EPIDEMIOLOGICAL LANDSCAPE OF

NUTRITIONAL STATUS AMONG PREGNANT WOMEN ATTENDING ANC in Mbeya Region, Tanzania: A Baseline Survey

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LIST OF ABBREVIATIONS

ANC	Antenatal care
CHMT	Council Health Management Team
ODK	Open Data Kit
DMO	District Medical Officer
IFA	Iron and folic acid
IPD	Individual patient data
IUGR	Intrauterine growth restriction
LGAs	Local Government Authorities
LMICs	Low- and middle-income countries
MMS	multiple micronutrient supplements
MUIC	Median Urinary Iodine Concentration
MRDR	modified relative dose response
MUHAS	Muhimbili University of Health and Allied Sciences
NGOs	non-governmental organizations
NMNAP	National Multi-sectoral Nutrition Action Plan
PI	principle investigator
RCH	reproductive and child health
RDA	recommended daily allowance
SDG	Sustainable Development Goals

SRS	systematic random sample
TAG	Technical Advisory Group
TDHS	Tanzania Demographic Health Survey
TFNC	Tanzania Food and Nutrition Centre
UNICEF	United Nations Children Fund
WHO	World Health Organization

FOREWORD

The successful completion of the Assessment of the Nutritional Status of Pregnant Women Attending Antenatal Clinics in Mbeya region was made possible by the joint efforts of various institutions and individuals whose participation is highly appreciated. Various stakeholders and partners were involved and/or consulted and their contributions are very much acknowledged. Tanzania Food and Nutrition Centre (TFNC) conducted the assessment under the leadership of the Managing Director, Dr. Germana Leyna as the Principal Investigator (PI) and supported by two Co-PI: Dr. Elifatio Towo, Director of Food Science and Nutrition and Dr. Fatma Abdalla, the acting Director of Community Health and Nutrition. TFNC acknowledges the contribution by the Ministry of Health, Community Development, Gender, Elderly and Children for providing recommendation to undertake this study to benchmark the Improving Maternal and Adolescent Nutrition project in Mbeya region.

TFNC wishes to recognize and extend its sincere gratitude to United Nations Children's Fund (UNICEF) for the financial support and overall technical assistance that made the implementation of the survey possible. Special thanks go to Ms. Fatoumata Lankoande, Dr. Ramadhan Noor and Abraham Sanga for their technical support and guidance throughout the survey preparation, implementation and report writing.

TFNC, also acknowledges the support provided by Mbeya Region Secretariat and all Local Government Authorities (LGAs) for accepting and supporting the undertaking of this survey in their catchment areas and for their full participation. TFNC particularly thanks the Regional Medical Officer Dr. Salum Manyata and Regional Nutrition Officer Mr. Benson Sanga for their participation, leadership, and guidance.

Last but not least, gratitude goes to the TFNC staff who provided technical support in the design and implementation of the survey. This includes the Survey Manager and Field Coordinator, Sauli Epimack; Biomarker and Field Coordinator, Tedson Lukindo and; Data Management Team, Adam Hancy and Esther Kabula. Thanks are extended to all field team supervisors, laboratory technicians and enumerators who worked tirelessly to make this assessment a success. Sincere gratitude goes to the pregnant women who patiently spared their time for information gathering by the biomarker survey team. TFNC also thanks the drivers who worked tirelessly with the team for the whole period of the survey implementation.

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Benson Sanga	Regional Nutrition Officer	Field Approval and Logistics
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EXECUTIVE SUMMARY

Background: Maternal nutritional problems including micronutrient deficiencies are common among pregnant women in low- and middle-income countries (LMICs) primarily due to the inadequate dietary intake of diverse, nutrient-rich foods including fruits, vegetables, animal protein, and fortified foods[1]. As such, promotion of healthy diets and consumption of fortified foods as well as antenatal multiple micronutrient supplementation (MMS), including iron and folic acid (IFA), has been recommended among potential intervention to improve maternal nutrition as well as pregnancy and birth outcomes[1, 2]. Hence, the WHO review and update of the 2016-recommendations on ANC, to include multiple micronutrient supplementation (MMS) in the context of rigorous research[3]. In considering nutrient supplementation among pregnant women, it is important to assess the need in terms of the nutrient requirements and how these requirements are met through diet as well as food-based approaches. This survey, examined the nutritional status, diet quality, and consumption of supplements among pregnant women attending antenatal care (ANC) services in Mbeya region.

Findings from this study will be used to design interventions on delivering an integrated package for improving maternal health and nutrition.

Objectives: The primary objective of the survey was to establish a comprehensive data set on the nutritional status among pregnant women aged 15–49 years attending ANC in Mbeya region. Specifically, the survey aimed to assess the nutritional status during pregnancy, including (a) anthropometry; (b) prevalence of micronutrient deficiencies (iron, vitamin A, iodine, vitamin B12, and folic acid); (c) anaemia; and assess dietary quality among pregnant women aged 15–49 years attending ANC in Mbeya region.

Methodology: This is a cross-sectional study among pregnant women 15–49 years below 28 weeks of gestation in Mbeya region between September and October 2020. A

1. World Health Organization. WHO recommendations on antenatal care for a positive pregnancy experience. Geneva, Switzerland: World Health Organization; 2016.
2. Haider BA, Bhutta ZA. Multiple-micronutrient supplementation for women during pregnancy. Cochrane Database of Systematic Reviews 2017; 4:CD004905.
3. WHO antenatal care recommendations for a positive pregnancy experience. Nutritional interventions update: Multiple micronutrient supplements during pregnancy. Geneva: World Health Organization; 2020.

cluster random sampling of 420 pregnant women from 44 selected health facilities in the seven councils in Mbeya region were recruited. Those who did not provide consent; were unable to communicate due to illness (hyperemesis gravidarum and pre-eclampsia); and were taking any medication at the time of survey were excluded.

Structured questionnaires were used to collect socio-demographic and economic information on household and individual background characteristics, pregnancy and lifestyle variables, dietary intake using the Prime Diet Quality Score (PDQS)[4] and a single 24-hour dietary recall (24 HR). After the face-to-face interviews, anthropometric measurements [height, weight, and Mid-Upper Arm Circumference (MUAC)] were taken.

Blood and urine samples were collected for laboratory analyses of biomarker indicators (anaemia, malaria, vitamin A status, iron status, inflammation, vitamin B12 status, serum folate status, red blood cell folate status and urinary iodine) for those who further consented to clinical assessment.

