016).

Limited research exists on the status of zinc and folate in South African women. For vitamin D status, a study conducted in the KwaZulu-Natal province assessing vitamin D status, found that 39% of the WRA had a serum level of 25-hydroxyvitamin D [25(OH)D] below 20 ng/ml, which indicates vitamin D deficiency (Naidoo *et al.* 2019). Data on iodine status for women according to urinary iodine concentration (UIC), is contradictory, as the National Food

Consumption Survey (NFCS) of 2005 reported excess concentrations of urinary iodine for 40% of women. A more recent study which included national data of South African adults, reported that, among women, 57% had a UIC < 100 µg/L, indicating iodine deficiency (Charlton *et al.* 2018).

2.3 Dietary intakes of South African women

2.3.1 Energy and macronutrient intake

Urbanization and the nutrition transition have been shown to contribute to poor dietary practices in adults, including increased intakes of energy, mainly from sugar, and fats (Steyn *et al.* 2012, Micklesfield *et al.* 2013, Shisana *et al.* 2014). A review of dietary intakes in South African adults, which looked at data from the year 2000-2015 showed that, except for women in KwaZulu-Natal and urban North West province, mean energy intakes were below the estimated energy requirement (EER), which indicates inadequate energy intakes (Mchiza *et al.* 2015). A study in the Free State province reported similar energy intakes for female participants (Oldewage-Theron, Egal, *et al.* 2014). In the review of dietary intakes, the total energy contribution from protein ranged from 11-15%, fat from 17-37% and carbohydrates from 47-60%, which were all within the AMDR (Mchiza *et al.* 2015). A cross-sectional study conducted in urban areas of the Northern Cape and Western Cape and a rural area of the Limpopo province reported very similar results for women, with 13-14% energy from protein, 47-68% energy from carbohydrates and 16-37% energy from fat (Ford *et al.* 2016). The SANHANES used a fat score, which was based on dietary habits of fat used in the diet, to classify the intake of fat, a high fat score ranged from 11-20, a moderate score from 6-10 and a low score from 0-5. The survey found that the national mean score of the fat intake was 7.2 for women and therefore can be referred to as a dietary pattern which included a moderate amount of fat in the diet (Shisana *et al.* 2014). Literature therefore shows inadequate energy intakes with the percentage energy from macronutrients to be within the AMDR ranges.

2.4 Assessment of dietary intake as measured by nutrient adequacy and dietary diversity

2.3.2 Micronutrient intake

In the last 10 years, the micronutrient intakes of WRA, specifically the intake of iron, vitamin A, zinc and folate, are reported to be below the EARs, indicating inadequate intakes

(Oldewage-Theron and Kruger 2011, Kolahdooz *et al.* 2013, Oldewage-Theron, Egal, *et al.* 2014). A review which assessed micronutrient intakes found that the reported mean intake of vitamin D and calcium of adult women to be below the EARs (Mchiza *et al.* 2015). Another review paper by Harika *et* al. 2017, using the EAR cut-point method, reported inadequate intakes for iron, vitamin A, folate, zinc and iodine in WRA (Harika *et al.* 2017).

For iodine intakes, UIC is used as an indicator because dietary iodine is readily absorbed and up to 90% of dietary iodine is excreted in urine. The median UIC (MUIC) is used as an epidemiological criteria for adults. The global cut-offs for MUIC are ≤ 100 µg/L as inadequate intake and ≥ 300 µg/L as excessive intake (WHO 2013). As previously stated, data from the 2005 NFCS, reported a high MUIC among 40% of women, which indicated a high intake of iodine (Labadarios *et al.* 2005). More recent data also report sufficeint intakes for women (Mabasa *et al.* 2019). However, a study in South African adults and iodine status report that, among women, 57% had an inadequate iodine intake (Charlton *et al.* 2018).

2.4.1 Nutrient adequacy

Nutrient adequacy has been defined achieving the recommended daily macro- and micronutrients (Ruel 2003). The criteria of adequacy refers to the intake a given nutrient in a specific amount which is required to prevent unwanted health outcomes like chronic diseases, deficiency diseases or risk of diet related diseases and imbalances required for maintaining physiological balance (Dhonukshe-Rutten *et al.* 2013). Nutrient adequacy is the assessement of the nutrient intake and the nutrient requriement of a certain individual or population. Nutrient adequacy assessment can be done using the probability approach and the estimated average requirement (EAR) cut-point method (which is a modification of the probability approach) (Castro-Quezada *et al.* 2014).

The probability approach takes into account the probability of inadequate intakes of a nutrient for each individual in a population group, then the average of the probabilities are used as an estimate to for prevalence of the level of nutrient inadequacy (Tabacchi *et al.* 2009). The EAR cut-point method can be described as a modified or shortcut to the probability approach, for this the prevalence of inadequate intakes is simply the proportion of a population with intakes below the median EAR requirement (IOM 2000). The nutrient adequacy ratio compares the individual's daily intake of a nutrient with the relevant nutrient reference value (Hatløy *et al.* 1998). The Institite of Medicine recommends using the EARs as a nutrient reference value

when assessing the adequacy of a group. The mean adequacy ratio (MAR) is the sum of all the NARs (capped at 1 or 100%), divided by the number of nutrients evaluated (Steyn *et al.* 2006). It should be noted that Meng et al., (2018), used a cut-off point of 0.75 (75%) for MAR to define an overall micronutrient inadequacy (IOM), which was also applied in previous studies (Schuette *et al.* 1996, Hatløy *et al.* 1998) and used the RDA as a nutrient reference value. The nutrient adequacy for women in South Africa over the past 3 decades has increased, despite not achieving a 100% MAR. Data from 2004 -2007 showed a MAR of 74.25% (Acham *et al.* 2012), where another study with data from 1990 -2009, showed a MAR of 75 -76% (Steyn *et al.* 2016). Additionally, a study conducted in women in a rural area of the KwaZulu-Natal province, compared the nutrient intakes to the EARs or AIs reference values (where EARs not defined) and found inadequate nutrient intakes for vitamin A, B12, C, D, E, calcium, zinc and pantothanate (Kolahdooz *et al.* 2013). Overall, the nutrient adequacy of micronutrients which are of public health concern, have increased over time, with the expection of calcium, which predomanintly remains at 40% nutrient adequacy, possibliy due to the low dietary intake of dairy or the typical dietary intake of foods which contain compounds that may reduce to bioavailability of dietary calcium (Acham *et al.* 2012, Kolahdooz *et al.* 2013, Steyn *et al.* 2016).

2.4.2 Dietary diversity

The dietary diversity score (DDS) is a simple count of food groups based on what an individual has consumed in a specified time period; it provides information on intake of food groups which is scored and compared to a cut-off value to determine low or adequate dietary diversity (Steyn *et al.* 2006, Kennedy *et al.* 2013). The Minimum Dietary Diversity for Women (MDD-W) is as a validated indicator for the assessing the micronutrient adequacy of diets in WRA (FAO and FHI 360 2016). Similar to the traditional use of diet diversity scores, the MDD-W is a dichotomous indicator of assessing whether WRA have consumed food from at least five out of ten defined food groups in the last 24 hours. The ten food groups are: (1) grains, white roots, tubers and plantains; (2) pulses: beans, peas and lentils; (3) nuts and seeds; (4) dairy; (5) meat, poultry and fish; (6) eggs; (7) dark green leafy vegetables; (8) other vitamin A-rich fruits and vegetables; (9) other vegetables and (10) other fruits. The scores of the 10 food groups are summed to calculate the M-DDW. A dietary diversity score of five or more indicates the achievement of MDD-W and can be presented as a percentage of women more likely to have more adequate micronutrient intakes than women who have not achieved the minimum dietary diveristy score (FAO and FHI 360 2016). A study conducted by Chakona and Shackleton

(2017), using a 48-hour dietary recall to determine the diet diversity in WRA, in three South African towns, found that only 25% of women achieved a MDD-W and a mean (SD) score for the total group of 3.5 (0.1).

The MDD-W has been proposed as one of the nutrition indicators to be included in the Sustainable Development Goals framework, particularly as it relates to Sustainable Development Goal 2, 'End hunger, achieve food security and improved nutrition and promote sustainable agriculture', (Gil *et al.* 2019). This indicator has also been used to investigate the association of dietary diversity with socioeconomic factors including household food security (HHFS) status, (Chakona and Shackleton 2017). A more recent study within the Free State province, used the Food and Agriculture organisation (FAO) tool for dietary diversity where a dietary diversity score of 3 or less was considered low dietary diversity score; 4 to 5 was a moderate dietary diversity score and 6 or more was a high dietart diversity score. This study reported that almost 45% of participants had a low dietary diversity score, about 51% had moderate dietary diversity score and just under 4% had a high dietary diversity score (Jordann *et al.* 2020).

2.5 Factors associated with dietary intake

There are many factors which can directly or indirectly influence dietary intake. The UNICEF conceptual framework for malnutrition describes factors that influence dietary intake with immediate, underlying and basic causes that lead to, consequential nutritional status or health outcome. Inadequate dietary intake is an immediate cause of malnutrition, with the major underlying cause being food security and is linked to the basic cause of resources including employment and income (UNICEF, 2013).

2.5.1 Food security

According to the FAO, food security is defined as "all people, at all times having social, physical and economic access to sufficient, safe and nutritious foods to meet their dietary needs, food preferences and for an active and healthy life style", (FAO 2009). The SANHANES 2012 used the Community Childhood Hunger Identification Project (CCHIP) index as an indicator of food security. This index is composed of eight questions assessing whether individuals in the household are affected by food insecurity, food shortages, perceived food insufficiency or altered food intake because of constraints on resources and measures severity of food insecurity (Shisana *et al.* 2014). In earlier studies, this index was also used as

an indicator for food security in four national surveys and the data showed that the percentage of food insecure households halved from 1999 to 2008, from 52.3% to 25.9% respectively, while the proportion of households at risk of food insecurity varied between 23.0% and 27.9% (Labadarios *et al.* 2008, Labadarios, Mchiza, *et al.* 2011). Subsequently the SANHANES 2012 reported that 45.6% of the population was food secure, 28.3% was at risk of hunger and 26.0% experienced hunger (was food insecure) (Shisana *et al.* 2014). Using a shortened version of the household food insecurity access scale (HFIAS), the SADHS of 2016 reported 10.4% of South African households to be vulnerable to hunger, of which 63.4% came from urban areas (NDoH *et al.* 2017).

The causes of food security are mainly linked to poverty (per capita income and resources of income) and inequality (including access to food) (Misselhorn 2005, Altman *et al.* 2009). Statistics South Africa (Stats SA) reported 25.2% of South African were living below the food poverty line (R441 per person per month in 2015 prices) in 2017, which by definition, lowers an individual's ability to afford food to meet the daily energy requirements and diet quality (Statistics South Africa 2019).

According to Statistics South Africa 2017, there was a decline in poverty from 17.9% in 2001 to 7% in 2017. Based on the General Household Survey (GHS) 2017, the main contributors to the sources of income was 42% from businesses, salaries or wages and 19.9% from social grants (Statistics South Africa 2019). Stats SA used the South African Multidimensional Poverty Index (SAMPI) as the indicator for poverty, which was constructed using four dimensions of poverty; namely, health (nutrition and child mortality), education (years of schooling and school attendance), living standards (fuel for cooking, lighting and heating, sanitation, water, type of dwelling and assets) and economic activity (adult unemployment), (Statistics South Africa 2019).

2.6 Global strategies to address micronutrient malnutrition

Apporaches that address malnutrition are nutrition specific and nutrition sensitive interventions and programs which are described in the Lancet series on Scaling Up Nutrition (SUN) (Ruel *et al.* 2013). Nutrition specific interventions address nutrition and the immedtiate causes of malnutrition, whereas nutrition sensitive interventions focus on improving food and nutrition security to benefit the nutrition specific programs, which are underlying causes of malnutrition (Ruel *et al.* 2013, WFP 2014). The authors from the Lancet series on Maternal and Child

Nutrition, 2013, also advocated the scaling up of nutrition sensitive programs to enchance the effectiveness of nutrition specific programs. For the purpose of this literature review, an overview of nutrition specific interventions is presented.

The four main nutrition specific approaches to address micronutrient malnutrition are dietary diversification, fortification and bio-fortification, supplementation of both food and individual nutrients and global public health and disease control measures (Kennedy *et al.* 2003). Dietary diversification includes improving the production, processing, marketing and consumption of a variety of foods (Gibson and Hotz 2001). Dietary diversification is a food-based approach which focuses on improving the overall dietary quality and not only single nutrients (WHO and FAO 2002). Consideration of nutrient-nutrient interactions can be considered when using the food-based approach. Other low-cost, food-based approaches to diet diversification are community-based strategies which include: identification and promoting use of culturally appropriate complimentary, foods rich in micronutrients; preservation of micronutrients in fruits and vegetables by using solar drying or canning technologies; promotion of community gardens; rearing of small livestock and improving year round supply of micronutrient-rich foods (Kennedy *et al.* 2003).

Food fortification is the addition of micronutrients to processed foods. It is a cost effecitive practice of increasing the essential micronutrient content in food to improve the nutritional quality of the food supply and provides a public benefit with minimal risk to health (Allen *et al.* 2006). Large scale food foritfication (LSFF) of staple foods are population based programs which aim to address micronutrient deficiencies within a population by shifting intakes towards adequate levels (Mbuya and Neufeld 2018). Many studies in various countries have conducted research on dietary intake with the focus on foods consumed as staple or daily, that can be identified as a potential food to be fortified for increased intake of micronutrients (Department of Health 2003, Abdeen *et al.* 2014, Engle-Stone and Brown 2015). Globally, a number of fortification strategies is in place. Among them is mass fortification of table salt with iodine, which is the most widely adopted form of fortification. Fortification of food vehicles with multiple micronutrient include salt and staple foods like flour or sugar, margarine or oils and the fortificantion vehicle will differ within countries (Bailey *et al.* 2015, Aaron *et al.* 2017, Doggui *et al.* 2017). According to GAIN, fortified staple foods contribute significantly to the vitamin A and iodine intakes of WRA, in four African countries (Nigeria, South Africa, Tanzania and Uganda), (Friesen *et al.* 2020). A systematic review and meta-analysis report

which looked at the micronutrient status and health outcomes following LSFF in LMIC, reported increased serum micronutrient concentrations among several populations and reduced the odds of health outcomes from micronutrient deficiencies (Keats *et al.* 2019).

Biofortification refers to the breeding of crops, mostly staple food plants for enhancing the micronutrient content to improve micronutrient malnutrition (Bouis *et al.* 2013). The consumption of biofortified orange-fleshed sweet potato with high β-carotene content has shown a significant improvement of vitamin A status among children in South Africa (van Jaarsveld *et al.* 2005). In addition, consumption of iron-rich biofortifed beans showed to improve iron status of university women in Rwanda (Haas *et al.* 2016). Additionally, consumption of zinc-rich biofortified wheat flour among a small group of Mexcian women (n=27) showed increased zinc absorbption (Rosado *et al.* 2009).

Supplementation is the provision of micronutrients in large doses by means of syrup or pills. It is targeted at specific populations that are at high risk for deficiencies or life stages which require acute increase in requirements of specific nutrients, such as pregnant or lactating women and children under 5 years (Kennedy *et al.* 2003). As previously stated, the VAS is a global strategy which aims at reducing VAD and the health outcomes thereof. Globally this intervention has been successful among children and WRA and was terminated for women postpartum as the deficiency status has decreased (WHO 2009, 2011a). The supplementation of pregnant women with iron, folate and calcium is an ongoing intervention program which aims to reduces the risk of anaemia, birth defects and pre-eclamsia (Department of Health 2013, The Government of the Republic of South Africa 2018).

2.7 Nutrition-specific and nutrition-sensitive interventions addressing malnutrition in South Africa

Nutrient specific strategies include a number of interventions which target the entire life cycle. These include preconception nutrition, micronutrient supplementation, breastfeeding and complementary feeding education and the management of nutritionally vulnerable groups (The Government of the Republic of South Africa 2018). The iodization of salt as a fortification program in South Africa, has been shown to significantly increase iodine intakes among women (Labadarios *et al.* 2005, Mabasa *et al.* 2019), and this is similar for studies on fortification of maize meal and bread wheat flour (Department of Health, 2003; Labadarios *et al.*, 2008). Biofortification research has increased in South Africa and the focus is on the

implementation of biofortification of staple food crops like maize with iron and zinc; and sweet potatoes with β-carotene (Wolson 2007, Bouis and Saltzman 2017). Biofortification of these crops have been suggested as strategies for combating micronutrient malnutrition and shown to improve the micronutrient intake and status of these nutrients (van Jaarsveld *et al.* 2005, Laurie *et al.* 2015, Siwela *et al.* 2020).

In terms of supplementation, there are intervention programmes in South Africa which include: the VAS for children under 5; therapeutic zinc supplementation for children under 5 with diahorrea; iron and folic acid supplementation of pregnant women; calcium supplementation for pregnant women with pre-eclampsia and multiple micronutrient supplementation for undernourished individuals (Department of Health 2013). Policy documents or guidelines for the intervention strategies are summariezed in the national 'Roadmap for Nutrition' document (Department of Health 2013). The nutrition sensitive strategies include agriculture and food security; social grants; VAT exemption or zero-rated of basic foods stuffs; maternal health and famliy planning services; promotion of hygeine and access to claen and safe water with additional proposed interventions of women empowerment (UNICEF SA 2016, The Government of the Republic of South Africa 2018).

2.7.1 Fortification as an intervention to address micronutrient deficiencies in South Africa

National Food Fortification Programme (NFFP)

In general, food fortification is the addition of one or more nutrients to food during the manufacturing process (Department of Health SA *et al.* 2007). At a national level staple foods are used as vehicle for multiple micronutrient fortification which is targeted at children under 5 and women of child bearing age (Department of Health SA *et al.* 2007). The South African Vitamin A Consultative Group (SAVACG) and the NFCS 1999 reported poor micronutrient intakes and MND of iron and vitamin A in children. As a result, the NFFP was implemented in 2003 as a food-based approach with the aim to address micronutrient malnutrition in the country (Department of Health SA *et al.* 2007). The NFCS 1999 identified maize meal and bread to be two of the five most commonly consumed foods (sugar, tea and milk being the other three) by 1-9-year-old children and were considered appropriate vehicles for fortification in South Africa. Selected micronutrients for fortification (indicated in ***Appendix 1, Table 1.1***) were based on the consumption data of children in the NFCS 1999 (Labadarios *et al.* 2005).

Hence, the South African government decided to make it mandatory to fortify all white and brown bread wheat flour and maize meal (super, special, sifted and unsifted) with eight micronutrients (vitamin A, thiamin, riboflavin, pyridoxine, folic acid, inron and zinc) in sufficient quantities indicated in ***Appendix 1, Table 1.1*** . In October 2003, legislation came into effect requiring any person or company who manufactures, imports, or sells bread wheat flour and maize meal to fortify them accordingly. This applies to large and small millers; and urban, peri-urban and rural producers. The regulation is contained in the Foodstuffs, Cosmetics and Disinfectants Act (Act No. 54) of 1972 (Department of Health SA *et al.* 2007).