All data were uploaded to the secure server, the analysis file was created and analysed using Stata 15.

Results: About 574 pregnant women were eligible and only 420 (response rate 73 per cent) consented to participate. Our findings show that the mean age of pregnant women was 25.49±6.37 years and more than half (55 per cent) were aged between 20 and 29 years old. Sixty-nine per cent attended training after primary school, about four per cent attended secondary school and one per cent did not attend school. Fifty-seven per cent were married, 32 per cent were cohabiting and only 10 per cent were single. With respect to occupation, about 84 per cent were self-employed, 4 per cent were formally employed and only 12 per cent were not employed.

Regarding household composition, the findings indicated that about one third (31 per cent) of households in which the pregnant woman lived had electricity in their houses, 64 per cent used wood as the main cooking fuel, about 72 per cent had access to improved sources of drinking water and 65 per cent of households used improved non-shared toilet facilities.

Forty per cent of pregnant women interviewed used IFA tablets or iron syrup for 90 days or more during that pregnancy. Among them, a majority (71 per cent) were from Chunya DC. Most of the pregnant women (74 per cent) attended ANC clinics at 12–26 weeks of pregnancy and about half of them visited ANC clinics only two to three times. Further, 17 per cent were currently drinking alcohol.

Findings on nutritional status as measured by mid-upper-arm circumference (MUAC) indicated that the majority (91 per cent) had a normal nutritional status, 5 per cent were overweight/obese and 4 per cent were thin. The proportion of thinness was higher (11 per cent) among younger age group (15–19 years). The corresponding proportion of overweight/obese was higher (11 per cent) among those in the older age group (40–49 years).

The prevalence of anaemia in pregnant women was 25.6 per cent. Among them, 62 per cent had mild, 37 per cent had moderate, and about 1 per cent had severe anaemia. Anaemia was more prevalent in Mbarali DC (39 per cent) and less (6 per cent) in Mbeya city.

4. Prime Diet Quality Score (PDQS) contains 13 "healthy" food groups (dark green leafy vegetables, cruciferous vegetables, dark orange vegetables and fruits, other vegetables, citrus fruits, other fruits, legumes, nuts and seeds, poultry, fish, whole grains, liquid oils, white roots and tubers) and 7 "unhealthy" food groups (red meat as a main dish, processed meats, refined grains and baked products, sugar-sweetened beverages, fried foods away from home, sweets and ice cream, low-fat dairy). Scores are allocated according to consumption frequency.

The mean PDQS was 16.2±2.7, with a range of 8–24 out of the possible 42 points. The consumption of at least four servings per week of food groups was as follows: dark green/leafy green vegetables (29.2 per cent), other vegetables (14.7 per cent), and vegetable liquid oil (57.2 per cent). However, consumption of refined grains was high (48.0 per cent) among pregnant women. Self-employed pregnant women were more likely to consume healthy foods in the middle and highest quintiles compared to those who are in formal employment [Adjusted OR 6.94 (95 per cent CI 1.12–43.12) and, adjusted OR 6.90 (95 per cent CI 1.12–42.47)].

The Median Urinary Iodine Concentration (MUIC) was 279.4 µg/L. The value ranged from 26.1 to 1915µg/L. According to the criteria recommended by WHO/UNICEF/ICCIDD, 17.14 per cent of pregnant women had a MUIC below 150 µg/L indicating insufficient iodine intake. Only 24.29 per cent had the recommended adequate iodine level at 150–249µg/L and 39.52 per cent of the women had sightly excessive iodine level (250–499 µg/L) and 18.81 per cent had non-recommended excessive level (500 µg/L).

Recommendations/ next steps:

1. Promote maternal nutrition counselling on appropriate dietary intake, importance of ANC attendance and compliance with IFA supplementation.

2. Strengthen the health system to ensure weight-gain monitoring and appropriate supplementary feeding to support undernourished women during pregnancy.

3. Optimize the community health system and platforms to provide follow-up support during pregnancy.

4. Undertake social and behaviour change communication on addressing micronutrient deficiencies during pregnancy; and

5. Establish social protection measures to improve affordability and accessibility of quality diets, transport to health facilities for ANC visits.

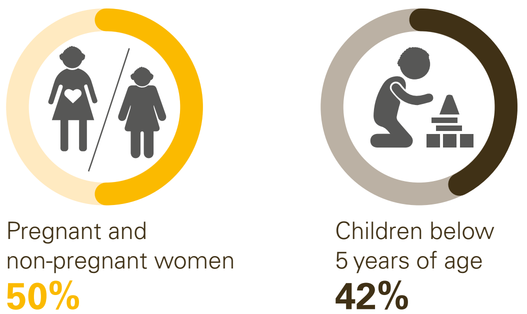
CHAPTER 1

INTRODUCTION

1.1. Background

Globally, anaemia is estimated to affect about 1.62 billion people, which corresponds to about 25 per cent of the global population, with the highest prevalence being among preschool-aged children (47.4 per cent) and the relative lowest prevalence among men (12.7 per cent) 3. It is further estimated that, 50 per cent of all cases of anaemia are among non-pregnant and pregnant women and 42 per cent of cases occur among children below 5 years of age worldwide4. During pregnancy, anaemia contributes to about 20 per cent of maternal deaths[5].

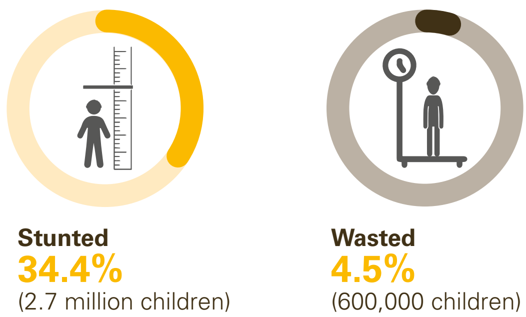
Percentage distribution of all cases of anaemia



In Tanzania, an estimated 45 per cent of women aged 15–49 years and 57 per cent of pregnant women are anaemic1.