Consumption of fortified staple foods may increase the mean adequacy ratio of the diet in women and has been shown to imporove the micronutrient intakes but not nesessarliy meet the EARs for all fortificant nutrients (Steyn *et al.* 2008, Papathakis and Pearson 2012).

There are limited studies reporting the contribution of fortified stable foods amoung South African women. However, a study conducted with South African children, found that among children who consumed fortified staple food, more children (51.4%) in the age group of 12 months had an adequate intake of the all the fortificant micronutrients compared their counterparts aged 6 months and 12 months (Swanepoel *et al.* 2019). This study also showed that fortified staples contributed more than 30% of total intake for iron, zinc, vitamin A, thiamin, niacin, vitamin B6 and folate for children at 18 months of age (Swanepoel *et al.* 2019). Friesen et al. (2020) also found that consumption of fortifed staple food made significant contribution to the intakes of vitamin A and iodine of WRA.

2.7.2 Conclusion

The DBM shows an increase in overweight and obesity and a decrease in underweight prevelance among South African women. The energy intakes however are inadequate and is associated with low nutrient adequacy. The micronutrient malnutrition status of women, for certain micronutrients, has improved from a severe public health problem to moderate a public health problem. Overall, the literature suggests a mere 2% increase (74.25% -76.00%) in nutrient adequacy for women and therefore WRA are still at risk for micronutrient malnutrition (MNM) despite the current national interventions in place to address this. The suggested increased nutrient adequacy among women has also been attributed to many nutrient specific interventions, in particular micronutrient supplementation and staple food fortification. There is, however, limited data which report the contributions of fortified staple foods to the nutrient

intakes and nutrient adeqaucy of South African women. The dietary diversity reported for women in studies still show a higher proportion not meeting the minimum dietary diversity scores which suggests that a diet with lower variety is being consumed among South African women. Poverty and it's realted factors were shown to be the most common underlying cause of low nutrient adequacy and poor dietary diversity.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter describes the research methodology employed to achieve the aim and objectives of the study, which were to assess the nutrient adequacy and dietary diversity of WRA in two provinces of South Africa, using a 24HR to estimate the contribution of fortified staple foods to their micronutrient intake. The chapter describes the research design, the sampling methods of the FACT survey, study population, sampling of participants for the 24HR and data collection process thereof. Then a descrption of the nutrient intakes, appliaction of the nutrient adequacy and dietary dieveristy assessments methods based on the 24HR and the data analysis which where applied. It concludes by discussing ethical considerations regarding the study.

3.2 Research design

3.2.1 Secondary analysis of existing data

To address the objectives of this current study, a combination of primary and secondary data analysis of existing cross-sectional data was done. Secondary data analysis was done on a subset of the data, which was collected for the FACT survey. Primary analysis of data was done on the data collected from the 24HR. Secondary data analysis has been shown to be a cost-effective way to make full use of readily available data which can address new research questions and provide a different perspective or meaning of the assessed data other than the analysis of the original study (Cheng and Phillips 2014).

3.3 Methodology fact survey

3.3.1 Fortification assessment coverage toolkit (FACT) survey methodology

The aim of the FACT survey was to collect data on coverage and potential contribution of fortified staple foods to the micronutrient intakes among households of WRA, (18-49 years) in the Gauteng and Eastern Cape provinces of South Africa. The data collection was done in May and June 2015. The estimated number of households to be included in the sample was approximately 1720 households**.** For the sampling of the population, a two-stage stratified random sampling strategy was applied within each of the two provinces. At the first stage of sampling, census enumeration areas (EAs) served as the primary sampling units (PSUs) and was selected within each province. The second sampling stage was the selection of households

within the sampled PSUs. In each province, a simple random sample technique was used to randomly select 40 clusters (EAs) from the total EA list by a statistician from Statistics South Africa. In each EA a mini-census was conducted to obtain the total number of households. Within each province, 632 households, or a minimum of 15-16 randomly selected households per EA, were included to provide a 95% confidence interval, 50% prevalence rate, precision of 0.06 and a design effect of 2. The number of randomly selected households per EA was 23 for Gauteng and 20 for the Eastern Cape. This translated to 920 households in Gauteng and 800 households in Eastern Cape. All women aged between 18-49 years old within selected households were selected as part of the sampling. For these households the FACT survey was conducted by trained research interviewers who used 3 different sets of questionnaires.These questionnaires can be seen in ***Appendix 1-4***. The survey questionnaires included 1) a Household Questionnaire 1, which collected information on household characteristics; water, sanitation and hygiene; access to health services and household income; 2) a Household Questionnaire 2, which collected information on household hunger; coverage of oil, maize meal, cake flour, bread flour and bread fortification, as well as salt iodization; and fortification logo knowledge and influence; and 3) a Female Respondent Questionnaire, which collected information on dietary diversity; consumption of bread flour and maize meal; and health data.

The HHFS was assessed using the simplified HHS (Ballard *et al.* 2011). Dietary diversity was assessed using a diet diversity survey questionnaire consisting of 18 food groups. Consumption of individual fortified staple foods (bread flour and maize meal; any products made with these items) was determined using a shortened 7-day quantified food frequency questionnaire (QFFQ). Nutritional indicators, health indicators and fortification logo awareness data were also collected to determine their association with the contribution of fortified food to the total intake. The measurement of fortification level within the foods was done with collection of food samples from the homes. (FACT survey manual, 21 May 2015). Data variables used from the FACT survey according to codes are shown in ***Appendix 5.***

3.4 Methodology for current study

3.4.1 Study population

This study included women of reproductive age (18-49 years) within the Gauteng and Eastern Cape provinces who participated in the FACT survey and for whom a 24HR has been completed (n=286).

3.4.2 Sampling and data collection

The original plan was to collect 24HR dietary intake data for a sub-sample of 50% of the households participating the FACT survey. This would have translated to 440 households from Gauteng and 400 households from Eastern Cape. The sampling framework is shown in ***Appendix 1, Figure 2***. As stated in the FACT report (GAIN *et al.* 2015), this plan was revised within the first few days of fieldwork as there were not many women available for the interview and thereafter every available woman (18-49 years) within the households were invited to participate in the 24HR dietary assessment.

The 24HR questionnaire had additional questions regarding purchased bread or homemade bread (flour used for baking), to help determine if the bread eaten was fortified or not. If the participant reported eating unlabeled bought bread during the 24HR recall period, the fieldworker did a bakery visit at place of purchase to determine if the bread was fortified. The questionnaire is given in ***Appendix 1***. Trained fieldworkers collected dietary intake data by conducting a quantified 24HR ietary recall with the study participants. A standardised "dietary kit" that included examples of food containers and wrappers, plastic food models, household utensils and three-dimensional sponge models was used to help the participants describe the amount of food consumed. In addition, dish-up-and-measure was used to quantify portion sizes of certain food items, especially cooked food, whereby the participant used dry oats to indicate the quantity resembling the amount of food consumed, which the fieldworker then quantified using a measuring cup (Faber *et* al., 2016) .

Food intake reported in household measures was converted into weight using the SAMRC Food Quantities Manual (Langenhoven *et al.* 1991). STATA software was used to convert food intake to macro- and micronutrients, using the SAFOODS database (Wolmarans *et al*., 2010). The nutrient analyses of the baseline dietary intake data was conducted by the SAMRC at the Biostatistics Unit. Thie food item data was coded according to nutrient composition from South

African Food Composition Database of the SAMRC and the other variables within the 24HR were coded according to the variable name shown in ***Appendix 5***. This primary data was then made available in a Microsoft Excel document for data analysis for the current study.

3.4.3 Socio-economic characteristics and fortification logo awareness

Data pertaining to socio-economics, preganacy or lactation, HHFS and the fortification logo were extracted from the FACT survey data set. Information on sociodemographic status included highest education level completed, household income and the number and type of government social grants received by the household.

The HHFS status was determined by using data obtained from simplified HHS questions, which consisted of three quantified questions ***(Table 1.2).*** The hunger scale questions were based on whether various levels of food insecurity occurred and for each occurrence, the frequency of occurrence during the past month was recorded. To construct the hunger scale, the frequency during the past 30 days for each occurrence was coded as: Never= 0; once or twice = 1; 3-10 times = 2; and more than 10 times days = 3. The sum of the scores for the three conditions were used to define HHFS status (***Table 1.3)***. The three categories are: little to no hunger in the household (score 0-1); moderate hunger in the household (score 2-3); and severe hunger in the household (score 4-6) as per the HHS Measurement guide (Ballard *et al.*, 2011).

Information on the fortification logo was 1) if the logo had been seen; 2) what the logo meant; 3) the influence on decision to buy fortified products and 4) knowledge of mandatory fortification to bread flour and maize meal.

Living standards measure (LSM) was included as it has been reported to be correlated to socio-economic characteristics and can be used as a poverty indicator (Haupt 2006). LSM was calculated using the LSM 2011 guideline from the South African Advertising Research Foundation (SAARF) segmentation tools (SAARF 2011). This tool assesses 29 variables which are household assets and facilities. The LSM is comprised of ten groups, where households with a LSM of 1 is classified as being the most impoverished and households with LSM of 10 being less impoverished with more household assets (Haupt 2006). A binary variable for LSM was created with grouping of LSM ≤6 (lower LSM) and LSM ≥7 (higher LSM).

3.4.4 24-Hour recall data and dietary data processing

The cleaning of the data was done as per the framework by Van den Broeck et al, 2005, ***(Appendix 1, Figure 3).*** Cleaning included screening for implausable data, appropriate food codes, realistic portion sizes or amounts (minimum and maximum, outliers), and realistic energy and nutrient intakes (minimum and maximum, outliers, considering gender and age specific requirements). Outliers or non-realistic nutrient values and food amounts were identified within the dataset and manually verified against the original 24HR questionnaires. There was no unique identifier within the data sets, therefore, to manually locate each participants dietary intake data, the dietary intake data from the 24HR was merged with the socioeconomic data according to a combination of variables namely : "idn", "eaid", "hh" and "lnr". The cleaned dietary intake data was rerun to update the nutritional analysis of the corrected food codes and for the daily energy and nutrient intakes.

In the 24HR recall data, two new variables were computed, "total carbohydrates" and "Vitamin A RAE" (retinol activity equivalents) as the DRI references values for these variables are in this form. Total carbohydrates was computed by adding-up the values of available carbohydrates and the total fibre. For vitamin A RAE, the vitamin A RE (retinol equivalents) values for all plant sources were divided by two and combined with vitamin A RE of non-plant sources and fortifed foods to form the new variable.

3.4.5 Nutrient intakes

Energy from macronutrients was calculated and expressed as a percentage of ot total energy intake, i.e. grams of carbohydrates and protein respectivly were multiplied by 17 kilojoules and then divided by the total kilojoules and finally multiplied again by 100 to obtain a percentage. For fat, the grams were multiplied by 38 kilojoules. The percentage energy from macronutrients were compared to the reference intakes of the AMDR for adults (IOM 2005, 2011). For each of the micronutrients, the percentage of women with an intake below the age- and life-stage appropriate estimated average requirement (EAR) was calculated (IOM 2011).

Energy and nutrients from fortified wheat flour; maize meal flour and fortified bread were calculated. These included macronutrients (carbohydrates, protein and fat) and the fortificant micronutrients, namely zinc, iron, thiamin, riboflavin, niacin, vitamin B6, folate and vitamin A (Department of Health 2003). Micronutrients from fortified wheat flour, maize meal flour and fortified bread were expresed as the percentage contribution of total intakes for each

micronutriet respectively. This percentage of nutrient contribution from the fortified food intake was determined by the following formula:

$$\%\ Fortified\ Food\ Contribution = \frac{Energy\ or\ Nutrient\ from\ fortified\ food}{Total\ Energy\ or\ Nutrient\ intake} \times 100$$

3.4.6 Nutrient adequacy

The nutrient adequacy ratio (NAR) was calculated for each of the 14 micronutrients (vitamins A, C, B6, B12, riboflavin, niacin, folate, iron, thiamin, zinc, calcium, magnesium, phosphorus and potassium) and expressed as a percentage of the EAR for the specific age and life stage group (females, pregnant, lactating aged 19 – 30 years and 31- 50 years (IOM 2011). The mean MAR was calculated as the average of the NARs for the 14 nutrients (capped at 100% if the NAR was >100%). The intake value of 100% for the MAR or NAR would indicate that the intake of the nutrients are adequate and meet the EAR for these nutrients. In addition, the EAR cut-point method was used to calculate the percentage participants with an intake below the EAR for each of the micronutrients.

3.4.7 Minimum dietary diversity for wowen

The Minimum Dietary Diversity for Women of reproductive age (MDD-W) indicator was calculated following the guidelines for assessing the MDD-W (FAO and FHI 360 2016). The MDD-W is a dichotomous indicator of whether women have consumed food from at least five out of ten defined food groups in the last 24-hours. The ten food groups are (1) grains, white roots, tubers and (2) pulses: beans, peas and lentils; (3) nuts and seeds; (4) dairy; (5) meat, poultry and fish; (6) eggs; (7) dark green leafy vegetables; (8) other vitamin A-rich fruits and vegetables;(9) other vegetables and (10) other fruits. Foods reported during the 24HR period were assigned to the applicable food group. For each food group from which at least one food item was consumed a score of one was allocated; and a score of 0 was given to each food group from which no food items were consumed. For foods usually consumed in large amounts, a minimum of 15g consumed was used as a criterion to be counted. The scores of the 10 food groups were summed into a score ranging from 0 to 10, followed by creating the binary MDD-W indictor, with a score of 5 or more indicating that the MDD-W was achieved and a score of 0 to 4 indicating that the MDD-W was not achieved (FAO and FHI 360 2016).

3.4.8 Data analysis

Data analysis was done using IBM Statistical Package for Social Science (SPSS) program Version 26. Results are reported for the total sample and per province. A Shapiro-Wilk's test ($p>0.05$) and a visual inspection of histograms, normal Q-Q plots and box plots were used to determine whether the data was normally distributed. For normally distributed data the means and standard deviation (SD) were generated and for non-normally distributed data the medians with interquartile ranges (IQR) were generated. Statistical significance between groups for continuous data variables was tested using the independent t-test (normally distributed data) or Mann-Whitney U-test (skew data) and for categorical variables the chi-square test was used. Linear and binary logistic regression analysis as well as Spearman correlation (skewed data) analysis were used to explore the association of nutrient adequacy and dietary diversity with socio-economiccharacteristics, nutrient intakes and MAR. Control variables were included in the regression analysis models to estimate and account for any shared explanatory power the predicting variable may have on the on the outcome varible in the model. Statistical significance was set at $p<0.05$.

3.4.9 Ethical issues

According to the FACT survey report, prior to data collection, ethics approval was obtained from the Senate Research committee of the University of the Western Cape (reference number 15/2/5). After finalization of the questionnaires, the final set of questionnaires were submitted as an amendment to the Senate Research Committee. During the data collection process, written consent was obtained from each participant that was eligible and willing to participate; it included a letter explaining the research study, requesting their participation and assuring them of confidentiality. See ***Appendix 6.*** All assessments were done with strict adherence to high ethics standards at all aspects such as during data collection, storage and analysis.

Ethical clearance for this Masters study was obtained from the Biomedical Science Research Ethics Committee of the University of the Western Cape, Ethics Reference Number: BM18/7/10.

CHAPTER 4: RESULTS

4.1 Sample description and socio-economic characteristics

From the total sample of 286 women who completed the 24HR, 18 participants were excluded due to incomplete or implausible data (energy intake ≤2500 kJ or ≥ 20000 kJ). The final sample therefore consisted of 268 women, of whom 16 were pregnant and 27 were breastfeeding. The number of women from the Eastern Cape (rural) was 117 (43.7%) and 151 (56.3%) from the Gauteng province (urban). The socio-economic characteristics are given in ***Table 4.1.*** The mean age for women was 31 (SD 9). For highest level of school education completed, 45.5% had grade 7 and 40.7% had grade 12. A higher percentage of women in Gauteng had completed grade 12, compared to women in Eastern Cape (53.0% versus 31.1%, $p<0.01$). Seventy percent of the respondents reported a household income of R5000 or less and 61% of households were receiving a child support grant. Crosstablutaion of household income and edcuation level showed that more 93.5% of women who completed grade 3 and 82.5% of women who completed grade 7 had a lower household income of R0-R5 000. When compared to Gauteng, more households in the Eastern Cape received a child support grant (72.8% versus 47.0%; $p<0.001$) and pensioners grant (32.5% versus 11.1%; $p<0.01$) respectively. In Gauteng, 58.2 % of women fell into the higher LSM group (≥7) and 70.9% women from Eastern Cape fell into the lower LSM group (≤6). For household assets (data not included in ***Table 4.1***), which were used to assess the LSM, about 75% of households had access to tap water, either in their yard or dwelling. Close to 87% had access to electricity, which was similar to the percentage of households who used electricity as a source of cooking fuel. Most of the households (89.9%) had a flushing toilet (62.3%) or pit latrine facility (27.6%). According to the HHS, 11.6% of households had severe hunger.