One in three women suffer from multiple micronutrient deficiencies, especially iron, iodine, and vitamin A2. Maternal micronutrient deficiencies, especially anaemia, are among the main causes of maternal mortality, with 20 per cent of maternal deaths attributed to severe maternal anaemia. Furthermore, maternal anaemia accounts for 12 per cent of low birth weight, 18 per cent of perinatal mortality, and 19 per cent of preterm births. The adverse birth outcomes contribute to high rates of infant morbidity and mortality, childhood stunting, and longer term poor cognitive function. Currently, 34.4 per cent of under-five children are stunted (2.7 million children) and 4.5 per cent are wasted (600,000 children) [1].

Stunting and wasting among under-five children in Tanzania



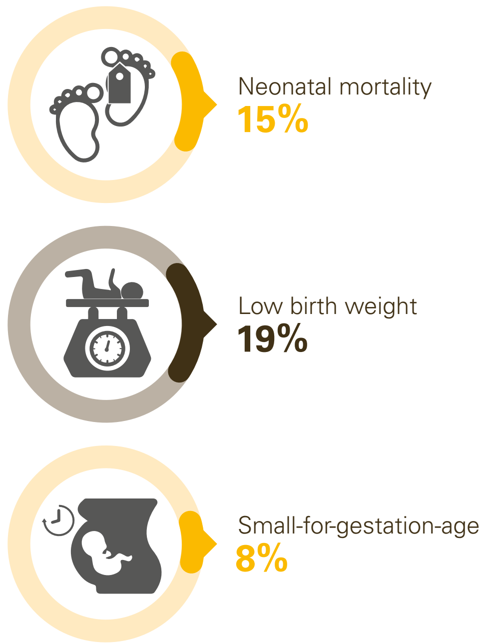
Recent trends point to a deterioration in the prevalence of anaemia among women aged 15–49 years with rates increasing from 40 per cent in 2010 to 45 per cent in 2015. Low birth weight remained unchanged from 6.8 per cent in 2010 to 6.9 per cent in 2015. Furthermore, despite recent reductions in the prevalence of stunting among children under-five years from 44.3 per cent in 2005 to 34.4 per cent in 2015, stunting rates are still 'very high', and due to population growth, the number of stunted children increased from 2.5 to 2.7 million during the same period [1].

Anaemia among women of reproductive age and pregnant women is one of two deteriorating nutrition indicators. Although the use of IFA by pregnant women is an intervention that has been ongoing for some time, anaemia rates remain high. It is therefore important to adopt a comprehensive package of services including promotion and support of nutritious diets, food fortification and MMS.

Antenatal MMS, including IFA, has been identified as a potential intervention to improve maternal and child health in LMICs [3] [4] [5]. In 2016, in its "Recommendations on antenatal care for a positive pregnancy experience", the World Health Organization (WHO) did not recommend universal MMS for pregnant women in LMICs but stated that 'policymakers in populations with a high prevalence of nutritional deficiencies might consider the benefits of MMS on maternal health to outweigh the disadvantages, and may choose to give MMS that includes iron and folic acid [6].

Since the WHO ANC recommendations were developed in 2016, additional information from newly completed studies and individual patient data (IPD) meta-analyses found that MMS containing IFA has better birth outcome benefits than IFA alone (9). When comparing the two, MMS reduces the risk of neonatal mortality by 15 per cent, low birth weight by 19 per cent and small-for-gestation-age by 8 per cent [7]. Data from newly completed studies [8] [9] [10] [11] showed no increased risk of neonatal mortality with MMS or any other negative effect.

Percentage by which MMS reduces the risk of various pregnancy-related problems



MMS contains 15 vitamins and minerals, including iron and folic acid, at approximately one recommended daily allowance (RDA) for pregnancy. Two global reviews have consistently concluded that MMS given to pregnant women is superior in improving birth outcomes than IFA alone [7] [10]. Benefits were seen across most subgroups, with larger gains among undernourished women and survival among female infants. No harmful effects were observed.

Over 15 clinical trials with various micronutrients have been conducted in Tanzania under the guidance of experts from Muhimbili University of Health and Allied Sciences (MUHAS) [8] [9]. These studies show that women who take MMS have a lower risk of giving birth to infants who are born too soon or too small. MMS also improves survival and has even greater benefits among women with poor nutritional status.

These findings are further augmented by a similar but smaller scale survey where MMS was provided with or without extra provisions of protein and carbohydrate supplements [11]. MMS use within the range of the Dietary Reference Intake will not result in excess intake, even when consuming fortified food. MMS can help improve the nutrient supply and overcome problems of inadequacy and are safe for long-term use (>10 years), as documented in recent clinical trials [10] [12].

In addition, maternal dietary diversity is a proxy indicator of maternal nutrient adequacy and improves health outcomes for both mothers and babies. However, little is documented on dietary diversity alongside dietary quality scores among pregnant women in Tanzania.

1.2. Objectives

The primary objective of the survey was to provide up-to-date data on the nutritional status and dietary quality among pregnant women aged 15–49 years attending ANC in Mbeya region. Specifically, the survey aimed to:

i. Assess the nutritional status during pregnancy, including (a) anthropometry (b) prevalence of micronutrient deficiencies (iron, vitamin A, iodine, vitamin B12 and folic acid) (c) anaemia among pregnant women aged 15–49 years attending ANC in Mbeya region.

ii. Assess dietary quality among pregnant women aged 15–49 years attending ANC in Mbeya region.

CHAPTER 2

METHODOLOGY

2.1. Survey and sample design

2.1.1. Survey design

The assessment of nutritional status among pregnant women attending antenatal clinics in Mbeya region was a cross-sectional survey implemented from September–October 2020. It was evaluated using the baseline data on diet quality and intake of pregnancy-specific micronutrients among pregnant women aged 15–49 years old attending antenatal visits. In addition, a single 24-hour recall (24 HR) dietary assessment was done among pregnant women participating in this survey for validation and reproducibility.

2.1.2. Sample design

Sample size: The sample size was calculated using the Lwanga and Lemeshow formula based on the prevalence of anaemia among women of reproductive age, which was 45 per cent according to the Tanzania Demographic Health Survey (TDHS) carried out in 2010. At a confidence level of 95 per cent, with 5 per cent degree of precision and 10 per cent non-response rate, data had to be collected on a minimum of 420 pregnant women. The final sample of 420 pregnant women was taken to estimate both the regional and district-specific prevalence of all the key nutrition indicators for the Mbeya Micronutrient Survey, 2020.

Sampling procedures: This survey used a systematic random sampling approach in selecting health facilities offering ANC services, as well as pregnant women aged 15–49 years attending antenatal care in health facilities in Mbeya.

For health facilities: The complete list of health facilities providing RCH services in Mbeya region was requested and used to prepare a master list comprising a total of 251 health facilities providing RCH services in Mbeya region. The master list of facilities contained information concerning the following.

- The number of health facilities in public (governmental and faith-based organizations) within each district in Mbeya region
- A detailed (but brief) description of the breakdown of facilities and the overall context of RCH services provided within all districts in Mbeya region

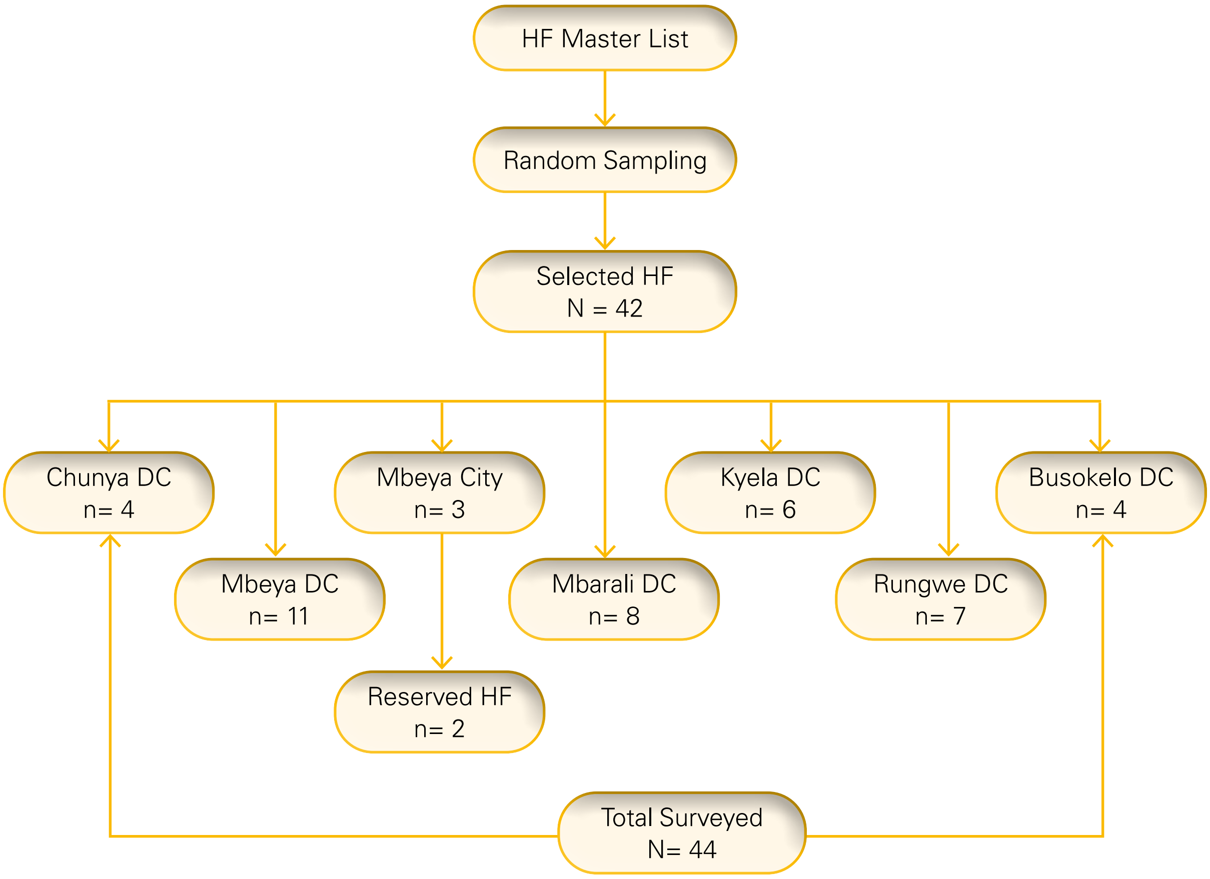
The complete list of health facilities offering RCH services in Mbeya region was then used in a random selection of the health facilities for each district based on probability proportional to size sampling.

A total of 44 health facilities from a pool of 251 were randomly selected for the survey.

Selection of pregnant women for administration of the semi-structured questionnaire: The second step involved the selection of required pregnant women from each selected health facility. An eligibility form was used to list all pregnant women attending ANC in the selected health facility. The listing was done in the RCH office for each of the selected health facilities. The resulting list of pregnant women served as the sampling frame for the selection of those who met the inclusion criteria. Systematic random sampling was done by obtaining an accurate and complete list of the pregnant women attending ANC in a particular selected health facility. The list was then used to randomly select 420 pregnant women to participate in the survey.

Given the sampling frame of public health facilities in Mbeya, probability proportional to size was performed to allocate the number of facilities per district for inclusion in the survey. The distribution of health facilities per district is shown in the **Figure 1.**

Figure 1: Mbeya Micronutrient Survey sampling design



Hence, a total of 44 health facilities offering RCH services located in Mbeya region were visited and surveyed.

Selection of pregnant women for the 24-hour method: Twenty per cent of all selected pregnant women participated in the 24-hour dietary assessment.

2.2. Target population

The target population of the survey included pregnant women aged 15–49 years within the second trimester of pregnancy and below (<28 weeks of gestation). Pregnant women were excluded from the survey if they were unable to communicate due to illness (hyperemesis gravidarum and pre-eclampsia) or were taking any medication at the time of sampling.

This survey enrolled a random sample of 421 pregnant women from the surveyed health facilities.

2.3. Tools and pre-testing

This survey administered a semi-structured questionnaire to collect data from pregnant mothers. The questionnaire included five key sections:

Key sections of the questionnaire

1. **Sociodemographic information:** Individual and household characteristics
2. Pregnancy information
3. Lifestyle information
4. **Food consumption:** Prime Diet Quality Score (PDQS) and 24-hour recall dietary assessment
5. Anthropometry assessment and other measurements (haemoglobin measurements and blood pressure)

This tool was programmed into the Open Data Kit (ODK) and administered using Android tablets.

A preliminary draft version of the questionnaires was prepared in English and then translated into Kiswahili then back translated from Kiswahili into English to verify the accuracy of the initial translation. The PDQS [13] which is a 21-unit food-based score developed using a modified Prime Screen questionnaire [14] was adopted. An ODK compatible tool was used to collect 24-hour dietary information.