Table 4.1: Socio-economic characteristics of women within the two provinces and significant differences among provinces and socio-economic characteristics

	Study Sample (n=268)	***Gauteng (n=117)***	***Eastern Cape (n=151)***	***p value***
Mean (SD) age in years	31 (9.3)	32 (9.5)	30 (8.9)	[1]0.056
Highest education completed (%)				
At least Grade 5	11.6	6.0	15.9	**[2]<0.001**
Grade 7	45.5	38.5	51.0	
At least Grade 12	40.7	53.0	31.1	
Household income (%)				
R 0 -R 5000	70.9	67.5	73.5	[2]0.139
R 5000 -R 20 000	14.9	19.7	11.3	
R 20 001 or More	11.9	10.3	13.2	
Social grants (%)				
Child Support Grant	61.6	47.0	72.8	**[2]<0.001**
Social Relief Grant	1.5	0.9	2.0	[2]0.458
Disability Grant	4.5	0.9	7.3	**[2]0.013**
Pensioner Grant	23.1	11.1	32.5	**[2]<0.001**
Household hunger scale (HHS), (%)				
Little to no Hunger	81.0	84.6	78.2	[2]0.187
Moderate Hunger	6.3	4.3	8.0	
Severe Hunger	11.6	8.6	13.9	
Living standards measure (LSM), (%)				
LSM Group ≤ 6	58.2	41.9	70.9	**[2]<0.001**
LSM Group ≥ 7	41.8	58.1	29.1	

Note: Missing data: Education level 4% (*n*= 6); Household income 5% (*n*= 6); Household Hunger Scale 1.1% (*n*= 3); Child support grant 1% (*n*= 2)

Bolded p-values are statistically significant; $p<0.05$

[1] Chi-square test for categorical data; [2]independent t-test for continuous data

4.2 Nutrient intakes

Nutrient intakes are reported in ***Table 4.2.*** The median intake of energy (kJ) for the total group was 6559 kJ (IQR: 5000 kJ; 9190 kJ). Compared to Eastern Cape, women in Gauteng had a significantly higher intake of energy and all macronutrients except for percentage energy from carbohydrates, which was significantly higher for Eastern Cape. For the study sample the mean

(SD) percentage energy intake for carbohydrates, 64.9% (14.0%), total fat, 25.0% (10.9%) and total protein, 13.4% (4.8%) were are all within the AMDRs for adults. The percentage of energy from total protein did not differ significantly between the two provinces ($p>0.05$). Dietary intake of fibre and all micronutrients, except calcium, folate, panothanate, vitamin A and vitamin E, were significantly higher for women in the Gauteng province ($p<0.05$)

Table 4.2: Total energy and nutrient intakes and mean percentage of total energy intakes from macronutrients

Nutrient	*Study sample (n=268)*		*Gauteng (n=117)*		*Eastern Cape (n=151)*		p value
	Median	***IQR***	***Median***	***IQR***	***Median***	***IQR***	
Energy (kJ)	6559	(5000; 9190)	7285	(5589; 9963)	5717	(4680; 8423)	**0.002**
Carbohydrate (g)	247	(179 ;342)	263	(188; 359)	232	(173; 327)	0.071
Protein (g)	52	(36 ;69)	56	(41; 74)	48	(32; 69)	**0.004**
Fat (g)	43	(27 ;64)	53	(35; 79)	35	(26; 50)	**<0.001**
Mean carbohydrate %TE, (SD)	64.9 (14.0)		62.4 (13.0)		66.8 (14.5)		**[1]0.010**
Mean fat %TE, (SD)	25.0 (10.9)		28.1 (10.2)		22.6(10.8)		**[1]<0.001**
Mean protein %TE, [SD]	13.4 (4.8)		13.5 (4.3)		13.3 (5.2)		[1]0.277
Cholesterol (mg)	102	(42; 252)	131	(71; 285)	76	(13; 210)	**0.001**
Monounsaturated fat (g)	13	(7; 20)	17	(11; 26)	10	(5; 16)	**<0.001**
Polyunsaturated fat (g)	11	(5; 17)	13	(7; 21)	10	(5; 16)	**0.009**
Saturated fat (g)	10	(5; 16)	13	(8; 21)	9	(5; 15)	**<0.001**
Total fibre (g)	18	(11; 25)	21	(14; 29)	16	(10; 23)	**0.001**
Calcium (mg)	204	(107; 399)	204	(112; 384)	204	(100; 445)	0.960
Iron (mg)	10.0	(7.5; 17.3)	12.8	(9.1; 18.6)	10.6	(6.7; 16.3)	**0.006**
Magnesium (mg)	206	(142; 289)	238	(163; 318)	176	(119; 266)	**0.001**

Nutrient	***Study sample***		***Gauteng***		***Eastern Cape***		**p value**
	Median (n=268)	***IQR***	***Median (n=117)***	***IQR***	***Median (n=151)***	***IQR***	
Phosphorous (mg)	692	(488; 954)	746	(541; 977)	625	(442; 907)	**0.041**
Potassium (mg)	1524	(1011; 2124)	1658	(1229; 2160)	1424	(921; 2012)	**0.007**
Zinc (mg)	9.31	(6.09; 13.32)	10.39	(6.85; 14.08)	8.06	(5.25; 12.95)	**0.006**
Thiamin (mg)	1.42	(0.78; 1.97)	1.6	(0.94; 2.34)	1.28	(0.73; 1.66)	**0.002**
Riboflavin (mg)	0.92	(0.56; 1.51)	1.01	(0.67; 1.54)	0.77	(0.44; 1.43)	**0.003**
Niacin (mg)	14.1	(9.4; 20.2)	15.2	(10.9; 21.0)	12.6	(8.1; 19.3)	**0.027**
Vitamin B6 (mg)	2.38	(1.32; 3.71)	2.56	(1.66; 4.04)	2.04	(1.07; 3.39)	**0.013**
Folate (mcg)	348	(200; 591)	392	(230; 590)	312	(169; 593)	0.227
Vitamin B12 (mcg)	1.37	(0.30; 3.06)	1.70	(0.46; 3.32)	1,12	(0.22; 2.83)	0.072
Pantothenate (mg)	2.69	(1.92; 3.64)	2.68	(2.06; 3.69)	2.69	(1.72; 3.56)	0.247
Biotin (mcg)	29.05	(17.62; 46.52)	34.82	(22.30; 50.51)	25.99	(15.71; 40.00)	**0.004**
Vitamin A (mcg RAE)	444	(238; 732)	503	(297; 749)	374	(199; 694)	0.071
Vitamin C (mg)	30	(14; 67)	40	(17; 104)	28	(14; 53)	**0.040**
Vitamin D (mcg)	0.89	(0.11; 4.28)	1.29	(0.22; 4.71)	0.69	(0.03; 3.18)	**0.043**
Vitamin E (mg)	7.23	(3.54; 11.63)	7.04	(3.31; 11.95)	7.26	(3.94; 11.60)	0.955

p-values: [1]Mann-Whitney U-tests(skew data) and Independent t-test (all other normal distributed data)

Bolded p-values are statistically significant

%TE, percent of total energy

4.3 Nutrient adequacy

The median NAR for selected 14 micronutrients are reported ***Table 4.3.*** In general, the nutrients that had a median NAR of ≥100% were iron, thiamin, niacin, riboflavin, vitamin B6, phosphorous and zinc. Nutrient with median NAR of ≥ 90% <100% was folate. Nutrients with a NAR of ≥60% <90% were vitamin B12, magnesium and vitamin A. Calcium, potassium and vitamin C had a median NAR below 60%. The median NARs showed no significant differences among the provinces for folate, vitamin B12, vitamin A and calcium. The remaining micronutrients were significantly higher for women in Gauteng. The MAR had a significantly strong positive correlation with total energy (kJ) intake ($r=0.720$, $p<0.001$). The median MAR was 77.8% (IQR, 64.5; 84.4), indicating an overall inadequate micronutrient intake for this study sample. The median MAR, as a measure of micronutrient adequcy, did not show any significant associations with socio-economic characteristics *(data not shown)*.

Table 4.3: Median nutrient adequacy ratios and median adequacy ratio with interquartile ranges among women

	Study Sample		**Gauteng**		**Eastern Cape**		**p value**
	Median (n=268)	***IQR***	***Median (n=117)***	***IQR***	***Median (n=151)***	***IQR***	
NAR % Iron	138.5	(86; 219)	158.0	(110; 233)	123.1	(78; 200)	**0.004**
NAR % Thiamin	157.8	(86; 219)	177.3	(104; 260)	142.7	(81; 184)	**0.002**
NAR % Niacin	126.2	(79; 173)	129.2	(93; 182)	112.9	(73; 166)	**0.033**
NAR % Riboflavin	101.6	(62; 167)	112.4	(73; 171)	85.0	(49; 158)	**0.004**
NAR % Vitamin B6	197.6	(118; 304)	217.2	(146; 331)	169.1	(95; 288)	**0.018**
NAR % Vitamin B12	67.8	(14; 148)	74.2	(22; 166)	52.7	(11; 130)	0.074
NAR % Folate	98.6	(54; 172)	109.8	(60; 167)	90.1	(51; 176)	0.282
NAR % Calcium	25.4	(13; 49)	25.4	(13; 47)	25.5	(12; 55)	0.961
NAR % Magnesium	77.6	(53; 109)	89.8	(61; 119)	66.2	(44; 100)	**0.001**
NAR % Phosphorus	119.3	(22; 45)	128.5	(93; 168)	107.7	(76; 156)	**0.041**
NAR % Potassium	32.4	(84; 164)	35.3	(26; 45)	30.3	(19; 42)	**0.007**
NAR % Zinc	157.6	(93; 264)	173.6	(103; 269)	139.0	(83; 252)	**0.031**
NAR % Vitamin A	75.8	(43; 138)	93.5	(51; 145)	70.8	(38; 134)	0.101
NAR % Vitamin C	46.3	(21; 110)	58.3	(25; 172)	42.8	(20; 86)	**0.046**
MAR %	77.8	(64; 84)	80.6	(71; 86)	74.7	(61; 84)	**0.002**

p-values: Non-parametric independent t-tests, $p<0.05$.

Bolded p-values are statistically significant

NAR-Nutrient adequacy ratio, MAR-Mean adequacy ratio

Additionally, in ***Table 4.4***, the percentage of women with intakes below the EAR for the individual nutrients are given. More than 50% of women had an intake below the EAR for vitamin A, vitamin C, vitamin B12, folate, magnesium, potassium and calcium. A higher percentage of women in the Eastern Cape had intakes below the EAR for for iron, thiamin, niacin, vitamin B6, magnesium, phosphorus and vitamin C, compared to women in Gauteng.

Table 4.4: Percentage of women with micronutrient intakes below the EAR

Nutrient	**Study sample** ***(n=268)***	**Gauteng** ***(n=117)***	**Eastern Cape** ***(n=151)***	**p value**
Iron	29.9	20.5	37.1	**0.003**
Thiamin	31.3	23.9	37.1	**0.021**
Niacin	35.4	28.2	41.4	**0.029**
Riboflavin	31.3	42.7	54.3	0.060
Vitamin B6	20.5	12.8	26.5	**0.006**
Vitamin B12	64.9	60.7	68.2	0.200
Folate	50.7	46.2	54.3	0.186
Calcium	93.7	94.9	92.7	0.473
Magnesium	68.3	59.8	74.8	**0.009**
Phosphorus	37.7	29.1	44.4	**0.010**
Potassium	99.3	98.3	100.0	0.107
Zinc	28.0	22.2	32.5	0.064
Vitamin A	59.7	55.6	62.9	0.223
Vitamin C	73.1	65.0	79.5	**0.008**

p value: Chi-square test

Bolded p-values are statistically significant

4.4 Fortified staple food intake of women and the percentage of energy and nutrient contributions from consumed fortified staple foods

Table 4.5 shows the number of women who consumed fortified maize meal flour, wheat flour and food items made with these fortified flours. On the day of recall, 234 (87.3%) women consumed fortified staple foods. In terms of the individual fortified staple foods, 61.9% of women consumed fortified maize meal; 51.5% consumed fortified bread and 8.2% consumed other fortified bread flour products. More women from the Gauteng province consumed fortified maize meal compared to women from the Eastern Cape (72.6% vs 53.6%, p=0.009).

Table 4.5 further shows the percentage contribution of fortified staple foods to total intake for particants who consumed fortifified staple foods on the day of recall. For consumers thereof, fortifed staple foods contributed over a third of the total energy intake and almost half the carbohydrate intake. The contribution of total carbohydrates for fortified staple foods was significantly higher for women from Gauteng (51.4% vs 44.4%, p=0.032). For consumers thereof, fortified staple foods show significant contribution to micronutrient intakes, with more than 50% contribution for vitamin A, iron, zinc, folate, vitamin B6, niacin and thiamin.

Table 4.5: Percentage of women consuming fortified staple foods and mean percentage of nutrient contribution from fortified food during 24 HR.

	Study Sample		**Gauteng**		**Eastern Cape**		**[1]p value**
	n	***%***	***n***	***%***	***n***	***%***	
Consumption of fortified staples (maize meal, bread, fortified flour)	234	87.3	107	45.7	127	53.4	0.073
Consumption of fortified maize meal	166	70.9	85	79.4	81	63.8	**0.009**
Consumption of fortified bread	154	65.8	76		78	51.8	0.123
Consumption of other foods made with fortified flours	22	9.4	7	6.5	15	11.8	0.170
Mean (SD) percentage contribution of fortified staple foods the to total energy and nutrient intakes for women who ate fortifed staple foods during the recall period							
	Mean (SD) n=234		***Mean (SD) n=107***		***Mean (SD)n=127***		**[2]p value**
Energy	36.8 (21.4)		38 (22.3)		35.8 (20.6)		0.439
Protein	34.6 (21.8)		34.2 (21.0)		34.9 (22.5)		0.801
Fat	19.8 (20.7)		16.9 (17.3)		22.2 (23.0)		**0.050**
Carbohydrates	47.6 (24.9)		51.4 (26.4)		44.4 (23.2)		**0.032**
Vitamin A	52 (31.5)		52.4 (30.3)		51.7 (30.7)		0.711
Niacin	52.5 (23.5)		49.8 (24.1)		54.8 (22.9)		0.106
Thiamin	64.2 (22.3)		65.2 (23.4)		63.3 (21.4)		0.526
Riboflavin	35.5 (25.5)		36.6 (26.8)		34.7 (24.5)		0.572
Vitamin B6	69.6 (22)		70.4 (22.3)		68.9 (21.7)		0.598
Folate	68.8 (24.8)		69.1 (24.5)		68.5 (25.0)		0.850
Iron	56.7 (22.9)		58.6 (23.3)		55.2 (22.6)		0.258
Zinc	51.9 (23.8)		52.9 (23.8)		51 (23.9)		0.548

Note: Micronutrients included are only the fortificant nutrients

Bolded p-values are statistically significant; $p<0.05$

[1] Chi-square test used for categorical data; [2] Independent t-test used for continous data

Table 4.6 shows the median NAR for the eight fortificant micronutrients, which were significantly higher for women who consumed fortified staple foods on the day of recall, compared to women who did not consume these foods on the day of recall. The median MAR was also significantly higher in women who consumed fortified food compared to those who did not consume fortified staple foods, 79.1% (IQR 67.5; 85.5) vs. 59.6 % (IQR 47.0; 70.9).

For consumers of fortified staple foods on the day of recall, Spearman correlation analysis showed that energy (kJ) from fortified staple foods was significantly correlated with NAR for iron (r=0.442, p<0.001), zinc (r=0.235, p<0.001), vitamin A (r=0.308, p<0.001), thiamin (r=0.730, p<0.001), riboflavin (r=0.325, p<0.001), folate (r=0.520, p<0.001); but not for niacin (r=0.-0.044, p=0.505) and vitamin B6. Energy (kJ) from fortified staple foods was also significantly correlated with MAR (r=0.254, p<0.01).

Table 4.6: Median adequacy ratio and median nutrient adequacy ratio with interquatrile ranges of selected fortificant micronutrients based on consumption of fortified staple foods during the recall period

Nutrient	**Consumption *n=234***		**Non-consumption *n=34***		**p-value**
	Median	***IQR***	***Median***	***IQR***	
Vitamin A	83.9	(49; 138)	27.4	(6; 112)	**< 0.001**
Iron	150.2	(100; 229)	79.7	(56; 113)	**< 0.001**
Riboflavin	105.9	(64; 168)	63.8	(45; 140)	**< 0.001**
Niacin	136.3	(88; 181)	81.7	(56; 104)	**< 0.001**
Thiamin	166	(103; 236)	61.2	(41; 94)	**< 0.001**
Vitamin B6	217.5	(142; 329)	72.8	(40; 120)	**< 0.001**
Folate	110.9	(63; 183)	31.7	(17; 90)	**< 0.001**
Zinc	173.4	(105; 276)	81.5	(49; 96)	**< 0.001**
MAR	79.1	(68; 86)	59.6	(47; 71)	**< 0.001**

p-values: Non-parametric independent t-tests <0.05

Bolded p-values are statistically significant

4.5 Fortification logo awareness

Data indicated that 45.0% of the women had seen the fortifcation logo. For these women (n=120), 55.0% though that the logo meant good health, 6.7% thought it meant better quality and only 5.0% knew that it meant that the product is fortified. Additionally, 39.0% of women indicated that they were aware of the mandate of fortifying of the maize and bread flour

products with certain vitamins and minerals. For the purchasing influence of the fortification logo, 42.5% of women who saw the logo confirmed it influenced them to buy the fortified products.

4.6 Dietary diversity

4.6.1 Minimum dietary diversity for women and food groups consumed

Table 4.7 reports the mean dietary diversity score, percentage of women with adequate dietary diversity (MDD-W≥5) and poor dietary diversity (MDD-W<5) and percentage of women who consumed food from each of the specific food groups. The mean dietary diversity score for the ten food groups was 3.7 (SD 1.3) and 75.4% of women consumed fewer than 5 of the 10 food groups and did, therefore, not achieve the minimum dietary diversity. There was no significant difference in the mean dietary diversity score of women among the two provinces. Significantly more women from the Gauteng province consumed nuts and seeds; meat, fish and poultry; and other fruits, whilst more women from Eastern Cape consumed pulses. Nearly all of the women in both dietary diversity groups consumed foods from the grains, white roots and tubers group and more than 50% in both groups consumed meat, fish, poultry and vegetables not rich in vitamin A. For both dietary diversity groups, <25% consumed pulses, nuts and seeds and dark green leafy vegetables during the recall period.

Table 4.7: Mean dietary diversity score, percent adequate and poor dietary divversity and percentage of women who consumed food groups by province

	Study Sample		**Gauteng**		**Eastern Cape**		**[1]p-value**
	n	***(%)***	***n***	***(%)***	***n***	***(%)***	
Mean diet diversity score	268	3.7 (1.3)	117	3.9 (1.3)	117	3.6 (1.3)	0.091
Adequate diet diversity (MDD-W≥5)	66	24.6	32	27.4	151	22.5	
Poor diet diversity (MDD-W<5)	202	75.4	85	72.6	34	77.5	0.362
Percentage of women consuming each food group							**[2]p-value**
Grain and white roots (%)	266	99.3	116	99.1	150	99.3	0.856
Pulses (%)	42	15.7	8	6.8	34	22.5	**<0.001**
Nuts and seeds (%)	5	1.9	5	4.3	0	0	**0.010**
Dairy (%)	94	35.1	44	37.6	50	33.1	0.444
Meat, fish and poultry (%)	201	75	103	88.0	98	64.9	**<0.001**
Eggs (%)	45	16.8	23	19.7	22	14.6	0.269
Dark leafy vegetables (%)	25	9.3	10	8.5	15	9.9	0.699

Percentage of women consuming each food group							
	Study Sample		**Gauteng**		**Eastern Cape**		**[2]p-value**
	n	***(%)***	***n***	***(%)***	***n***	***(%)***	
Other Vitamin A rich fruit and Vegetables (%)	61	22.8	22	18.8	39	25.8	0.174
Other vegetables (%)	167	62.3	71	60.7	96	63.6	0.628
Other fruit (%)	86	32.1	49	41.9	37	24.5	**0.003**

Note: Bolded p-values are statistically significant; $p<0.05$

[1]Chi-square test for categorical data; [2]Independent t-test for continuous data

Table 4.8 reports the percentage of women who consumed foods from each of the specific food groups according to the dietary diversity group (adequate vs poor). A significantly higher percentage of women with adequate dietary diversity consumed milk and milk products; meat, poultry and fish; eggs; dark leafy vegetables; vitamin A rich fruits and vegetables; other fruits; and other vegetables (all $p<0.001$), compared to women with low dietary diversity. For the food groups not included when calculating the dietary diversity score, more than 50% of the women consumed oils and fats and savoury or fried snacks during the recall period, with no significant difference between the two dietary diversity groups.

Table 4.8: Percentage of women who consumed specific food groups during the 24 hr recall period within the two dietary diversity groups

Food group consumed (%)	**MDD-W < 5 (*n*= 202)**	**MDD-W ≥ 5 (*n*= 66)**	**[1]*p* value**
Food groups used to calculate MDD-W:			
Grains and white roots	99.0	100.0	1.000
Pulses	14.9	18.2	0.518
Nuts and seeds	0.5	6.1	0.140
Milk and milk products	22.8	72.7	**< 0.001**
Meat, fish and poultry	67.8	97.0	**< 0.001**
Eggs	11.9	31.8	**< 0.001**
Dark-green leafy vegetables	5.4	21.2	**< 0.001**
Other vitamin A rich fruit & vegetables	16.3	42.4	**< 0.001**
Other vegetables	52.0	93.9	**< 0.001**
Other fruit	22.8	60.6	**< 0.001**

Food group consumed (%)	MDD-W < 5 (*n*= 202)	MDD-W ≥ 5 (*n*= 66)	*p* value
Other food groups not included for MDD-W:			
Sugar-sweetened beverages	34.7	36.4	0.800
Other oils and fats	70.8	81.8	0.078
Sweets	19.8	12.1	0.432
Savoury and fried snacks	22.8	18.2	0.234
Mean Adequacy Ratio (SD)	66.5 (15.8)	78.6 (12.8)	**< 0.001**

Note: Low dietary diversity = MDD-W <5; Adequate dietary diversity = MDD-W ≥5

Bolded p-values are statistically significant; p<0.05; [1]Chi-square test

4.6.2 Energy and macronutrient intakes according to MMD-W

Median (IQR) intakes for energy and macronutrients as well the MAR for the two dietary diversity groups are given in ***Table 4.9***. Women with adequate dietary diversity had a higher energy (kJ), protein (g) and fat (g) intake compared to women with low dietary diversity. For women with low dietary diversity, percentage energy from carbohydrates exceeded the upper limit of the AMDR. Energy distribution from macronutrients differed between the two dietary diversity groups. For women who achieved minimum dietary diversity, percentage energy from carbohydrates was significantly higher and percentage energy from fat and protein respectively, was significantly lower compared to women with adequate dietary diversity.

The mean MAR was significantly lower for women who did not achieve minimum dietary diversity, compared to those who did [66.5% (SD 15.8%) versus 78.6% (SD 12.8%), p<0.001]. Spearman correlation analysis showed a significant positive association between the dietary diversity scores and MAR (r=0.431; p<0.001).

Table 4.9: Energy and macronutrient intakes according to MDD-W

Nutrient	MDD-W < 5 *(n= 202)*	MDD-W ≥ 5 *(n= 66)*	[1]p-value
	Median (IQR)	***Median (IQR)***	
Energy (kJ)	6093 (4696; 8971)	7407 (5885; 10423)	**0.016**
Carbohydrate (g)	246 (173; 334)	248 (202; 375)	0.887
Protein (g)	48 (32; 65)	57 (48; 82)	**< 0.001**
Fat (g)	37 (25; 54)	61.379 (37; 81)	**< 0.001**
Cholesterol (mg)	75 (29 ;196)	159.89 (100; 463)	**< 0.001**

Nutrient	MDD-W < 5 *(n= 202)*	MDD-W ≥ 5 *(n= 66)*	p-value
Total fiber (g)	17 (10; 25)	20.1925 (14; 28)	0.065
% TE carbohydrates	68.8 (56.6; 77.7)	58.2 (50.7; 66.9)	**< 0.001**
% TE fat	22.7 (14.9; 31.6)	28.7 (23.4; 36.7)	**< 0.001**
% TE protein	12.3 (9.5; 15.7)	13.9 (11.3; 16.3)	**0.016**

Note: Acceptable Macronutrient Distribution Ranges (AMDR) reference values: protein 10-35%, Carbohydrates 45 -65% and fat 20 – 35% (IOM 2011)

p-values Non-parametric independent t-tests <0.05; Bolded p-values are statistically significant

4.6.3 Dietary diversity and micronutrient adequacy

Table 4.10 shows the percentage of respondents who had micronutrient intakes below the EAR. The percentage of women with intakes below the EAR was significantly higher in the low dietary diversity group for vitamin A, vitamin C, vitamin B12, niacin, riboflavin, pantothenic acid, phosphorous, calcium and biotin ($p<0.05$). For these nutrients, women with adequate dietary diversity were between 2 to 3 times more likely to meet the EAR compared to women with low dietary diversity. After adjusting for total energy intake and province, the relationship between adequate diversity and meeting the EAR was no longer statistically significant for niacin, riboflavin and pantothenic acid. The MAR, based on the 18 micronutrients presented in ***Table 4.10***, was significantly lower for women who did not achieve minimum dietary diversity, compared to those who did [66.5 (SD 15.8) versus 78.6 (SD 12.8), $p<0.001$]. Spearman correlation analysis showed a significant positive association between the dietary diversity scores and MAR ($r= 0.431$; $p<0.001$).

Table 4.10: MDD-W by percentage of women with micronutrient intakes below the EAR and the association between dietary diversity and micronutrient adequacy

Micronutrient	% Women with intakes <EAR			Association between adequate dietary diversity and meeting the EAR	
	MDD-W <5 *(n= 202)*	MDD-W ≥5 *(n= 66)*	p-value[1]	OR (95% CI)	AOR (95% CI)[2]
Vitamin A	66.3	39.4	**< 0.001**	**3.032 (1.708-5.380)**	**2.460 (1.334-4.536)**
Vitamin D	92.6	86.4	0.139	1.968 (0.818-4.736)	1.587 (0.632-3.989)
Vitamin E	79.7	68.2	0.065	1.833 (0.985-3.410)	1.306 (0.654-2.608)
Vitamin C	77.2	60.6	**0.011**	**2.204 (1.218-3.989)**	**1.997 (1.078-3.699)**

Micronutrient	% Women with intakes <EAR			Association between adequate dietary diversity and meeting the EAR	
	MDD-W <5 (*n= 202)*	**MDD-W ≥5 (*n*= 66)**	**p-value**[1]	**OR (95% CI)**	**AOR (95% CI)**[2]
Vitamin B6	22.8	13.6	0.118	1.868 (0.859-4.058)	1.132 (0.475-2.697)
Vitamin B12	72.8	40.9	**< 0.001**	**3.861 (2.161-6.897)**	**3.368 (1.859-6.103)**
Thiamin	33.7	24.2	0.171	1.586 (0.841-2.990)	0.782 (0.357-1.717)
Niacin	40.6	19.7	**0.002**	**2.786 (1.428-5.436)**	2.058 (0.994-4.263)
Riboflavin	54.0	34.8	**0.007**	**2.191 (1.231-3.902)**	1.608 (0.846-3.057)
Folate	50.5	51.5	0.888	0.960 (0.551-1.674)	0.519 (0.266-1.016)
Pantothenic acid	91.5	81.8	**0.038**	**2.418 (1.088-5.375)**	1.728 (0.729-4.091)
Magnesium	71.3	59.1	0.690	1.719 (0.965-3.063)	0.977 (0.414-2.303)
Phosphorus	45.0	15.2	**< 0.001**	**4.591 (2.218-9.505)**	**3.840 (1.633-9.030)**
Potassium	100	97.0	0.060	-	-
Calcium	96.0	86.4	**0.016**	**3.829 (1.413-10.378)**	**3.089 (1.068-8.933)**
Iron	32.2	22.7	0.165	1.613 (0.845-3.081)	0.838 (0.379-1.852)
Zinc	30.2	21.2	0.206	1.607 (0.829-3.116)	0.889 (0.412-1.919)
Biotin	56.4	33.3	**0.002**	**2.591 (1.447-4.639)**	**2.019 (1.065-3.827)**
MAR (SD)	66.5 (15.8)	78.6 (12.7)	**< 0.001**		

[1] Chi-square test

[2] Binary logistic regression analysis, adjusted for energy intake (kJ) and province

Bolded values are statistically significant, p<0.05

4.6.4 Dietary diversity and contribution of fortified staple foods

Fortified staple foods contributed 2169 kJ (36.1% of total energy) in the low dietary diversity group and 1847 kJ (24.6% of total energy) in the adequate dietary diversity group. While percentage energy contribution from fortified staple foods combined did not differ significantly between the two dietary diversity groups, percentage energy from fortified maize meal was significantly higher in the low dietary diversity group [18% (IQR 0.0, 43.3) versus 7.5% (IQR 0.0, 24.2), p=0.049]. The contribution of fortified staples to the total micronutrient intakes can be seen in ***Table 4.11.*** There were significant differences in the contribution of all fortificant micronutrients, except for vitamin B6 in both dietary diversity groups. Women with a low dietary diversity had a higher percentage contribution of these micronutrients.

Table 4.11: Percent of fortified staple food contribution to micronutrient intakes

Nutrient %	**DDS < 5 *(n = 202)***		**DDS ≥ 5 *(n = 66)***		**p-value**
	Median	***(IQR)***	***Median***	***(IQR)***	
Vitamin A	59.9	(36.1; 87.8)	31.3	(14.6; 44.7)	**< 0.001**
Thiamin	71.1	(50.8; 84.2)	56.3	(32.8; 76.1)	**< 0.001**
Niacin	56.0	(37.1; 74.2)	45.9	(25.3; 63.7)	**0.008**
Riboflavin	36.5	(17.3; 58.5)	15.1	(7.6; 30.1)	**< 0.001**
Vitamin B6	77.5	(57.1; 88.1)	71.0	(56.6; 83.3)	0.164
Folate	80.6	(56.3; 92.6)	63.6	(34.9; 77.7)	**< 0.001**
Iron	62.7	(43.9; 78.3)	47.4	(27.1; 61.5)	**< 0.001**
Zinc	56.8	(34.2; 75.7)	40.6	(27.4; 59.5)	**0.001**

p-values: Non-parametric independent t-tests <0.05; Bolded p-values are statistically significant

4.7 Measures of nutrient intake and dietary diversity in relation to socioeconimic characteristics

The results showed no significant associations between MAR and socioeconomic characteristics. The socioeconomic characteristics according to the two dietary diversity groups are reported in ***Table 4.12.*** Receiving a child support grant and LSM grouping differed significantly between the two groups. Overall, 65.8% of women who did not achieve minimum dietary diversity (MDD-W≥ 5) received a child a child support grant, compared to 48.5% of women who did meet the MDD-W cut-off (p=0.009). Additionally, 45.5% of women who achieved minimum dietary diversity fell in the lower LSM group (≤ 6), compared to 62.4% who did not achieve it (p=0.016).

Table 4.12: Socioeconomic characteristics according to MDD-W

Socioeconomic characteristic	MDD-W< 5 *(n= 202)*	MDD-W ≥ 5 *(n= 66)*	p value[1]
Mean age (years)	31(9.0)	31(10.0)	0.713
Highest education completed (%)			
At least Grade 5	12.4	9.1	0.608
Grade 7	46.0	43.9	
At least Grade 12	39.0	45.5	
Household income (%)			
R0 – R5000	73.3	65.6	0.332
R5000 – R20 000	13.4	19.7	
R20 001 or More	11.4	13.6	
Receiving child support grant (%)	65.8	48.5	**0.009**
Household hunger scale (HHS) (%)			
Little to no hunger	79.2	86.4	0.548
Moderate hunger	6.9	4.5	
Severe hunger	12.4	9.1	
Living standards measure (LSM), (%)			
LSM group ≤ 6	62.4	45.5	**0.016**

Note: Missing data: Education level 4% (*n*= 6); Household income 5% (*n*= 6);
Household Hunger Scale 1.1% (*n*= 3); Child support grant 1% (*n*= 2)
Bolded p-values are statistically significant; p<0.05
[1] Chi-square test for categorical data; independent t-test for continuous data

In ***Table 4.13,*** household assets are reported according to dietary diversity group. A significantly higher percentage of women with adequate dietary diversity (MDD-W≥5) had the following assets, which may influence dietary diversity, within their households; refrigerator (p=0.003), microwave (p=0.031), built in kitchen sink (p=0.002) and water in own dwelling or yard (p=0.012).

Table 4.13: Household assets according to MDD-W

Household Asset	Total	MDD-W <5	MDD-W ≥5	p-value
MNet –DSTV	38.1	32.7	54.5	**0.001**
Computer	16.8	12.9	28.8	**0.003**
Deep freezer	17.5	15.3	24.2	0.099
Refrigerator	73.9	69.3	87.9	**0.003**
Cooking stove electric	86.2	85.1	89.4	0.385
Cooking stove gas	20.5	18.3	27.3	0.118
Microwave oven	55.2	51.5	66.7	**0.031**
Built-in kitchen sink	29.1	24.3	43.9	**0.002**
Home security system	6.3	4.5	12.1	**0.027**
Home theatre system	18.3	13.4	33.3	**0.000**
Motorised vehicle	22.4	18.8	33.3	**0.014**
Domestic worker	6.0	4.0	12.0	**0.015**
Water source				
In yard or own dwelling	74.6	70.8	86.4	**0.012**
Elsewhere	25.4	29.2	13.6	

Note: Low dietary diversity = MDD-W <5; Adequate dietary diversity = MDD-W ≥5

Bolded p-values are statistically significant; p<0.05; Chi-square test

4.7.1 Association of dietary diversity with socio-economic characteristics

Controlling for energy and province, the results of the binary logistic regression analyses showed that women in the lower LSM groups (≤6) were less likely to have an adequate dietary diversity compared to those in the higher LSM groups (≥7) [OR=0.449, (95% CI 0.244-0.827)]. Additionally, women who received a child support grant were less likely to have an adequate dietary diversity compared to those who did receive a child support grant [OR=0.478, (95% CI 0.263-0.870).

CHAPTER 5: DISCUSSION

5.1 Introduction

The aim of this study was to assess the (1) nutrient adequacy by means of NARs/ MAR and EAR cut point method; and (2) diet diversity based on the MDD-W guideline, from data of a 24-hour dietary recall. Additonally, the aim included estimating the contribution of fortified staple foods to total nutrient intakes among WRA, in Gauteng and Eastern Cape, South Africa.

We found that women in this study had nutrient adequacy for half the micronutrients assesed and the MDD-W was only achieved for 25% of women. This study provides evidence that fortified staple foods contribute significantly to the micronutrient intake and nutrient adeqaucy of WRA. Although the MDD-W and median MAR were below the recommended cut-offs, women who were more impoverished had lower dietary divesity scores and no relation to MAR. Overall, women in the Gauteng (urban) consumed more nutrients which explains higher values for the MARs and all the NARs for these women compared to women in the Eastern Cape (rural).

When comparing the two provinces, women in Gauteng (urban) had higher; energy and protein intakes, as well as a higher %TE from protein and lower percentage from carbohydrates, compared to women in the Eastern Cape (rural). Except for energy from carbohydrates, the percentages of energy from macronutrients were all within the range of the AMDR. Women in Gauteng consumed more micronutrients, as reflected by the higher NARs and MAR, compared to women in the Eastern Cape. Fortified maize flour, wheat flour or food items made with these fortified flours contributed more than a third of the energy,protein and carbohydrate intakes and to more than 50% micronutrient intakes of women who consumed these fortified staple foods, which demonstrates the contribution of the NFFP to micronutrient intake. Majority of the women in this study sample did not achieve the MDD-W, which indicates poor dietary diversity. The association between the MAR and MDD-W also illustrates the need for improving the dietary diversity to improve the micronutrient intakes of women. The MAR showed no significant associations with any of the socioeconomic characteristics and the MDD-W was only associated with the LSM and receipt of a child support grant.

5.2 Socio-economic characteristics of women

The attainment of primary school education or no education results in lower income, increased risk of food insecurity and other poverty related consequences (Oldewage-Theron, Kruger, *et al.* 2014). Literature shows that barriers to female education include cultural or societal expectations of women, as young women are expected to bear children and often look after them or other family members who are older or ill. This is more so in the rural areas (Micklesfield *et al.* 2013). Although there were more women from lower income households, the food security status was not significantly related to household income levels. This finding differs from other data reported, as food security is usually associated with income and nutrient adequacy measures (Faber *et al.* 2009, Chakona and Shackleton 2017), but for this study food security was not related to the socioeconomic factors. Child support grants are a source of income for vulnerable or impoverished households. In this study population the social grants seem to be assisting the income deficeit or women maybe finding alternatives to overcome hunger within households but not nessecsarly achieving nutritional adequacy.

Additionally, the higher levels of education and LSM among women in the Gauteng province showed a generally more favourable socioeconomic outcome, when compared to the women in the Eastern Cape.

5.3 Energy, nutrient intakes and nutrient adequacy of women

Energy expenditure and energy intake are highly correlated and therefore do not allow for an accurate interpretation of the prevalence of adequate energy intakes in this study (May *et al.* 2014). The median energy intakes of women in this study sample were similar to findings in other studies among South African women (Napier and Oldewage-Theron 2015, Steyn *et al.* 2016). These studies also report the mean energy intake to be below the DRIs or EER used for women.

When comparing the two provinces, energy intakes of women in the Eastern Cape were lower, which is similar to other data (Steyn *et al.* 2012, Mchiza *et al.* 2015). The higher energy intake of women in Gauteng province is attributed to the higher intakes of fat and protein. Generally, women in ubran areas have more westernized diets which are higher in fats and more accessible to protein sources (Oldewage-Theron, Kruger, *et al.* 2014), which may explain the higher, overall energy intake. Compared to women in the Gauteng province, the energy contribution from carbohydrates was higher among women in the Eastern Cape (rural), this was also

reported among rural areas in South Africa (Steyn *et al.* 2012). This reflects a higher dependancy on starchy foods for energy intakes among women in Eastern Cape . Energy intake has been shown to be associated with nutrient adequacy (Oldewage-Theron, Kruger, *et al.* 2014). In this study, energy intake and NARs for most micronutrients were higher for women in Gauteng, compared to the women in the Eastern Cape.

The median MAR for the study sample showed an overall inadequate micronutrient intake, which is similar to other studies and reflects a poor dietary intake or micronutrient intake (Oldewage-Theron and Kruger 2011, Oldewage-Theron and Egal 2015). Although the MAR was inadequate based on the ideal MAR of 100%, it should be noted that the MAR was above 75%, which is higher compared to other reported data for women in South Africa (Oldwage-Theron & Kruger, 2011; Oldewage-Theron & Egal, 2015) and similar to nutrient adequacy data from 2009 (Steyn *et al.* 2016). The MAR value of >75% for found women in Gauteng can be explained by the intake of more protein and fat. The association of MAR with total protein and fat intake can reflect that these macronutrients include food groups with higher amounts or more varied micronutrients, among them are B vitamins, iron and fat soluble vitamins. Micronutrients below the EAR include folate, vitamin B12, magensium, vitamin A, calcium, potassium and vitamin C. These nutrient inadequacies are risk factors for maternal health and fetal develpoment among WRA and pose a risk for deficencies (Labadarios *et al.* 2005, UNICEF 2013, Shisana *et al.* 2014, Wells *et al.* 2020).