The survey team performed an internal pre-test of the programmed tablets, paper questionnaires, and consent forms before the enumerator training. The survey team ensured that each question, all response options, and the instructions were identical between the final electronic and paper questionnaires. Skip patterns were also tested. Modifications were made to electronic and paper questionnaires as needed, based on findings of the pre-test.

2.4. Survey procedures

2.4.1. Ethical approval and confidentiality

Ethical clearance was obtained from the National Institute for Medical Research before the actual implementation of the survey. The survey team worked closely to obtain appropriate authorization from the responsible authorities at regional, council and health facility levels. Council administration leaders were consulted for permission to conduct the survey in their respective councils. The permission to obtain information from health facilities for data-collection was sought from the District Medical Officers (DMO). All eligible subjects were informed about the survey before they were invited to participate. The purpose and nature of the survey was explained and those who agreed to participate gave their written informed consent. Potential participants who were illiterate were allowed to identify an impartial witness to participate in the consent process. Participants were assured that participation was totally voluntary and that there were no negative consequences if they decided not to participate. This survey ensured confidentiality of the participants.

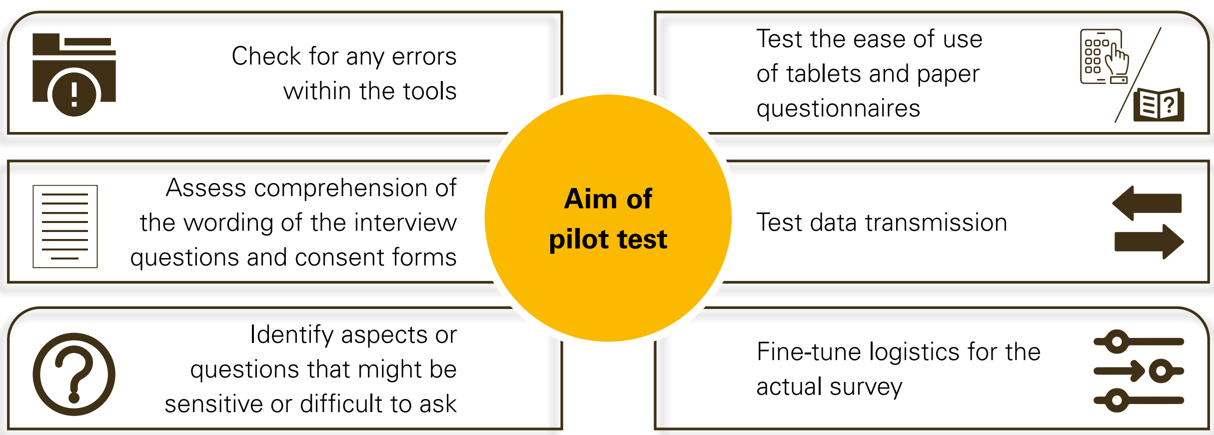
2.4.2. Team recruitment and training

Nurses and laboratory personnel who had prior experience in phlebotomy, including venous blood collection in children, were recruited from government hospitals in Mbeya region and TFNC respectively. Supervisors were recruited from among TFNC staff.

Survey personnel received three days of intensive training on the survey objectives, anthropometry measurement, questionnaire administration, and procedures for biological specimen collection. Specialists from TFNC conducted the training and supervised the pilot-test and initial data-collection which involved the trained personnel. Staff from UNICEF provided technical support throughout data-collection and the survey.

2.4.3. Pre and pilot test

The survey team then conducted an external pilot test of the survey tools and processes in health facilities different from those selected for the survey. The aim of this was to check for any errors within the tools, assess comprehension of the wording of the interview questions and consent forms, identify aspects or questions that might be sensitive or difficult to ask, test the ease of use of tablets and paper questionnaires, test data transmission, and fine-tune logistics for the actual survey.



The survey team held a debriefing meeting to discuss key lessons learned from the pilot test, made necessary changes before the tools were deployed for use, and addressed areas that needed attention during field operations. These issues were discussed during training of enumerators. The pilot test was conducted for two days after the field team training and included all supervisors and enumerators.

Following this pilot test, the software developers incorporated changes that were reflected on the data entry screens. The questionnaires were then revised and finalized based on the pre-test results and direct observations by survey teams.

2.4.4. Survey team

Three teams were responsible for conducting the Mbeya Micronutrients Survey. Each team comprised one supervisor, one enumerator (nurse), and one laboratory technician. One survey manager/field coordinator, one biomarker coordinator, one data manager and three people for survey quality assurances (one principal investigator and 2 co-principal investigators) oversaw the entire data collection process **(Table 1).**

Table 1: Field team composition

Team	Role
The survey manager and field coordinator	» Oversee fieldwork operations including field logistics to and from the field
Biomarker coordinator	» Oversee sample collection, transportation logistics, processing, and biomarker assessment » Solve any protocol difficulties in handling samples in the field and testing
Data manager	» Develop data-collection tools in ODK, data management and processing as well as analysis
Five supervisors	» Manage their interviewers' workload and the quality of the data gathered » Synchronize data to central web-based server on a daily basis
Three enumerators	» Inform the sampled health facilities about the study, seek informed consent and document consent, if given » Conduct the interview and note responses, check the final data after each interview and drawing of blood
Three lab technicians	» Assist in collection of blood and urine samples as well as labelling and handling of samples in the field » Maintain a proper cold chain for samples after collection and during transportation
Two central lab technicians	» Conduct initial field laboratory tests, sample processing and storage

2.4.5. Data-collection activity

The Mbeya Micronutrients Survey 2020 was conducted from mid-September 2020 to end-October 2020. The survey teams collected survey data electronically using hand tablet computers. On arrival in the health facility, the supervisor, nurses, enumerator, and laboratory technicians set up a mobile laboratory, and the supervisor and enumerator began enrolling subjects. All pregnant women who attended the antenatal clinic on a particular day were approached and screened for eligibility. All pregnant women who met inclusion criteria were enrolled in the survey. Random sampling was then done to select pregnant women as per the number required for the given health facility. The supervisor and enumerator proceeded with the consent process and conducted the interview. Enrolled pregnant women were given tagging bracelets for identification. Again, enumerators and laboratory technician measured haemoglobin, collected blood samples and urine specimens.