5.4 Contributions of fortified staple foods and logo awareness

In this study, except for riboflavin, fortified staples contributed to more than 50% of the fortificant micronutrients (vitamin A, niacin, thiamin, vitamin B6, folate, iron and zinc) among women consuming fortifed staples. This may suggest that the consumption of these fortified staples may have the potential to increase the micronutrient intakes of women by more than 50% for the micronutrients added to these products. Other reported data also showed an increase in micronutrient intakes from consumption of fortified staples or an improvement in micronutrient adequacy among children and women respectivley (Papathakis and Pearson 2012, Swanepoel *et al.* 2019). It should be noted that, despite the intake of fortifed staples, there was still an inadequate intake of vitamin A among women in this study. Consequentially, women who consumed fortified staples had higher median NARs values, with all but vitamin A meeting the NAR of >100%, and almost 20 percentage points higher MAR value compared to those who did not consume fortified staples. Fortified staple foods contributed to more than

50% of the vitamin A intakes but the vitamin A intakes for women consuming fortified staples was still below the EAR, posing a greater risk of VAD. Overall, the consumption of fortified staple foods can be promoted as a primary carbohydrate source to improve the micronutrient intakes of South African women where other micronutrient rich food sources are not available. Public awareness of the fortification logo on fortified bread, wheat flour and maize flour may also encourage women to purchase fortified staple foods, as more than 30% of women in this sample,who consumed fortified staple foods, were motivated to buy fortified maize or wheat flour, based on the awarness of fortification.

5.5 Minimum dietary diversity of women

The MDD-W is a dichotomous indicator for assessing whether WRA consumed at least five out of ten specific food groups in the last 24 hours. According to the guidelines for MDD-W, women in this study sample, from both provinces did not meet the cut-off of dietary diversity score of 5≥, which indicates poor dietary diversity. Just just over 75% of women in this sample did not achieve the MDD-W, which is similar to other studies (Chakona and Shackleton 2017, Adubra *et al.* 2019). Compared to women in the Gauteng province, women in the Eastern Cape (rural) had a lower dietary diversity score, which has also been reported in other South African rural areas (Steyn *et al.* 2012, Chakona and Shackleton 2017).

When comparing the dietary diversity groups, more than half of the women who did not achieve a MDD-W of 5≥, consumed at least 3 out of the 10 food groups. The three consumed food groups were grains, roots and tubers known as starchy staples; meat, fish and poultry and other vegetables. This is consistent with other studies (Arimond *et al.* 2010, Oldewage-Theron and Kruger 2011, Chakona and Shackleton 2017). More than 50% of women who had an adequate dietary diversity (MDD-W≥5) consumed at least 6 groups and these were more nutrient dense foods, like vitamin A rich fruits and vegetables and animal source foods.

In this study, energy intake was associated with dietary diversity score, which is similar to other reported data (Oldewage-Theron and Kruger 2011). Additionally, dietary intake for women who did not achieve minimum dietary diversity reflected a more traditional diet, with lower %TE from protein and fat respectively and %TE from carbohydrates (67%) exceeding the upper limit of the AMDR. The higher %TE for both protein and fat for women who achieved minimum dietary diversity, can probably be contributed to the higher proportion of of these women consuming foods from the meat, fish and poultry group; milk and milk products and

eggs. Vegetables are foods sources of folate, vitamin A, vitamin C, magnesium and potassium; and meat and diary products provide calcium, vitamin B12 and vitamin A. The intake of these micronutrients where below the EAR for women in this study population. According to the guideline for MDD-W, fats and oils as a food group is excluded when calculating the dietary diversity score, as this does not contribute to micronutrient density but may be calculated separately as this reflects fat-soluble vitamins (Acham *et al.* 2012, FAO and FHI 360 2016).

5.5.1 Dietary diversity and fortified staple foods

The NFFP, as previously explained, is an intervention to address micronutrient malnutrition. Fortified staple food intake was not associated with dietary diversity in this study, which means that the intake of fortifed staple food increase the dietary diversity score of the women in this study sample. It should be noted that women who had a poor dietary diversity had higher energy intakes from fortifed maize meal, which could suggest a higher consumption of this fortified staple food based on the percentage of energy it contributed. Similar to the nutrient adequacies, the micronutrient contributions of fortified staple food provide more than 50% of the selected micronutrient intake among women with low dietary diversity who consumed fortified staples. This illustrates the complimentary approach the NFFP brings to improving micronutrient malnutrition where dietary diversity is low.

5.5.2 Dietary diversity in relation to socioeconomic factors

Higher levels of education has been associated with an higher dietary diversity score and dietary intake (Taruvinga *et al.* 2013, Oldewage-Theron, Kruger, *et al.* 2014, Morseth *et al.* 2017). Additionally, literature has shown that socioeconomic factors including education, income, food security and poverty influence the dietary diversity and dietary intake (Misselhorn 2005, Labadarios, Steyn, *et al.* 2011, Acham *et al.* 2012, Taruvinga *et al.* 2013, Oldewage-Theron, Kruger, *et al.* 2014, Chakona and Shackleton 2017, Adubra *et al.* 2019). However, for this study there was no significant association between education, income, HHFS and dietary diversity.

LSM as a measure of poverty assesses households according to household assets. Household assets or facilities particularly involved in the preparation and storage of food (fridge, microwave or water in dwelling), were associated with women who had a MDD-W ≥5. This is consistent with findings that have been reported within South Africa (Faber *et al.* 2009). A lower LSM indicates that women are more impoverished and have less household assets or

facilities (Faber *et al.* 2009, Oldewage-Theron, Kruger, *et al.* 2014, Chakona and Shackleton 2017). Futhermore, higher LSM has been associated with higher dietary diversity (Faber *et al.* 2009, Labadarios, Steyn, *et al.* 2011). Not having a fridge limits a household's ability to store perishable foods, which may limit intake thereof. Also, financial constraints limit households' ability to consume a diverse diet and it has been argued that a healthy diet is unaffordable for a large majority of the South African population. (Schonfeldt et al. 2013).

The child support grant is means tested so that it may reach children within poor and vulnerable households and was implemented with other social grants like, pensioner's grant, to improve the household income and food security of poor households (Devereux and Waidler 2017, Statistics South Africa 2019). Just over 44% of households in South Africa reported that social grants are their main source of income (Statistics South Africa 2019). In this study, the association of a lower LSM and the receipt of a child support grant with a MDD-W<5, demonstrate that women from more impoverished households, consumed a diet with low diversity .

HHFS was surprisingly not associated with dietary diversity and median MAR. Several studies have shown the relation between food insecurity and low dietary diversity (Faber *et al.* 2009, Kennedy 2009, Adubra *et al.* 2019). This study shows that less than 20% of women with MDD-W <5, had moderate to severe hunger. MDD-W has been used as a proxy indicator of food security which reflects the association of these two indicators (Kayitakire *et al.* 2016, Chakona and Shackleton 2017, Adubra *et al.* 2019). Also, seasonality has been reported to influence the MDD-W and the HHFS status of women (Hjertholm *et al.* 2019), but this could not be assessed due to the cross-sectional study design. In general, most women in this study have little to no hunger and this combined with the high percentage of women who did not achieve the MDD-W can possibly explain not having a significant association.

5.6 Study limitations

The cross-sectional design of the study allows for investigating associations, but not cause-effect relationships. The targeted households for the 24HR interview were supposed to be approximately 840 households. This was greatly reduced and the sample size included in the study was only 268 women which is a relatively small study sample. Limitations of the 24 HR are that participants may not report their food intake accurately due to memory or they refused to complete the 24HR interview which resulted in a relatively small study sample. Additionally,

the use of a single 24HR does not account for day-to-day variation in diets and only provides a description of the average dietary intake of this population. Multiple recalls can therefore be used to assess the individual intake and population distributions with more complex statistical analyses. Lastly, as previously stated the sample size was reduced due to; unavailability of women for interviews and implausible data related to energy intake and missing data, therefore a convenience sample, rather than a representative sample (GAIN *et al.* 2015) was used, this may have affected the statistical power in the analysis (Boushey *et al.* 2008).

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

Measures of nutrient adequacy showed simliar findings, where women from a more urban area, like Gauteng, had higher values compared to women in a more rural area, like Eastern Cape. This can be related to an overall higher energy and nutrient consumption among women in Gauteng. Nutrient adequacy was particularly higher for the fortifiable micronutrients among women who consumed the fortified staples, which can demostrate the significant contribution of the fortification program. Achieving the MDD-W is still a challenge, espcially among impoverished households, as seen in the results of this study and was correlated with median MAR.

Macronutrient intakes of women in this study were within the recommended ranges except for a higher percentage of total energy from carbohydrates among women in the Eastern Cape (>65% of AMDR). To bring this percentage of total energy from carbohydrates within AMDR, a small increase the percentage of energy from fat or protein may allow for this and may also increase the median MAR i.e. intake of food sources with more fat or protein and less carbohydrates among women in the Eastern Cape.

Fortified staples contributed significantly to the micronutrient intakes of women who consumed these fortified staples. The intake of fortified staples and the promotion of these foods as an alternative or choice as a carbohydrate (starchy staple) will increase the micronutrient intakes and ultimately assist in increasing the micronutrient adequacy of women who consume them.

Dietary intake for women who did not achieve the minimum dietary diversity consumed a more traditional diet with lower micronutrient adequacy and a reliance on the NFFP, more so for women in the rural, Eastern Cape province. Although the promotion of a starch-based diet is not recommended (Vorster *et al.* 2013), education on starches or staples like fortified maize meal or bread flours and other vitamin A rich starchy vegetables as the choice for the intake of this food group will contribute to higher micronutrient intakes of women. Dietary diversity is the optimal intervention to improving the micronutrient adequacy of WRA, the education and promotion of adequate dietary diversity should continue, but this may be challenging in poorer communities with multiple factors contributing to low dietary diversity. Although majority of the women did not have household food insecurity, only a quarter of the women achieved the

minimum dietary diversity, which is not consistent with other studies. Women from more impoverished households were more likely to have a low dietary diversity and a lower median MAR.

Where appropriate, communities should be educated and supported on making food gardens or afforable alternatives for perishable foods. Communities can be educated on alternative measures to store perishable foods where household assets like a fridge or eletricity supply is not feasible. Also, making provisions for food preparation areas and especially, accessible clean water sources within households or on the dwellings can accommodate safe food preparation and promote dietary diversity. Poverty indicators like the above described, LSM, and household dependancy on social grants can be further investigated to assess the impact they may have on dietary diversity of women and where needed, interventions should be focused on addresing and identifying these underlying factors which may affect the of dietary diversity of WRA.

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APPENDICIES

Table 1.1: South African food fortification standards

Fortificant	***Wheat flour (g/kg)***	***Maize meal (g/kg)***	***Micronutrient requirement per 200g bread***		
RDA (mg)	**% of RDA**	**Amount (mg)**			
Vitamin A palmitate*	119.05	139	800 µg-RE	31	250 µg
Thiamin mononitrate	12.46	14.02	1.4	25	0.35
Riboflavin	8.89	8.44	1.6	20	0.32
Nicotinamide/niacinamide	118.42	125	18	25	4.5
Pyridoxine HCl	16.24	19.29	2	25	5
Folic acid	7.9	11.05	0.4	50	0.2
Iron (electrolytic)	178.57	178.57	14	50	7
Zinc oxide	93.75	93.75	15	20	3

(Department of Health, Republic of South Africa 2003)

Figure 2: Framework for Selection of Households for Sample Size

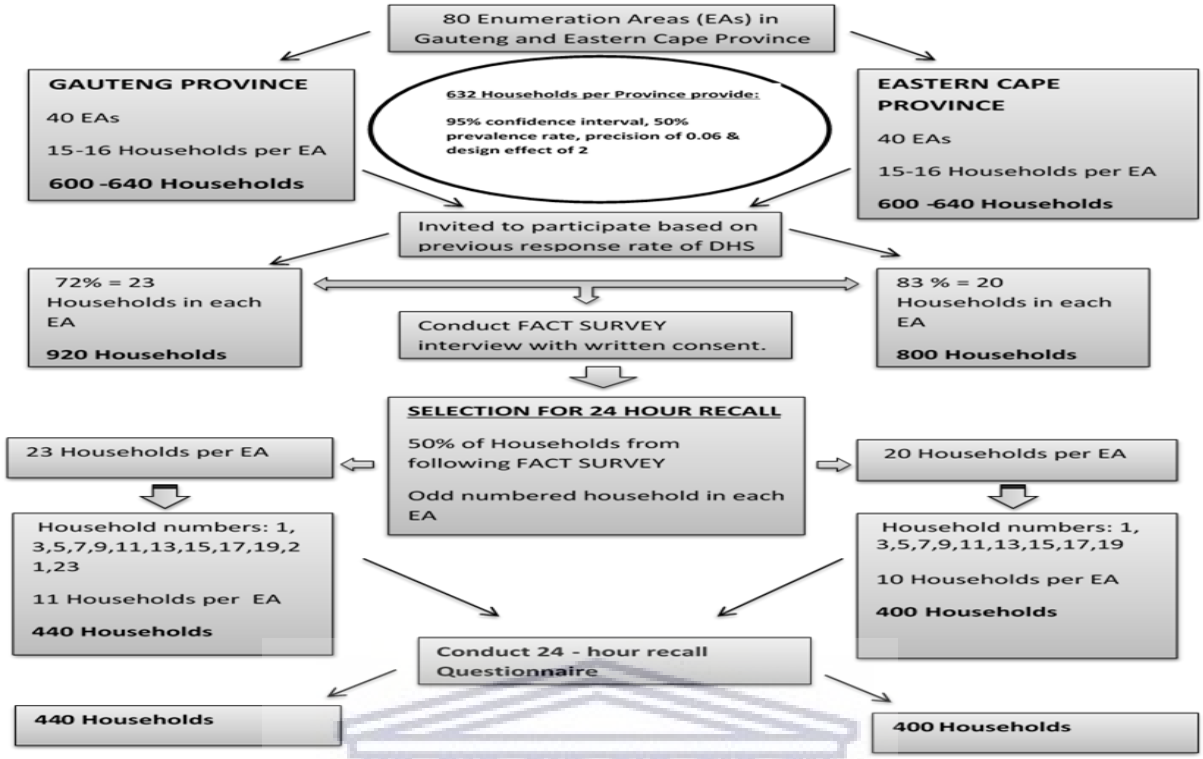
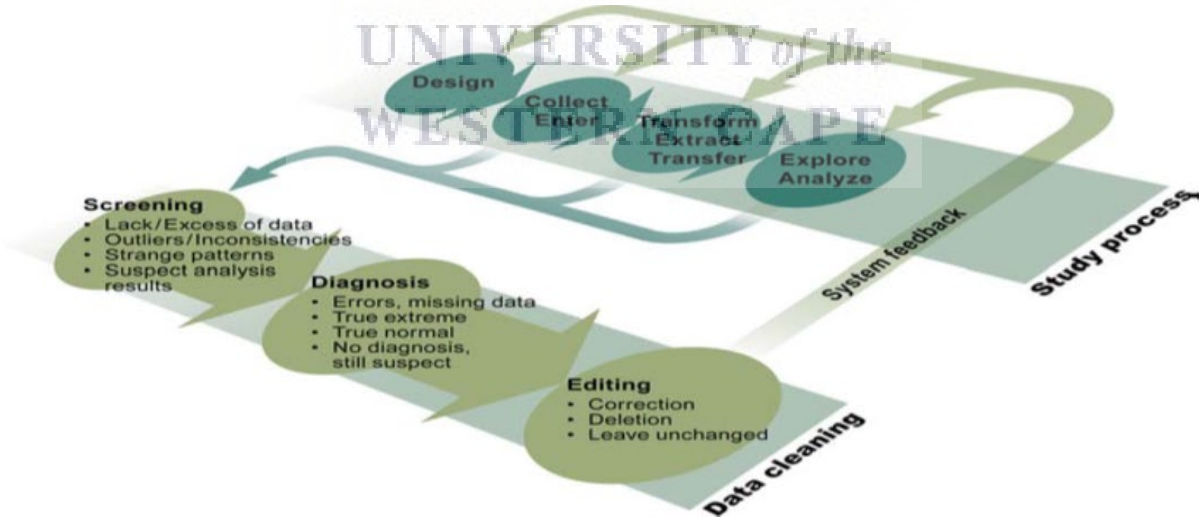


***Figure 3**: A Data Cleaning Framework*



(Van den Broeck et al. 2005)

Table 1.2: Household Hunger Scale (HHS) Questions

1.How many times in the last month did anyone in your house go to sleep at night hungry because there was not enough food?

2.How many times in the last month did anyone in your house go for a whole day and night without eating anything at all because there was not enough food?
3.How many times in the last month was there ever no food to eat of any kind in your house because of lack of resources to get food?

(Ballard et al. 2011)

The answers of each of these questions will be screened and scored on the following answer options:

Table 1.3: HHS Frequency Response Scoring

Score	Response Options
1	Once or twice in the past 30 days (1-2)
2	3-10 time in the past 30 days (3-10)
3	More than 10 time in the past 30 days (>10)

(Ballard et al. 2011)

The sum of the 3 questions will be scored and categorized according Table 1.4

Table 1.4: HHS Categorical Indicator

Household Hunger Score	Household Hunger Categories
0 – 1	Little to no hunger in the household
2 – 3	Moderate hunger in the household
4 – 6	Severe hunger in the household

(Ballard et al. 2011)

APPENDIX 1: *24 hour recall questionnaire*

SOUTH AFRICA FACT COVERAGE SURVEY 2015 **24 HOUR RECALL QUESTIONNAIRE**					
dateint	Date of interview	DD / MM / YY ☐☐ / ☐☐ / 1 5			
teamid	Team identifier	☐☐	intid	Interviewer identifier	☐☐
proid	Province	01. Gauteng 02. Eastern Cape			☐☐
eaid	Enumeration area identifier	☐☐☐☐☐☐☐☐			
areaname	Mainplace (area/village/town)	_____			
areacode	Mainplace code	☐☐☐☐☐☐			
hh	Household identifier	☐☐			

Hello, my name is _____. I'm from _____. The previous questionnaire asked general questions about how often you eat some foods. May we speak to you now to learn more specific details about what you ate in the last 24 hours?

If the person is available, check that Consent Form was completed for this person when the Female Respondent Questionnaire was done then complete 24 Hour Recall Questionnaire.

If the person is not available, schedule a second visit to return. If you return and the person is still not available, end.

(Do not interview a household member <18 years of age.)

lnr	Line number of respondents *Write in the number from the household roster in household questionnaire 1.*		☐☐
cons	Written consent obtained?	Yes…… .1 No……..… .2	If **yes**, begin If **no**, end
visitno	Number of attempts to visit household (up to one return visit) *Record at the time of completing the interview or after second household visit*		☐

out24	Outcome of 24-hour recall questionnaire *Fill in only after questionnaire has been completed for this woman.*	Completed.....1 Refused.....2 No household member at home or no adult respondent at home at time of visit(s).....3 Household member incapacitated or intoxicated…….4 Other: _____.....99	If 3 or 4, return later for a second visit.
		Supervisor check	Initial for yes _____

24-HOUR DIETARY INTAKE RECALL

Since the time you woke up yesterday to when you woke up today, please describe the foods (meals and snacks) that you ate or drank, whether at home or outside the home. Start with the first food or drink of the morning. I will also ask you where you ate the food and how much you ate. To help you to describe the amount of a food you eat, I will show you pictures and examples of different amounts of the food. Please say which picture or example is the same, bigger or smaller than the amount you ate or drank.
Remember, there are no right or wrong answers.

NOTE: In case of combination dishes, try to estimate the proportion of the components of the particular dish and record that underneath the dish e.g. if spaghetti bolognaise 180 g total weight, record the proportion in either weight or % of spaghetti and bolognaise sauce and anything else that was added such as cheese.

dyes	What day was yesterday? (choose one only)	So Mo Tu Wed Thu Fri 1 2 3 4 5 6
dusu	Would you describe the food you ate yesterday as typical of your usual food intake?	Yes ……1 No ……...2

				OFFICE USE	
Time of day	Food and drink	How was it prepared and what was added	How much was eaten?	CODE	GRAM
Waking up till about 9:00 Breakfast					
Midmorning (9:00-12:00)					

Lunchtime (12:00 – 14:00)					
				OFFICE USE	
Time of day	Food and drink	How was it prepared and what was added	How much was eaten?	CODE	GRAM
Afternoon (14:00 – 17:00)					
Supper time (17:00 – 21:00)					
Late evening and extra's					

bre1	*WAS <u>BREAD</u> REPORTED TO BE EATEN IN THIS 24-HOUR RECALL?* *(CIRCLE ONLY <u>ONE</u> ANSWER.)*		Yes……1 No……2		If yes, go to bread module. If no, end.

Now I would like to ask you a few more questions about the bread you ate yesterday.

BREAD CONSUMPTION			
bre2	Where did you get the bread you ate yesterday? *(CIRCLE ONLY **<u>ONE</u>** ANSWER.)*	Purchased…….....1 Made it at home.....2 Received from food aid.....3 Don't know / Don't remember.....88 Other: _____.....99	If **2,** go to **home-made bread** module.
bre3	When you got this bread, how was it packaged? *(CIRCLE ONLY **<u>ONE</u>** ANSWER.)*	Packaged in branded bag……...1 Packaged in clear plastic bag……...2 Unpackaged…….....3 Don't know .....88 Other: _____.....99	If **1**, skip to **bre4**.
bre4	From which bakery or shop did you get this bread? (A. *RECORD NAME.)* *(B. RECORD LOCATION.)*	A. Name: _____ B. Location: _____ _____	**End** After interview, **visit the bakery** and complete the **bakery bread** module.
bre5	Can you show me the bread you ate yesterday? *(CIRCLE ONLY **<u>ONE</u>** ANSWER.)*	Yes……..1 No……..……2	If **no**, **end.**
bre6	*IF BREAD IS AVAILABLE, **<u>LOOK FOR FORTIFICATION LOGO</u>**.* *(CIRCLE ONLY **<u>ONE</u>** ANSWER.)*	Logo not observed (labelled)……1 Logo not observed (no label)……2 Logo observed……..…….....3	**End**
HOME-MADE BREAD CONSUMPTION			

hmb1	What type(s) of flour did you use to make the bread you ate yesterday? *(CIRCLE ONLY **ONE** ANSWER.)*	Bread flour……..……..…1 Cake flour……2 Mixed bread and cake flours…….3 Don't know…….88 Other (specify): _____.....99	If **1**, skip to **hmb3**. If **2**, **88** or **99**, **end**.
hmb2	Of the total amount of flour used to make the bread, what proportion of it was **bread flour**? *(WRITE IN THE NUMBER.)* *(IF 'DON'T KNOW', RECORD 88.)*	Percentage ☐☐	
hmb3	Can you show me the **bread flour** you used to make the bread? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes……..……..1 No……..…2	
hmb4	*(IF BREAD FLOUR IS AVAILABLE):* ***OBSERVE BRAND**.* *(IF BREAD FLOUR IS NOT AVAILABLE, **ASK THE RESPONDENT**):* What is the brand of this bread flour? *(WRITE IN ONLY **ONE** ANSWER.)*	Brand name (write in) ..... (Code assigned) ☐☐ Don't know .....88 Other: _____.....99	
hmb5	*(IF BREAD FLOUR IS AVAILABLE):* ***OBSERVE PRODUCER**.* *(IF BREAD FLOUR IS NOT AVAILABLE, **ASK THE RESPONDENT**):* Who is the producer of this bread flour? *(WRITE IN ONLY **ONE** ANSWER.)*	Producer name (write in) ..... (Code assigned) ☐☐ Don't know .....88 Other: _____.....99	If **bread flour is not available,** end.
hmb6	***LOOK FOR FORTIFICATION LOGO**.* *(CIRCLE ONLY **ONE** ANSWER.)*	Logo not observed (labelled)……1 Logo not observed (no label)……2 Logo observed……..…….....3	**End**

BAKERY VISIT

For unlabeled bread that was not made at home, visit the bakery or shop where the bread was purchased (bakery name and location are reported in br3 of Bread module). Ask to speak to the person who is most knowledgeable about the type(s) of flour regularly used to bake bread.

outbak	Outcome of bakery visit	Completed…….…...1 Refused…….…...2 Not found…….…...3 Did not have time to visit…….…...4

		Other:_____..... ...99	
bak1	What type(s) of flour does this bakery regularly use to make bread? *(CIRCLE ONLY **ONE** ANSWER.)*	Bread flour……..……1 Cake flour……..…..2 Mixed bread and cake flours……..…...3 Bread flour premix……..4 Don't know…….88 Other: _____.....99	If **1**, skip to **bb3**. If **2**, **88** or **99**, **end**.
bak2	Of the total amount of flour regularly used to make bread, what proportion of it is bread flour or bread flour premix? *(WRITE IN THE NUMBER.)* *(IF 'DON'T KNOW', RECORD 88.)*	Percentage ☐☐	
bak3	Can you show me the bread flour or bread flour premix regularly used to make bread? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes……..……..1 No……..…2	
bak4	*(IF BREAD FLOUR / PREMIX IS AVAILABLE):* ***OBSERVE BRAND**.* *(IF BREAD FLOUR / PREMIX IS NOT AVAILABLE, **ASK THE RESPONDENT**):* What is the brand of this bread flour? *(WRITE IN ONLY **ONE** ANSWER.)*	Brand name (write in) ..... (Code assigned) ☐☐ Don't know .....88 Other: _____.....99	
bak5	*(IF BREAD FLOUR / PREMIX IS AVAILABLE):* ***OBSERVE PRODUCER**.* *(IF BREAD FLOUR / PREMIX IS NOT AVAILABLE, **ASK THE RESPONDENT**):* Who is the producer of this bread flour? *(WRITE IN ONLY **ONE** ANSWER.)*	Producer name (write in) ..... (Code assigned) ☐☐ Don't know .....88 Other: _____.....99	If **bread flour is not available,** end.
bak6	***LOOK FOR FORTIFICATION LOGO**.* *(CIRCLE ONLY **ONE** ANSWER.)*	Logo not observed (labelled)……1 Logo not observed (no label)……2 Logo observed…….…….....3	

APPENDIX 2: ***FACT survey household questionnaire 1***

SOUTH AFRICA FACT COVERAGE SURVEY 2015 HOUSEHOLD QUESTIONNAIRE 1					
dateint	Date of interview	DD / MM / YY ☐☐ / ☐☐ / 1 5			
teamid	Team identifier	☐☐	intid	Interviewer identifier	☐☐
proid	Province	01. Gauteng 02. Eastern Cape			☐☐
eaid	Enumeration area identifier	☐☐☐☐☐☐☐☐			
areaname	Mainplace (area/village/town)	_____			
areacode	Mainplace code	☐☐☐☐☐☐			
hh	Household identifier	☐☐	GPS	GPS coordinates	☐☐☐-☐☐☐

Hello, my name is _____. I work for the UWC. We are interested in learning about your family and food in your house. Who is the person in your household who is most knowledgeable about purchasing and preparing most of the food for your family? For example, we would like to know how much is purchased and how long it lasts for foods like oil, maize meal, and wheat flour. May we speak to this person? *(Do not interview a household member <18 years of age.)*

If this person is available:

- *Ask him/her to complete Consent Form and Household Questionnaires 1 and 2;*
- *Ask all eligible women in the household to complete Consent Form and Female Respondent Questionnaire.*

If this person is not available:

- *Ask another household member to complete Consent Form and Household Questionnaire 1;*
- *Ask all eligible women in the household to complete Consent Form and Female Respondent Questionnaire;*
- *Schedule a second visit to return to complete the Household Questionnaire 2 when the person knowledgeable about food in the household is available.*

On the second visit:

- *If the person knowledgeable about food is available, ask him/her to complete Consent Form and Household Questionnaire 2. If that person is not available, ask the next most knowledgeable person.*
- *If there are no adult members of the household who are familiar with food preparation and purchasing, have another household member to complete Consent Form and Household Questionnaire 2.*

cons	Written consent obtained?	Yes……1 No……2	If **yes**, begin If **no**, end
visitno	Number of attempts to visit household (up to one return visit) *Record at the time of completing the interview or after second household visit*		☐

outhh	Outcome of HH questionnaire *Fill in only after questionnaire has been completed for this household.*	Completed.....1 Refused.....2 No household member at home or no adult respondent at home at time of visit(s).....3 Household member incapacitated or intoxicated……..……..4 Dwelling vacant for extended period of time.....5 Household has permanently moved, or address is not a dwelling....6 Dwelling destroyed.....7 Other: _____.....99	If 3 or 4, return later for a second visit. If 5, 6 or 7,go on to next selected household.
		Supervisor check	Initial for yes _____

HOUSEHOLD ROSTER

Now we would like some information about persons who usually stay in your household. This will include anybody who sleeps in this household for at least 4 nights of the week and eats from the same pot of food.

Start by listing the head of the household.

Line number	A. Name of person	B. Sex	C. C. Age *(in years OR months). Record in months if <5 years or <60 months*		D. Currently attending school or college?	E. Highest educational level (grade) completed				
			Years	Months						
01	Head of Household	M / F	☐☐		Yes……1 No……2	0	5	7	12	>12
02		M / F	☐☐	☐☐	Yes……1 No……2	0	5	7	12	>12
03		M / F	☐☐	☐☐	Yes……1 No……2	0	5	7	12	>12
04		M / F	☐☐	☐☐	Yes……1 No……2	0	5	7	12	>12
05		M / F	☐☐	☐☐	Yes……1 No……2	0	5	7	12	>12
06		M / F	☐☐	☐☐	Yes……1 No……2	0	5	7	12	>12
07		M / F	☐☐	☐☐	Yes……1 No……2	0	5	7	12	>12
08		M / F	☐☐	☐☐	Yes……1 No……2	0	5	7	12	>12
09		M / F	☐☐	☐☐	Yes……1 No……2	0	5	7	12	>12
10		M / F	☐☐	☐☐	Yes……1 No……2	0	5	7	12	>12

11		M / F	☐☐	☐☐	Yes……1 No…….2	0	5	7	12	>12
12		M / F	☐☐	☐☐	Yes……1 No…….2	0	5	7	12	>12
13		M / F	☐☐	☐☐	Yes……1 No…….2	0	5	7	12	>12
14		M / F	☐☐	☐☐	Yes……1 No…….2	0	5	7	12	>12
15		M / F	☐☐	☐☐	Yes……1 No…….2	0	5	7	12	>12
hh1a	*Just to make sure that I have a complete listing:* Are there any other persons such as small children or infants that we have not listed? *If YES, add name to table.*									
hh1b	Are there any other people who may not be members of your family, such as domestic servants, lodgers, or friends who usually live here and share the same pot of food for at least 4 days of the week? *If YES, add name to table.*									
Note: Add a new page if more people in the household										
Lnr	Line number of respondent *(WRITE IN THE NUMBER FROM THE HOUSEHOLD ROSTER)*				☐☐					

SHORT BIRTH HISTORY			
N°	QUESTIONS	ANSWERS	SKIPS
bh1	Altogether, how many live births have there been in your household in the last 5 years? Please include any baby who cried or showed other signs of life. *(WRITE IN THE NUMBER.)* *(IF 'NONE', RECORD 00. IF 'DON'T KNOW', RECORD 88.)*	☐☐	If **00** or **88**, skip to **household characteristics** module.
bh2	Is this child / are these children still alive? *(CIRCLE ONLY **ONE** ANSWER.)*	All alive.....1 One or more has died in the past 5 years.....2 Don't know…….88	
HOUSEHOLD CHARACTERISTICS			
N°	QUESTIONS	ANSWERS	SKIPS
hc1	Does your household have electricity? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes……..1 No……2	

hc2	What fuel does your household mainly use for cooking? *(CIRCLE ONLY **ONE** ANSWER.)*	Electricity.....1 LPG.....2 Natural gas.....3 Biogas.....4 Kerosene / Parafin.....5 Coal / Lignite.....6 Candles.....7 Firewood.....8 Straw / Shrubs / Grass.....9 Animal dung.....10 Sun/solar cooker……..11 No food cooked in household.....12 Don't know.....88 Other: _____ 99	
hc3	Does your household or anyone in the household have ? ***(PROMPT FOR EACH ITEM**; RECORD ALL ITEMS IN THE HOUSEHOLD.)* *(CIRCLE ONLY **ONE** ANSWER FOR EACH ITEM.)*	A. Radio (other than a car radio) Yes……..1 No……..2 B. Television Yes……..1 No……..2 C. DVD player Yes……..1 No……..2 D. MNet-DSTV subscription Yes……..1 No……..2 E. Air conditioner Yes……..1 No……..2 F. Computer / desktop / laptop Yes……..1 No……..2 G. Vacuum cleaner / floor polisher Yes……..1 No……..2 H. Dishwashing machine Yes……..1 No……..2 I. Tumble dryer Yes……..1 No……..2 J. Home telephone (landline) Yes……..1 No……..2 K. Deep freezer Yes……..1 No……..2	

	Does your household or anyone in the household have … ? ***(PROMPT FOR EACH ITEM**; RECORD ALL ITEMS IN THE HOUSEHOLD.)* *(CIRCLE ONLY **ONE** ANSWER FOR EACH ITEM.)*	L. Refrigerator / combined fridge/freezer Yes…...1 No.…...2
		M. Cooking stove (electric) Yes……..1 No……...2
		N. Cooking stove (gas) Yes……..1 No……...2
		O. Microwave oven Yes……..1 No……...2
		P. Built-in kitchen sink Yes……..1 No……...2
		Q. Home security system Yes……..1 No……...2
		R. Home theatre system Yes……..1 No……...2
		S. Bicycle or tricycle Yes……..1 No……...2
		T. Motorcycle, scooter, auto-rikshaw, car, truck, jeep, or tractor Yes……..1 No……...2
		U. Boat with motor Yes……..1 No……...2
		V. Canoe or fishing nets Yes……..1 No……...2
		W. Animal-drawn cart Yes……..1 No……...2
		X. Domestic worker Yes……..1 No……...2
		Y. Hot water running from a geyser Yes……..1 No……...2
		Z. Cell phone Yes……..1 No……...2
		AA. 2 cell phones in household Yes……...1 No……....2

		BB. 3 or more cell phones in household Yes.…….1 No…....2	
hc3a	Does your household live in a single house, cluster house or town house? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes……..1 No……..…2	
hc4	*WHAT IS THE MAIN MATERIAL OF THE FLOOR OF THE DWELLING?* *(OBSERVATION.)* *(CIRCLE ONLY **ONE** ANSWER.)*	Natural floor Earth / sand.....1 Dung.....2 Rudimentary floor Wood planks.....3 Palm / bamboo.....4 Finished floor Parquet / polished wood.....5 Vinyl / asphalt strips.....6 Ceramic tiles.....7 Cement.....8 Carpet.....9 Other: _____ 99	
hc5	*WHAT IS THE MAIN MATERIAL OF THE ROOF OF THE DWELLING?* *(OBSERVATION.)* *(CIRCLE ONLY **ONE** ANSWER.)*	Natural roofing No roofing.....1 Thatch / palm leaves.....2 Sod.....3 Rudimentary roofing Rustic mat.....4 Palm / bamboo.....5 Wood planks.....6 Cardboard.....7 Finished roofing Metal.....8 Wood.....9 Calamine / cement fiber.....10 Ceramic tiles.....11 Cement.....12 Roofing shingles.....13 Other: _____..... 99	
hc6	*WHAT IS THE MAIN MATERIAL OF THE EXTERIOR WALLS OF THE DWELLING?* *(OBSERVATION.)*	Plastic / Cardboard……..... 1 Mud..... 2 Mud and cement..... 3 Corrugated iron / zinc..... 4	

	*(CIRCLE ONLY **ONE** ANSWER.)*	Prefab ..... 5 Bare brick or cement blocks……..6 Plaster / finished..... 7 Other: _____ 99	
WATER, SANITATION, AND HYGIENE (WASH)			
N°	QUESTIONS	ANSWERS	SKIPS
w1	What is the main source of drinking water for the members of your household? *(CIRCLE ONLY **ONE** ANSWER.)*	Piped water Piped into dwelling.....1 Piped to yard / plot.....2 Public tap / standpipe.....3 Tube well / borehole.....4 Dug well Protected /covered well.....5 Unprotected / open well.....6 Water from spring Protected spring.....7 Unprotected spring.....8 Rainwater.....9 Tankertruck.....10 Cart with small tank.....11 Surface water River / stream ……...12 Dam ……..……13 Lake / Pond .....14 Water vendor / Bottled / sachet .....15 Don't know.....88 Other: _____ 99	
w2	Where is that water source located? *(CIRCLE ONLY **ONE** ANSWER.)*	In own dwelling……. ….1 In own yard/plot…… …2 Elsewhere…… …….3	If **1 or 2**, skip to **w4**
w3	How long does it take to go there, get water and come back? *(WRITE IN THE NUMBER.)*	Minutes…… ☐☐☐	