Following the interview, the enumerator escorted the selected subject to the mobile laboratory. There, the nurse took consent from each individual and if they agreed, completed the remaining sections of the questionnaire, collected the biological specimens, and conducted anthropometry. After the specimens were collected, the questionnaire, remaining labels, and blood specimens were transferred to the laboratory technicians for processing. Haemoglobin and malaria were assessed in the mobile laboratory, and the results were provided to the individuals while they were at the laboratory. If necessary, referrals were made. Each participant was offered a snack after their biological samples were collected.

2.4.5.1. Anthropometry measurements

Anthropometric measurements (height, weight and MUAC) were taken from all consenting individuals at the mobile laboratory. Standard procedures using WHO methodology were utilized.

See Table 2 for an understanding of the Instruments that were used.

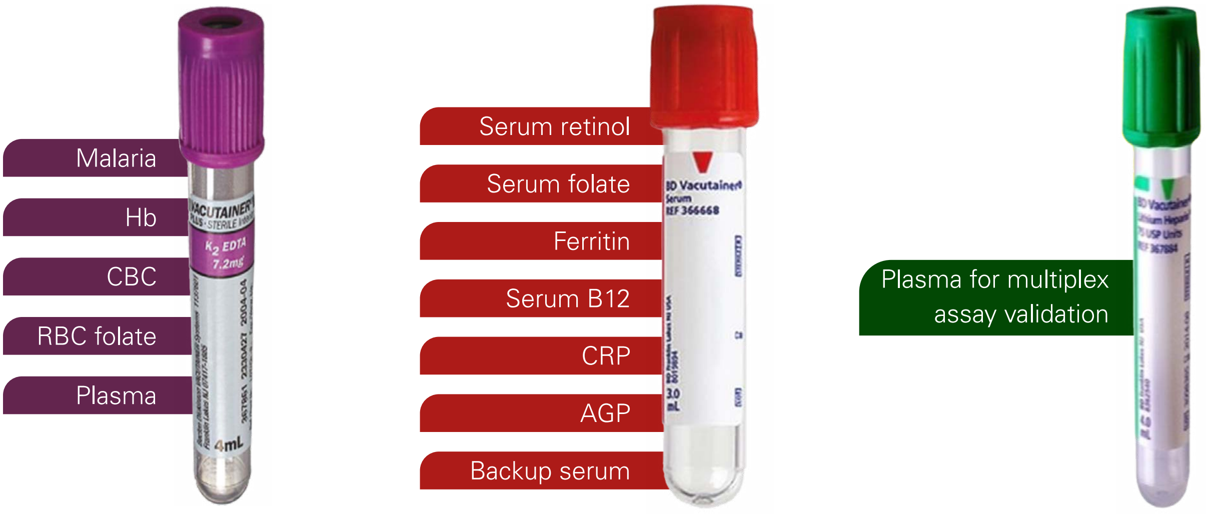
Biochemical assessments

In each health facility, nurses and laboratory technicians were required to set a temporary laboratory for sample collection and field testing. Nurses collected blood samples through vein puncture from participants who consented to having blood specimens taken. Blood samples (approximately 10 ml total) were collected into one plain (red top) vacutainer tube without anticoagulant, one lithium heparin (green top) vacutainer and one EDTA (purple top) vacutainer per participant (Figure 2).

Table 2: Equipment used for measurements

Measurement	Equipment
Height (cm) was measured without shoes with a precision of 0.1cm	Height measuring board (Shorr productions, Maryland USA)
Weight (kg) of the women was measured with precision of 100 gm	Seca electronic scale (Seca gmbh and Co.kg 22061, Hamburg, German)
MUAC was used to measure the upper arm circumference of pregnant women, helping identify malnutrition.	MUAC tapes

Figure 2: Specimen volume and testing



Whole blood from the purple top vacutainer was used to test for malaria using a rapid diagnostic test and haemoglobin using the HemoCue 201+. The remaining blood was transferred to the temporary processing laboratory for further tests and processing. In the designated temporary processing laboratory, 100µL of whole blood was mixed with ascorbic acid to make cell lysate for laboratory analysis of RBC folate. About 20 ml of this blood was used to conduct the complete blood cell count (CBC) using Sysmex XP300. The remaining blood in the purple top vacutainer was centrifuged, and the plasma and cell pellet was aliquoted and stored ready for shipment to the central laboratory at TFNC.

The plain red top vacutainer was left in the dark for about 30 minutes after collection to allow blood clotting before it was processed to obtain serum. Thereafter, the clotted blood was transferred under cold chain to the temporary processing laboratory. In the temporary processing laboratory, the blood was separated using a centrifuge and serum was collected into small vials. This serum was used for various micronutrient biochemical analyses as shown in **Figure 2** above.

Subsets of participants (about 20 per cent) were requested to participate in a modified relative dose response (MRDR) test for vitamin A assessment. This required participants to consume a small challenge dose of a retinol analogue. Before collection of blood, the participants were given a standard dose of 3, 4 didhyroxlretinol dose and were required to wait for four hours to allow dose equilibration. During this time a fatty snack (vitamin A free peanut bar) was given to participants to facilitate dose absorption. After dose equilibration, a venous blood sample was collected from the participants and centrifuged to obtained serum, which was aliquoted into sterile cryovials for MRDR and other required tests. (See Table 2 for details on biological indicators).

Table 3: Details of biological indicators

Indicator	Laboratory test	Sample volume	Location of testing
Anaemia	Haemoglobin, using Hemocue 201+	10 µL	Field test
Malaria	Rapid diagnostic test kit	10 µL	Field test
Vitamin A deficiency	Serum retinol – HPLC	250 µL	TFNC laboratory (Tanzania)
Vitamin A status	Modified relative dose response (MRDR)-HPLC	250 µL	TFNC laboratory (Tanzania)
Iron deficiency	Ferritin (Roche Cobas 400+)	10 µL	TFNC laboratory & MOI laboratory (Tanzania)
Inflammation	C-reactive protein and α–1 acid glycoprotein – (Roche Cobas 400+)	10 µL	TFNC laboratory & MOI laboratory (Tanzania)
Vitamin B12 deficiency	Immunoassay (Roche Cobas e411)	300 µL	TFNC laboratory & MOI laboratory (Tanzania)
Serum folate deficiency	Microbiologic assay	250 µL	TFNC laboratory (Tanzania)
Red blood cell folate deficiency	Microbiologic assay	250 µL	TFNC laboratory (Tanzania)
Urinary iodine	Urinary iodine- Sandell-Kolthoff reaction (Spectrophotometry)	250 µL	TFNC laboratory (Tanzania)

Soon after collection, all specimens were labelled, kept in a portable fridge or cooler box maintained at 2oC to 6oC in the field, and transported to the nearest temporary processing laboratory for processing and temporary storage (at -20o C). The samples were accompanied by sample tracking forms and thermometers to monitor the temperatures from field laboratories to the temporary laboratories until shipment to TFNC laboratory for analysis and long-term storage at-80oC.