	(IF 'DON'T KNOW', RECORD 888.)		
w4	Do you **usually** do anything to your drinking water to make it safer to drink? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes……1 No……...2	If **No**, skip to **w6**
w5	What do you **usually** do to the water to make it safer to drink? *(DO **NOT** PROMPT. PROBE "ANYTHING ELSE?")* *(CIRCLE YES FOR EACH ITEM MENTIONED AND NO FOR EACH ITEM NOT MENTIONED.)*	A. Boil Yes / No B. Add bleach / chlorine Yes / No C. Strain through a cloth Yes / No D. Use a water filter Yes / No (ceramic / sand / composite ...) E. Solar disinfection Yes / No F. Let it stand and settle Yes / No G. Don't know Yes / No H. Other: _____ Yes / No	
w6	What kind of toilet facility do members of your household usually use? *(DO **NOT** PROMPT.)* *(CIRCLE ONLY **ONE** ANSWER.)*	Flush / pour flush toilet Flush to piped sewer system.....1 Flush to septic tank.....2 Flush to pit latrine.....3 Flush to elsewhere.....4 Flush, don't know where.....5 Pit latrine Ventilated improved pit latrine.....6 Pit latrine with slab.....7 Pit latrine without slab / open pit.....8 Composting toilet.....9 Bucket toilet.....10 Hanging toilet / hanging latrine.....11 No facilities / bush / field.....12 Don't know.....88 Other: _____ ……...99	
w7	Do you share this facility with other households? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes……1 No……...2	

HEALTH SERVICES ACCESS

N°	QUESTIONS	ANSWERS	SKIPS
hs1	How long does it take to travel to the	A. Duration ☐☐☐	If **A** is **88**, skip to **income** module.

	nearest primary health care facility? *(A. WRITE IN THE NUMBER.)* *(B. CIRCLE THE UNIT.)* *(IF 'DON'T KNOW', RECORD 88.)*	B. Minute(s)……..1 Hour(s).....2 Day(s).....3	
HOUSEHOLD INCOME			
N°	QUESTIONS	ANSWERS	SKIPS
hi1	Do any members of this household receive any grants? *(CIRCLE **ALL** RESPONSES THAT APPLY.)*	None……1 Child support……..2 Social relief…….3 Disability…….4 Old age pension…….5 Don't know……88 Other _____.....99	
hi2	How many people contribute to the total income (money) in this household? *(CIRCLE ONLY **ONE** ANSWER.)*	None……1 1 person……..2 2 persons……3 3-4 persons……4 5-6 persons……....5 More than 6 persons……6 Don't know……88 Other: _____.....99	
hi3	What is the total household income per month before deductions (including wages, rent, grants, sales of vegetables, etc.) of everybody in the household added together? If you can tell me the amount off hand please do so, otherwise I will read out various income brackets. Please stop me when I say the amount that you think represents the total monthly income of the household. *(CIRCLE ONLY **ONE** ANSWER.)*	Less than R3001……..1 R3001-4000……..2 R4001-5000……..3 R5001-R7500……4 R7501-R10,000……5 R10,0001-R15,000……..6 R15,001-R20,000……..7 R20,0001-R30,000……..8 R30,0001-R40,000……..9 R40,001 or more……10 Don't know……..88	

APPENDIX 3: FACT survey household questionnaire 2

SOUTH AFRICA FACT COVERAGE SURVEY 2015 **HOUSEHOLD QUESTIONNAIRE 2**					
dateint	Date of interview	DD / MM / YY ☐☐ / ☐☐ / 1 5			
teamid	Team identifier	☐☐	intid	Interviewer identifier	☐☐
proid	Province	03. Gauteng 04. Eastern Cape			☐☐
eaid	Enumeration area identifier	☐☐☐☐☐☐☐☐			
areaname	Mainplace (area/village/town)	_____ ___			
areacode	Mainplace code	☐☐☐☐☐☐			
hh	Household identifier	☐☐			
lnr	Line number of respondent *Write in the number from the household roster in household questionnaire 1.*				☐ ☐
cons	Written consent obtained?		Yes……. 1 No……..…. 2		If **yes**, begin If **no**, end
visitno	Number of attempts to visit household (up to one return visit) *Record at the time of completing the interview or after second household visit*				☐

outhh2	Outcome of HH2 questionnaire *Fill in only after questionnaire has been completed for this household.*	Completed..... .....1 Refused..... .....2 No household member at home or no adult respondent at home at time of visit(s)..... .....3 Household member incapacitated or intoxicated……..4 Other: _____..... 99	If 3 or 4, return later for a second visit.
		Supervisor check	Initial for yes _____

"I would like to ask some questions about the availability of food in your household over the last month."

HOUSEHOLD HUNGER SCALE			
N°	QUESTIONS	ANSWERS	SKIPS
hh1	How many times in the last month did anyone in your house go to sleep at night hungry because there was not enough food? *(WRITE IN THE NUMBER. IF 'NONE', RECORD 00.)*	Number of times ☐☐	
hh2	How many times in the last month did anyone in your house go for a whole day and night without eating anything at all because there was not enough food? *(WRITE IN THE NUMBER. IF 'NONE', RECORD 00.)*	Number of times ☐☐	
hh3	How many times in the last month was there ever no food to eat of any kind in your house because of lack of resources to get food?	Number of times ☐☐	

	(WRITE IN THE NUMBER. IF 'NONE', RECORD 00.)		

"Now I'm going to ask you some questions about food items including cooking oil, maize meal, bread flour, bread and salt. If you have any of these food items in your household, please bring them here now before we start."

OIL FORTIFICATION COVERAGE			
N°	QUESTIONS	ANSWERS	SKIPS
of1	First I would like to talk with you about cooking oil. Does your household prepare foods using cooking oil? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes, regularly……..……...1 Yes, sometimes ……..……2 No, never …….……..3	If **3**, skip to **maize meal** module.
of2	What is the **main** type of cooking **oil** that is used in your household for most meals on most days? *(CIRCLE ONLY **ONE** ANSWER.)*	Refined palm oil…….....1 Soybean oil.....2 Groundnut oil…….3 Sunflower oil……..4 Olive oil.....5 Canola oil…….6 Coconut oil…….……7 Vegetable oil……..…….8 Don't know / Don't remember.....88 Other: _____.....99	
of3	Can you show me this **main** cooking **oil**? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes.……..……..1 No…….……2	
of4	*(IF MAIN OIL TYPE IS AVAILABLE):* When your household got this [MAIN OIL TYPE], where did you get it from? *(IF MAIN OIL TYPE IS NOT AVAILABLE):* The **last time** your household got [MAIN OIL TYPE], where did you get it from? *(CIRCLE ONLY **ONE** ANSWER.)*	Purchased…….....1 Made it at home.....2 Received from food aid.....3 Don't know / Don't remember.....88 Other: _____.....99	If **2,** skip to **maize meal** module.
of5	*(IF MAIN OIL TYPE IS AVAILABLE):*	Original package……...1 Re-packaged……..2 My own container.....3	

	When your household got this [MAIN OIL TYPE], how was it packaged? *(IF MAIN OIL TYPE IS NOT AVAILABLE):* The **last time** your household got [MAIN OIL TYPE], how was it packaged? *(READ **ALL** RESPONSES)* *(CIRCLE ONLY **ONE** ANSWER.)*	Don't know .....88 Other: _____.....99	
of6	*(IF MAIN OIL TYPE IS AVAILABLE):* When your household got this [MAIN OIL TYPE], how much did you get? *(IF MAIN OIL TYPE IS NOT AVAILABLE):* The **last time** your household got [MAIN OIL TYPE], how much did you get? *(SHOW EXAMPLES OF COMMONLY USED CONTAINERS AND MEASURES.)* *(A. WRITE IN THE NUMBER.)* *(B. CIRCLE THE UNIT.)*	A. Quantity ☐☐☐☐ B. Kg.....1 g.....2 L.....3 mL.....4	
of7	How long does this amount usually last in your household? *(A. WRITE IN THE NUMBER.)* *(B. CIRCLE THE UNIT.)*	A. Duration ☐☐ B. Day(s).....1 Month(s).....2	
of8	*(IF MAIN OIL TYPE IS AVAILABLE):* ***OBSERVE BRAND***. *(IF MAIN OIL TYPE IS NOT AVAILABLE, **ASK THE RESPONDENT**):* What is the brand of this [MAIN OIL TYPE]? *(WRITE IN ONLY **ONE** BRAND NAME.)*	Brand name (write in)…… (Code assigned) ☐☐ Don't know .....88 Other: _____.....99	
of9	*(IF MAIN OIL TYPE IS AVAILABLE):* ***OBSERVE PRODUCER***. *(IF MAIN OIL TYPE IS NOT AVAILABLE, **ASK THE RESPONDENT**):*	Producer name (write in)……..… (Code assigned) ☐☐ Don't know .....88 Other: _____.....99	If **oil is not available,** skip to

	Who is the producer of this [MAIN OIL TYPE]? *(WRITE IN ONLY **ONE** ANSWER.)*		**maize meal** module.
of10	***LOOK FOR FORTIFICATION LOGO***. *(CIRCLE ONLY **ONE** ANSWER.)*	Logo not observed (labelled)……1 Logo not observed (no label)……2 Logo observed……..…….....3	
of11	May I take a small sample? *(IF 'YES', TAKE SAMPLE AND STICK OIL LABEL ON SAMPLE CONTAINER.)*	Sample taken……1 No sample taken…….……2	
MAIZE MEAL FORTIFICATION COVERAGE			
N°	QUESTIONS	ANSWERS	SKIPS
mf1	Now, I would like to talk with you about maize meal. Does your household prepare foods using maize meal (e.g. porridge, pap)? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes, regularly……...1 Yes, sometimes ……..…..……2 No, never ……..3	If **3,** skip to **cake flour** module.
mf1a	What types of maize meal are used in your household? *(CIRCLE **ALL** RESPONSES THAT APPLY.)*	Sifted……..1 Supersifted…….……2 Course / Braaipap…….……..……..3 Instant / Quick cooking...……..……..4 Other:_____99	
mf1b	What is the **main** type of **maize meal** that is used in your household? *(CIRCLE ONLY **ONE** ANSWER.)*	Sifted……..……..1 Supersifted……2 Course / Braaipap…….……..……..3 Instant / Quick cooking...……..……..4 Other:_____99	
mf2	Can you show me this **main maize meal**? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes……..1 No……...……2	

mf3	*(IF MAIZE MEAL IS AVAILABLE):* When your household got this maize meal, where did you get it from? *(IF MAIZE MEAL IS NOT AVAILABLE):* The **last time** your household got maize meal, where did you get it from? *(CIRCLE ONLY **ONE** ANSWER.)*	Purchased…….....1 Grinded it at home.....2 Received from food aid.....3 Don't know / Don't remember.....88 Other: _____.....99	If **2,** skip to **cake flour** module.
mf4	*(IF MAIZE MEAL IS AVAILABLE):* When your household got this maize meal, how was it packaged? *(IF MAIZE MEAL IS NOT AVAILABLE):* The **last time** your household got maize meal, how was it packaged? *(READ **ALL** RESPONSES)* *(CIRCLE ONLY **ONE** ANSWER.)*	Original package……....1 Re-packaged……..2 My own container.....3 Don't know .....88 Other: _____.....99	
mf5	*(IF MAIZE MEAL IS AVAILABLE):* When your household got this maize meal, how much did you get? *(IF MAIZE MEAL IS NOT AVAILABLE):* The **last time** your household got maize meal, how much did you get? *(SHOW EXAMPLES OF COMMONLY USED CONTAINERS AND MEASURES.)* *(A. WRITE IN THE NUMBER.)* *(B. CIRCLE THE UNIT.)*	A. Quantity ☐☐☐☐ B. Kg.....1 g.....2	
mf6	How long does this amount usually last in your household? *(A. WRITE IN THE NUMBER.)*	A. Duration ☐☐ B. Day(s).....1 Month(s).....2	

	(B. CIRCLE THE UNIT.)		
mf7	*(IF MAIZE MEAL IS AVAILABLE):* ***OBSERVE BRAND***. *(IF MAIZE MEAL IS NOT AVAILABLE,* ***ASK THE RESPONDENT****):* What is the brand of this maize meal? *(WRITE IN ONLY* ***ONE*** *ANSWER.)*	Brand name (write in) ……..... (Code assigned) ☐☐ Don't know .....88 Other: _____.....99	
mf8	*(IF MAIZE MEAL IS AVAILABLE):* ***OBSERVE PRODUCER***. *(IF MAIZE MEAL IS NOT AVAILABLE,* ***ASK THE RESPONDENT****):* Who is the producer of this maize meal? *(WRITE IN ONLY* ***ONE*** *ANSWER.)*	Producer name (write in) ..... (Code assigned) ☐☐ Don't know .....88 Other: _____.....99	If **maize meal is not available**, skip to **cake flour** module.
mf9	***LOOK FOR FORTIFICATION LOGO***. *(CIRCLE ONLY* ***ONE*** *ANSWER.)*	Logo not observed (labelled)……1 Logo not observed (no label)……2 Logo observed.…….…….....3	
mf10	May I take a small sample? *(IF 'YES', TAKE SAMPLE AND STICK MAIZE MEAL LABEL ON SAMPLE CONTAINER.)*	Sample taken……1 No sample taken.……..…..……2	

CAKE FLOUR COVERAGE

N°	QUESTIONS	ANSWERS	SKIPS
cf1	Now, I would like to talk with you about cake flour. Does your household prepare foods using cake flour (e.g. bread or cakes)? *(CIRCLE ONLY* ***ONE*** *ANSWER.)*	Yes, regularly……...1 Yes, sometimes ……..……2 No, never ……..3	If **3,** skip to **bread flour** module .

cf2	What products does your household prepare using cake flour? *(CIRCLE **ALL** RESPONSES THAT APPLY.)*	Bread……..1 Fat cakes……2 Dry biscuits…….3 Cake / confectionary…….4 Other:_____99	
cf3	Can you show me what **main cake flour** your household uses? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes……..1 No……2	
cf4	*(IF CAKE FLOUR IS AVAILABLE):* When your household got this cake flour, where did you get it from? *(IF CAKE FLOUR IS NOT AVAILABLE):* The **last time** your household got cake flour, where did you get it from? *(CIRCLE ONLY **ONE** ANSWER.)*	Purchased…….....1 Made at home…….....2 Received from food aid.....3 Don't know / Don't remember.....88 Other: _____.....99	
cf5	*(IF CAKE FLOUR IS AVAILABLE):* When your household got this cake flour, how was it packaged? *(IF CAKE FLOUR IS NOT AVAILABLE):* The **last time** your household got cake flour, how was it packaged? *(READ **ALL** RESPONSES)* *(CIRCLE ONLY **ONE** ANSWER.)*	Original package……...1 Re-packaged……..2 My own container.....3 Don't know .....88 Other: _____.....99	
cf6	*(IF CAKE FLOUR IS AVAILABLE):* When your household got this cake flour, how much did you get? *(IF CAKE FLOUR IS NOT AVAILABLE):*	A. Quantity ☐☐☐☐ B. Kg.....1 g.....2	

	The **last time** your household got cake flour, how much did you get? *(SHOW EXAMPLES OF COMMONLY USED CONTAINERS AND MEASURES.)* *(A. WRITE IN THE NUMBER.)* *(B. CIRCLE THE UNIT.)*		
cf7	How long does this amount usually last in your household? *(A. WRITE IN THE NUMBER.)* *(B. CIRCLE THE UNIT.)*	A. Duration ☐☐ B. Day(s).....1 Month(s).....2	
cf8	*(IF CAKE FLOUR IS AVAILABLE):* ***OBSERVE BRAND***. *(IF CAKE FLOUR IS NOT AVAILABLE, **ASK THE RESPONDENT**):* What is the brand of this cake flour? *(WRITE IN ONLY **ONE** ANSWER.)*	Brand name (write in) ..... (Code assigned) ☐☐ Don't know .....88 Other: _____.....99	
cf9	*(IF CAKE FLOUR IS AVAILABLE):* ***OBSERVE PRODUCER***. *(IF CAKE FLOUR IS NOT AVAILABLE, **ASK THE RESPONDENT**):* Who is the producer of this cake flour? *(WRITE IN ONLY **ONE** ANSWER.)*	Producer name (write in) ..... (Code assigned) ☐☐ Don't know .....88 Other: _____.....99	

BREAD FLOUR FORTIFICATION COVERAGE

N°	QUESTIONS	ANSWERS	SKIPS
wf1	Now, I would like to talk with you about bread flour. Does your household prepare foods using bread flour (e.g. bread)? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes, regularly……...1 Yes, sometimes ……..……2 No, never ……..3	If **3,** skip to **bread** module .
wf2	Can you show me what **main bread flour** your household uses?	Yes……..1 No……2	

	*(CIRCLE ONLY **ONE** ANSWER.)*		
wf3	*(IF BREAD FLOUR IS AVAILABLE):* When your household got this bread flour, where did you get it from? *(IF BREAD FLOUR IS NOT AVAILABLE):* The **last time** your household got bread flour, where did you get it from? *(CIRCLE ONLY **ONE** ANSWER.)*	Purchased…….....1 Made it at home.....2 Received from food aid.....3 Don't know / Don't remember.....88 Other: _____.....99	If **2,** skip to **bread** module.
wf4	*(IF BREAD FLOUR IS AVAILABLE):* When your household got this bread flour, how was it packaged? *(IF BREAD FLOUR IS NOT AVAILABLE):* The **last time** your household got bread flour, how was it packaged? *(READ **ALL** RESPONSES)* *(CIRCLE ONLY **ONE** ANSWER.)*	Original package……....1 Re-packaged……..2 My own container.....3 Don't know .....88 Other: _____.....99	
wf5	*(IF BREAD FLOUR IS AVAILABLE):* When your household got this bread flour, how much did you get? *(IF BREAD FLOUR IS NOT AVAILABLE):* The **last time** your household got bread flour, how much did you get? *(SHOW EXAMPLES OF COMMONLY USED CONTAINERS AND MEASURES.)* *(A. WRITE IN THE NUMBER.)* *(B. CIRCLE THE UNIT.)*	A. Quantity ☐☐☐☐ B. Kg.....1 g.....2	
wf6	How long does this amount usually last in your household?	A. Duration ☐☐ B. Day(s).....1 Month(s).....2	

	(A. WRITE IN THE NUMBER.) *(B. CIRCLE THE UNIT.)*		
wf7	*(IF BREAD FLOUR IS AVAILABLE):* ***OBSERVE BRAND***. *(IF BREAD FLOUR IS NOT AVAILABLE,* ***ASK THE RESPONDENT****):* What is the brand of this bread flour? *(WRITE IN ONLY* ***ONE*** *ANSWER.)*	Brand name (write in) ..... (Code assigned) ☐☐ Don't know .....88 Other: _____.....99	
wf8	*(IF BREAD FLOUR IS AVAILABLE):* ***OBSERVE PRODUCER***. *(IF BREAD FLOUR IS NOT AVAILABLE,* ***ASK THE RESPONDENT****):* Who is the producer of this bread flour? *(WRITE IN ONLY* ***ONE*** *ANSWER.)*	Producer name (write in) ..... (Code assigned) ☐☐ Don't know .....88 Other: _____.....99	If **bread flour is not available,** skip to **bread** module.
wf9	***LOOK FOR FORTIFICATION LOGO***. *(CIRCLE ONLY* ***ONE*** *ANSWER.)*	Logo not observed (labelled)……1 Logo not observed (no label)……2 Logo observed……..…….....3	
wf10	May I take a small sample? *(IF 'YES', TAKE SAMPLE AND STICK BREAD FLOUR LABEL ON SAMPLE CONTAINER.)*	Sample taken……1 No sample taken……..……2	