Casual collection methods (single ~30 mL samples, not 24-hour collection) of urine were used to obtain samples). These were collected in sterile collection cups from all eligible participants. An aliquot (~10 mL) of urine was transferred into an iodine-free storage vial (in duplicate) and sent to the central laboratory for testing of urinary iodine.

All personnel responsible for collecting, processing, storing, shipping, and analysing biologic samples followed procedures outlined in a laboratory manual and laboratory standard operating procedures. The laboratories responsible for analysing biologic samples collected from participants successfully participated in VITAL-EQA and EQUIP CDC's external quality assurance programmes and followed standard laboratory quality control procedures. Additionally, backup samples for additional analyses (if needed) were stored at the TFNC Mikocheni laboratory.

During laboratory analysis, the following criteria and cut-offs were used to define the status of the targeted micronutrient:

- Anaemia was classified as follows: Severe anaemia (haemoglobin concentration <7.0 g/dl), moderate anaemia (haemoglobin concentration 7.0–9.9 g/dl), and mild anaemia (haemoglobin concentration 10.0–10.9g/dl. Haemoglobin concentration <11.0 g/dl was considered as normal.
- Depleted iron stores (IDA) was defined by the ferritin concentration >12ug/L. Since ferritin is also affected by inflammation and malaria infection, statistical adjustment was conducted.
- Inflammation was defined by the C-reactive protein concentration >5 mg/L or α-1-acid glycoprotein concentration >1 g/L).
- Folate insufficiency was defined by the cut-off serum folate level <7 nmol/L and RBC folate <748 nmol/L while folate deficiency that is more associated with the risk of neural tube defect was defined by RBC folate cut-off of <305 nmol/L.
- Vitamin B12 was considered as deficient if the vitamin B12 concentration was <148 pmol/L, and insufficient if the vitamin B12 concentration was 148–221 pmol/L while adequate was defined by the vitamin B12 concentration level >221pmol/L.
- Vitamin A deficiency was defined by serum retinol <20 ug/dl (<70 µmol/l) adjusted with MRDR cut-off ratio >0.06.
- Iodine among pregnant women was defined by median urinary iodine as insufficient (<150 µg/L), adequate (150–249 µg/L), above requirement (250–499 µg/L) and excessive (≥500).
- Vitamin D level was classified by Serum 25 (OH) D level as deficient (< 30 nmol/L), insufficient (30–50 nmol/L) and sufficient (≥ 50 nmol/L).

2.5. Data management and data analysis

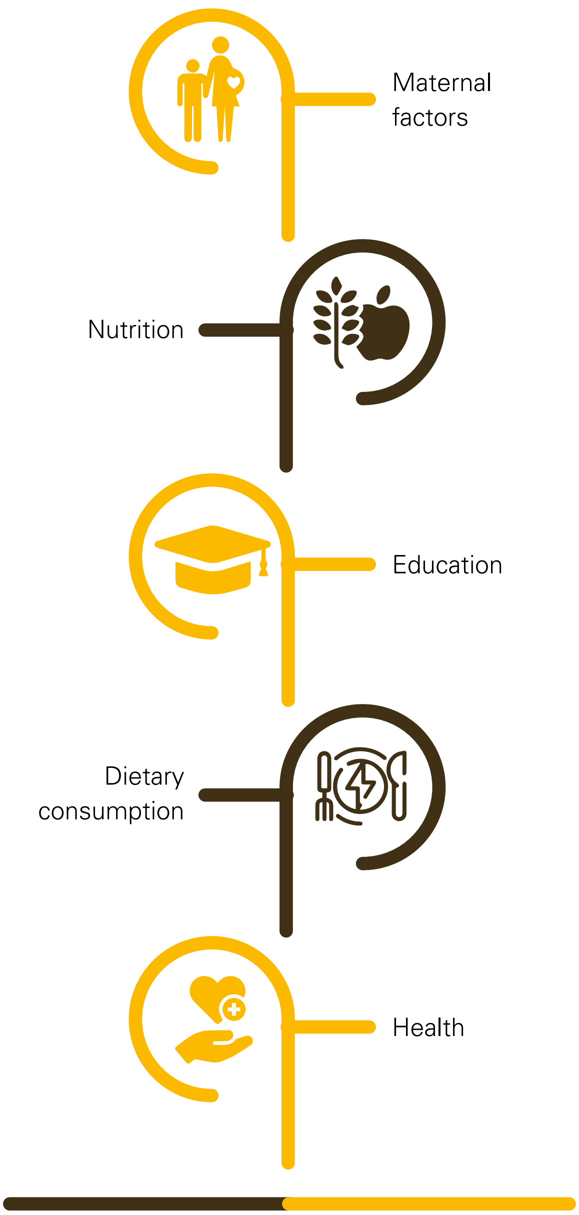
TFNC was responsible for initial data management, cleaning, and analysis. During the survey, questionnaires were reviewed for completion by the supervisor at the end of each day and edited and synchronized to the central web-based server daily. Discrepancies were reconciled by a data management supervisor and secondary editing was done wherever necessary.

After data collection was complete and all data were uploaded to the secure server, a separate file was created for analysis which was done using Stata 15. In addition, data dictionaries, variable and value labels, and metadata were also created. Statisticians conducted data cleaning and removed all inconsistencies based on a data quality protocol. As the initial step, data were cleaned, in such a way that: values were given their respective labels, new variables were generated, some of the data were grouped to form categorical variables, and all missing not at random/missing completely at random data were omitted from the data set.

Data analysis involved: sorting data, performing quality control, categorizing data coding, using symbols and summarizing data on a master sheet.

The dependent variables of the survey were the micronutrient deficiencies and dietary scores of pregnant women aged 15–49 years, and the independent variables were maternal factors (age, educational level, occupation, marital status, parity and morbidity), nutrition education, dietary consumption and health.