SALT IODIZATION COVERAGE

N°	QUESTIONS	ANSWERS	SKIPS
si1	Now, I would like to talk with you about salt. Does your household use salt? *(CIRCLE ONLY* ***ONE*** *ANSWER.)*	Yes, regularly……...1 Yes, sometimes ……..……2 No, never ……..3	If **3,** skip to **logo** module .
si2	Can you show me what **main salt** your household uses? *(CIRCLE ONLY* ***ONE*** *ANSWER.)*	Yes……..1 No……2	

si3	*(IF SALT IS AVAILABLE):* When your household got this salt, where did you get it from? *(IF SALT IS NOT AVAILABLE):* The **last time** your household got salt, where did you get it from? *(CIRCLE ONLY **ONE** ANSWER.)*	Purchased…….....1 Made it at home.....2 Received from food aid.....3 Don't know / Don't remember.....88 Other: _____.....99	If **2,** skip to **logo** module.
si4	*(IF SALT IS AVAILABLE):* When your household got this salt, how was it packaged? *(IF SALT IS NOT AVAILABLE):* The **last time** your household got salt, how was it packaged? *(READ **ALL** RESPONSES)* *(CIRCLE ONLY **ONE** ANSWER.)*	Original package……....1 Re-packaged……..2 My own container.....3 Don't know .....88 Other: _____.....99	
si5	*(IF SALT IS AVAILABLE):* When your household got this salt, how much did you get? *(IF SALT IS NOT AVAILABLE):* The **last time** your household got salt, how much did you get? *(SHOW EXAMPLES OF COMMONLY USED CONTAINERS AND MEASURES.)* *(A. WRITE IN THE NUMBER.)* *(B. CIRCLE THE UNIT.)*	A. Quantity ☐☐☐☐ B. Kg.....1 g.....2	
si6	How long does this amount usually last in your household? *(A. WRITE IN THE NUMBER.)*	A. Duration ☐☐ B. Day(s).....1 Month(s).....2	

	(B. CIRCLE THE UNIT.)		
si7	*(IF SALT IS AVAILABLE):* ***OBSERVE BRAND***. *(IF SALT IS NOT AVAILABLE,* ***ASK THE RESPONDENT****):* What is the brand of this salt? *(WRITE IN ONLY* ***ONE*** *ANSWER.)*	Brand name (write in) ..... (Code assigned) ☐☐ Don't know .....88 Other: _____.....99	
si8	*(IF SALT IS AVAILABLE):* ***OBSERVE PRODUCER***. *(IF SALT IS NOT AVAILABLE,* ***ASK THE RESPONDENT****):* Who is the producer of this salt? *(WRITE IN ONLY* ***ONE*** *ANSWER.)*	Producer name (write in) ..... (Code assigned) ☐☐ Don't know .....88 Other: _____.....99	If **salt is not available,** skip to **logo** module.
si9	***LOOK FOR FORTIFICATION LOGO***. *(CIRCLE ONLY* ***ONE*** *ANSWER.)*	Logo not observed (labelled)……1 Logo not observed (no label)……2 Logo observed……..…….....3	
si10	May I take a small sample? *(IF 'YES', TAKE SAMPLE AND STICK SALT LABEL ON SAMPLE CONTAINER.)*	Sample taken……1 No sample taken……..……2	

FORTIFICATION LOGO KNOWLEDGE AND INFLUENCE

lk1	*(SHOW FORTIFICATION LOGO.)* Have you ever seen this logo? *(CIRCLE ONLY* ***ONE*** *ANSWER.)*	Yes……1 No……..2	If **no**, skip to **lk2**.
lk1a	Where did you hear about it or see it? *(DO NOT READ RESPONSES TO RESPONDENT.)* *(CIRCLE* ***ALL*** *RESPONSES THAT APPLY.)*	Television……1 Radio……2 Campaign of Department of Health……..3 Health facility / clinic ……...4 Newspaper / magazine……...5 Other: _____.....99	

lk2	What does this logo mean? *(DO NOT READ RESPONSES TO RESPONDENT.)* *(CIRCLE **ALL** RESPONSES THAT APPLY.)*	Fortified / enriched / added micronutrients ……..1 Good for health…….2 Better quality ……3 Bad quality……4 More expensive……....5 No meaning …….6 The food is better for your health than a similar food without the logo……..7 The food tastes good…….8 The food is more expensive than a similar food without the logo……9 The food is good for the growth and development of children…….10 Happy / smiling people / family……11 Don't know……88 Other: _____.....99	
lk3	Does this logo influence your decision to buy? *(DO NOT READ RESPONSES TO RESPONDENT.)* *(CIRCLE ONLY **ONE** ANSWER.)*	No, it does not influence my decision to buy.....1 Yes, it motivates me to buy the product.....2 Yes, it discourages me to buy the product.....3 Don't know.....88 Other: _____.....99	
lk4	Do you know that the government has a law that important vitamins and minerals must be added to maize meal and bread flour? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes……1 No……..2	If **no**, then **end**.
lk4a	Where did you hear about it or see it? *(DO NOT READ RESPONSES TO RESPONDENT.)* *(CIRCLE **ALL** RESPONSES THAT APPLY.)*	Television……1 Radio……2 Campaign of Department of Health…….3 Health professional in health facility/clinic (medical doctor / nurse / health worker / pharmacist / etc.)…..4 Other: _____.....99	

APPENDIX 4: FACT survey female respondant questionniare

:SOUTH AFRICA FACT COVERAGE SURVEY 2015 FEMALE RESPONDENT (18 TO 49 YEARS) QUESTIONNAIRE					
dateint	Date of interview	DD / MM / YY ☐☐/☐☐/1 5			
teamid	Team identifier	☐☐	intid	Interviewer identifier	☐☐
proid	Province	05. Gauteng 06. Eastern Cape			☐☐
eaid	Enumeration area identifier	☐☐☐☐☐☐☐☐			
areaname	Mainplace (area/village/town)	_____			
areacode	Mainplace code	☐☐☐☐☐☐			
hh	Household identifier	☐☐			
lnr	Line number of respondent *Write in the number from the household roster in household questionnaire 1.*				☐ ☐
cons	Written consent obtained?		Yes…….1 No…….2		If **yes**, begin If **no**, end
visitno	Number of attempts to visit household (up to one return visit) *Record at the time of completing the interview or after second household visit*				☐
outfem	Outcome of female respondent	Completed.....1 Refused.....			If 3 or 4, return later for a second visit.

	questionnaire *Fill in only after questionnaire has been completed for this woman.*	.....2 No household member at home or no adult respondent at home at time of visit(s)..... .....3 Household member incapacitated or intoxicated……..4 Other: _____..... 99	
		Supervisor check	Initial for yes _____

DIETARY DIVERSITY

Since the time you woke up yesterday to when you woke up today, did you have any of the following things to eat or drink?

I am interested in whether you had the item I mention, even if it was combined with other foods. For example, if you ate a millet porridge made with a mixed vegetable sauce, you should reply yes to any food I ask about that was an ingredient in the porridge or sauce. Please do not include any food used in a small amount for seasoning or condiments (like chilies, spices, herbs, or fish powder), I will ask you about those foods separately.

*(READ **ALL** QUESTIONS. CIRCLE ONLY **ONE** ANSWER FOR EACH.)*

N°	ITEMS	
dd1	Any bread, rice noodles, biscuits, or any other foods made from millet, sorghum, maize, rice, wheat?	Yes……..... ..1 No…… …..2
dd2	Any potatoes, white sweet potatoes, or any other foods made from roots or tubers?	Yes……..... ..1 No……

		…..2
dd3	Any food made from vegetables or root crops with yellow or orange flesh such as carrots, pumpkin, orange sweet potatoes?	Yes……..... ..1 No…… …..2
dd4	Any food made from dark green leafy vegetables such as potato leaves, kale, spinach and other locally available dark green leafy vegetables such as imifino or marog?	Yes……..... ..1 No…… …..2
dd5	Any other vegetables?	Yes……..... ..1 No…… …..2
dd6	Any food made from fruits with yellow or orange flesh such as mangoes, papaya, pawpaw, squash or melon?	Yes……..... ..1 No…… …..2
dd7	Any other fruits?	Yes……..... ..1 No…… …..2
dd8	Any beef, pork, lamb, goat, rabbit wild game, chicken, duck, or other birds?	Yes……..... ..1 No…… …..2
dd9	Any liver, kidney, heart, or other organ meats?	Yes……..... ..1 No…… …..2
dd10	Any eggs?	Yes…….....

		..1 No…… …..2
dd11	Any fresh, canned or dried fish or shellfish?	Yes……..... ..1 No…… …..2
dd12	Any foods made from beans, peas, lentils, soya or peanuts?	Yes……..... ..1 No…… …..2
dd13	Any cashew, walnuts, almonds, pecan nuts, seeds or any other foods made from these nuts and seeds?	Yes……..... ..1 No…… …..2
dd14	Any cheese, yogurt, milk or other milk products?	Yes……..... ..1 No…… …..2
dd15	Any foods made with oil, fat, or butter?	Yes……..... ..1 No…… …..2
dd16	Any sugar or honey?	Yes……..... ..1 No…… …..2
dd17	Any other foods, such as condiments, coffee, tea?	Yes……..... ..1 No…… …..2

dd18	Red palm oil	Yes……..... ..1 No…… …..2

INDIVIDUAL BREAD FLOUR CONSUMPTION

In the last 7 days, how many times did you eat products made from bread flour, such as [FOOD ITEM]?

(IF FREQUENCY = 00, DON'T ASK THE PORTION SIZE)

Usually how much of [FOOD ITEM] did you eat at one sitting? *(SHOW PICTURES OF PORTIONS!)*

REPEAT QUESTIONS FOR EACH FOOD ITEM LISTED BELOW.

N°	ITEMS	1. Frequency (# times)	2. Portion size
wfc 1	Bread slice (white)	☐☐	☐
wfc 2	Bread slice (brown)	☐☐	☐
wfc 3	Bread homemade (Umbhaqu)	☐☐	☐
wfc 4	Steamed bread (Doboro / Idombolo)	☐☐	☐
wfc 5	Kota (bread filled with hot chips) white	☐☐	☐
wfc 6	Kota (bread filled with hot chips) brown	☐☐	☐
wfc 7	Rusks (made with bread flour)	☐☐	☐
wfc 8	Vetkoek (made with bread flour)	☐☐	☐

wfc 21	Others: _____	☐☐	☐

INDIVIDUAL MAIZE MEAL CONSUMPTION

In the last 7 days, how many times did you eat products made from maize meal, such as [FOOD ITEM]?

(IF FREQUENCY = 00, DON'T ASK THE PORTION SIZE)

Usually how much of [FOOD ITEM] did you eat at one sitting? *(SHOW PICTURES OF PORTIONS!)*

REPEAT QUESTIONS FOR EACH FOOD ITEM LISTED BELOW.

N°	ITEMS	1. Frequency (# times)	2. Portion size
mfc 1	Maize meal bread	☐☐	☐
mfc 2	Maize meal porridge soft	☐☐	☐
mfc 3	Maize meal porridge stiff	☐☐	☐
mfc 4	Maize meal porridge crumbly	☐☐	☐
mfc 5	Mageu	☐☐	☐
mfc 6	Traditional beer (Umqomboti)	☐☐	☐
mfc 21	Others: _____	☐☐	☐

HEALTH DATA

N°	QUESTIONS	ANSWERS	SKIPS
hd1	Are you currently pregnant? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes…… ……..1 No…… ……2	
hd2	Are you currently breastfeeding? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes…… ……..1 No…… ……2	

APPENDIX 5: ***Variables used from FACT survey***

FACT SURVEY-SA: Female respondent (aged 18-49 years) codebook (Combined variables from HH1, HH2 and food samples also applies)		
Variable name	**Question as per questionnaire**	**Respond Codes**
idnr	Unique identifier to link questionnaires and food samples	
sex	Sex of female respondent	F=Female
age_y	Age in years of female respondent	
c_school	Currently attending school or college	1=Yes 2=No
grade	Highest education level completed	0=None-less than Grade 5 5=Grade 5/Standard 3 7=Grade 7/Standard 5/Primary 12=Grade 12 / matric/ Secondary 13=Tertiary
hd1	Are you currently pregnant?	1=Yes 2=No
hd2	Are you currently breastfeeding?	1=Yes 2=No

Variables used from FACT survey

FACT SURVEY-SA: HH1		
Variable name	**Question as per questionnaire**	**Codes**
eaid	Enumeration area identifier	
hh	Household identifier	
proid	Province	1=Gauteng; 2=Eastern Cape
hi11	Members of this household receive no	1=Yes

	grants?	2=No
hi12	Do any members of this household receive any child support grants?	1=Yes 2=No
hi13	Do any members of this household receive any social relief grants?	1=Yes 2=No
hi14	Do any members of this household receive any disability grants?	1=Yes 2=No
hi15	Do any members of this household receive any old age pension grants?	1=Yes 2=No
hi188	Unknown if any members of this household receive any grants?	1=Yes 2=No
hi199	Do any members of this household receive any other grants?	1=Yes 2=No
hi2	How many people contribute to the total income (money) in this household?	1=None 2=1 person 3=2 persons 4=3-4 persons 5=5-6 persons 6=More than 6 persons 88=Don't know 99=Other
hi3	What is the total household income per month before deductions (including wages, rent, grants, sales of vegetables, etc.) of everybody in the household added together? If you can tell me the amount off hand please do so, otherwise I will read out various income brackets. Please stop me when I say the amount that you think represents the total monthly income of the household.	1=Less than R3001 1=R3001-4000 3=R4001-5000 4=R5001-R7500 5=R7501-R10,000 6=R10,0001-R15,000 7=R15,001-R20,000 8=R20,0001-R30,000 9=R30,0001-R40,000 10=R40,001 or more 88=Don't know

FACT SURVEY-SA: HH2 codebook Variables that are greyed out appear in questionnaire, but was omitted in data set or was replaced by a recoded variable		
Variable name	**Question as per questionnaire**	**Codes**
hh1	How many times in the last month did anyone in your house go to sleep at night hungry because there was not enough food?	
hh2	How many times in the last month did anyone in your house go for a whole day and night without eating anything at all because there was not enough food?)	
hh3	How many times in the last month was there ever no food to eat of any kind in your house because of lack of resources to get food?	
lk1	Have you ever seen this logo?	1=Yes 2=No
lk1a1	Did you hear about it or see it on television?	1=Yes 2=No
lk1a12	Did you hear about it or see it on television?	1=Yes 2=No
lk1a2	Did you hear about it or see it on radio?	1=Yes 2=No
lk1a22	Did you hear about it or see it on radio?	1=Yes 2=No
lk1a3	Did you hear about it or see it on campaign of Department of Health?	1=Yes 2=No
lk1a32	Did you hear about it or see it on campaign of Department of Health?	1=Yes 2=No

lk1a4	Did you hear about it or see it on health facility / clinic?	1=Yes 2=No
lk1a42	Did you hear about it or see it on health facility / clinic?	1=Yes 2=No
lk1a5	Did you hear about it or see it in newspaper / magazine?	1=Yes 2=No
lk1a52	Did you hear about it or see it in newspaper / magazine?	1=Yes 2=No
lk1a99	Did you hear about it or see it on anywhere else (other)?	1=Yes 2=No
lk1a992	Did you hear about it or see it on anywhere else (other)?	1=Yes 2=No
lk21	Does this logo mean that it is fortified / enriched / added micronutrients?	1=Yes 2=No
lk22	Does this logo mean that it is good for health?	1=Yes 2=No
lk23	Does this logo mean that it is better quality?	1=Yes 2=No
lk24	Does this logo mean that it is bad quality?	1=Yes 2=No
lk25	Does this logo mean that it is more expensive?	1=Yes 2=No
lk26	Does this logo mean that it is no meaning?	1=Yes 2=No
lk27	Does this logo means that this food is better for your health than a similar food without the logo?	1=Yes 2=No
lk28	Does this logo mean that the food tastes good?	1=Yes 2=No
lk29	Does this logo mean that the food is more expensive than a similar food without the logo?	1=Yes 2=No

lk210	Does this logo mean that the food is good for growth and development of children?	1=Yes 2=No
lk211	Does this logo mean that it is happy / smiling people / family?	1=Yes 2=No
lk288	Don't know what logo means	1=Yes 2=No
lk299	Any other meaning of this logo?	1=Yes 2=No
lk2992	Any other meaning of this logo?	1=Yes 2=No
lk3	Does this logo influence your decision to buy? -	1=No, it does not influence my decision to buy the product 2=Yes, it motivateds me to buy the product 3=Yes, it discourages me to buy the product 88=Don't know 99=Other
lk4	Do you know that the government has a law that important vitamins and minerals must be added to maize meal and bread flour?	1=Yes 2=No
lk4a1	Did you hear about the law on television?	1=Yes 2=No
lk4a2	Did you hear about the law on radio?	1=Yes 2=No
lk4a3	Did you hear about the law on campaign of the Department of Health?	1=Yes 2=No
lk4a4	Did you hear about the law from health professional in health facility /	1=Yes 2=No

	clinic (medical doctor / nurse / health worker / pharmacist / etc?	
lk4a99	Where else did you hear about the law? (Other)	1=Yes 2=No
lk2992	Any other meaning of this logo?	1=Yes 2=No

APPENDIX 6: Informed consent form

UNIVERSITY OF THE WESTERN CAPE
Private Bag X 17, Bellville 7535, South Africa
Tel: +27 21-959 2309 Fax: 27 21-959 3686
E-mail: rswart@uwc.ac.za

CONSENT FORM

Research topic: Fortification Assessment Survey

Name of study leader: Professor Rina Swart, University of the Western Cape

	Tick
I confirm that I fully understand the explanation that the researcher gave me about the above study, and have had a chance to ask questions. I have read and understood the information sheet.	
I understand that the aim of the study is to assess the coverage and potential contribution of fortified staple foods to the micronutrient intake of women of reproductive age (18-49 years of age) in Gauteng and Eastern Cape provinces in South Africa.	
I understand that the findings from this study could contribute to the improvement of the fortification programme of the Department of Health.	
The researcher regards the proposed study to have minimal risk to the participants and described the level of risk as low. The researcher also explained that I may receive counselling at no cost to myself, if I may experience any discomfort as a result of questions asked.	
I am fully aware that the information I will provide will remain confidential and that my personal details will not be made known.	
I understand that my participation is voluntary.	
I agree to take part in the above study.	
I disagree to take part in the above study.	

_____ _____ _____

Name of participant **Signature** **Date**

_____ _____ _____

Name of fieldworker **Signature** **Date**

This research has been approved by the University of the Western Cape's Senate Research Committee (reference number 15/2/5).