Independent variables of the survey



Dietary diversity was coded as '1' for those meeting the minimum dietary diversity and '0' for those not achieving minimum dietary diversity.

Descriptive analysis of demographic, socioeconomic, nutrition education and health was performed. The proportion of pregnant mothers consuming different food groups was also determined. Nutritional indices were used to determine prevalence of micronutrient deficiencies.

2.6. Strengths and weaknesses

2.6.1. Strengths

Strengths of the current study include the sample size, which included all districts of Mbeya region, and the assessment of multiple indicators of micronutrient status. In addition, this study was able to delineate factors associated with nutrition during gestation (demographic and socio-economic factors, obstetric history, the use of PDQS to assess diet quality and diversity and nutritional and health status), details that are often lacking in global estimates of micronutrient deficiency based on population level data.

2.6.2. Weaknesses

Several limitations must be considered.

1. The population in the present study was a convenience sample from pregnant women attending ANC services on specific days which on some occasions did not align with the survey schedule and resulted in a selection bias.

2. In addition, characterizations are limited to the second trimesters of pregnancy, as there were a limited number of participants in their first trimester.

3. Gestation age of some pregnant women was difficult to determine as the reported last menstruation date was different from what has been recorded in the ANC; this compelled need for verification from the survey nurse and therefore there was a possibility for recall bias.

4. The study was cross-sectional and cannot establish causation between predictor variables and biomarkers of micronutrient status or explore the relationships between

preconception health and nutritional status and the current situation.

5. Moreover, micronutrient status is difficult to assess during pregnancy (due to altered nutrient metabolism, haemodilution, increased erythropoiesis, the acute phase response to pregnancy and the lack of specific and sensitive biomarkers). Additionally, cut-offs to define micronutrient deficiencies based on functional outcomes during and after pregnancy have not been well established.

Nevertheless, the present study is the first to present information on the extent of multiple micronutrient deficiencies in pregnant women in rural Tanzania. These findings can be generalized to populations of pregnant women from regions that have similar agro-ecological food systems as Mbeya region.

CHAPTER

3 RESULTS

3.1. Household composition

This chapter describes the general characteristics of the sample population, including housing facilities and presence of durable goods in the household.

3.1.1. Housing characteristics

Table 4 presents information on the characteristics of the dwellings in which pregnant women live. The characteristics include electricity, flooring material and cooking fuel. The results showed that 31 per cent of interviewed pregnant women had electricity in their houses. The most common cooking fuel used was wood (64 per cent).

Table 4: Household characteristics

Percentage distribution of households by housing characteristics		
Variables	**N**	**(%)**
Use electricity		
No	292	69.5
Yes	128	30.5
Cooking fuel		
Electricity	3	0.7
LPG/natural gas/biogas	18	4.3
Charcoal	130	31
Wood	268	63.8
Total	**420**	**100**

3.1.2. Household drinking water

Table 5 below indicates the number of households in which pregnant women live by source of drinking water. About 72 per cent of households have an improved source of drinking water.

Table 5: Household drinking water

Percentage distribution of households by source of drinking water		
Variables	**N**	**(%)**
Source of drinking water		
Improved source	302	71.9
Unimproved source	118	28.1
Total	**420**	**100**

3.1.3. Household sanitation facilities

Table 6 below indicates the number of households in which the pregnant women live by sanitation facilities. Only 64.8 per cent of households have improved sanitation facilities.

Table 6: Household sanitation facilities

Percentage distribution of households by type and location of toilet/latrine facility		
Variables	**N**	**(%)**
Type and location of toilet/latrine facility		
Improved sanitation facility	272	64.8
Unimproved sanitation facility	148	35.2
Total	**420**	**100**

3.2. Response rates and background characteristics

This section reports the overall individual response rates and background characteristics of included pregnant women.

3.2.1. Response rate

Figure 3 summarizes the response rate for individual interviews based on inclusion criteria. Of the 1036 pregnant women targeted, 574 (55.4 per cent) were eligible and 421 (73.3 per cent) agreed to participate.

3.2.2. Background characteristics

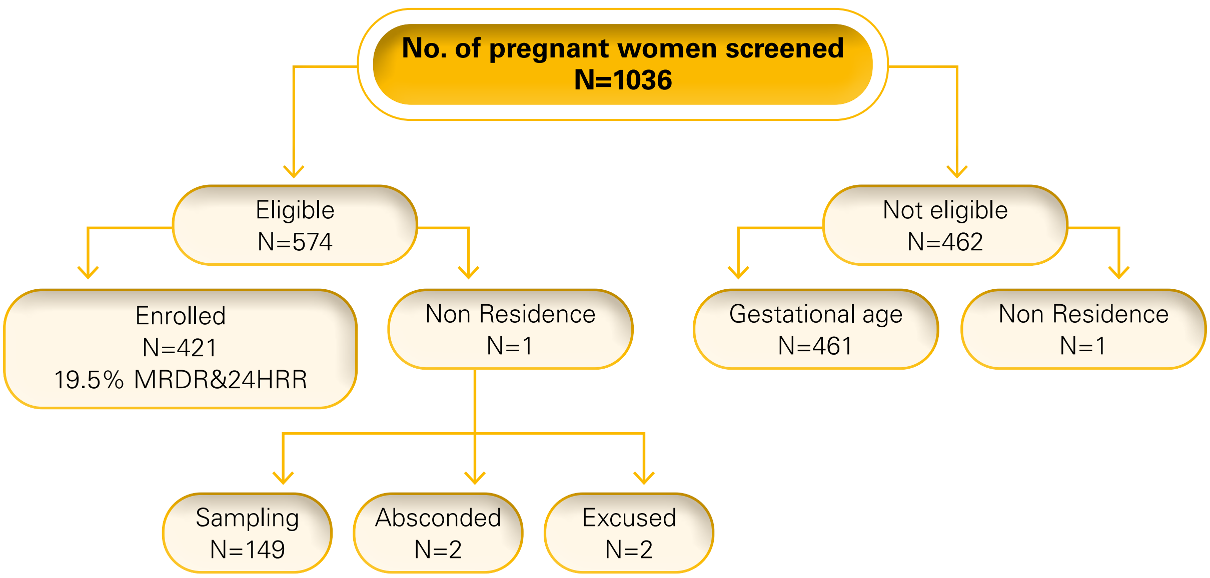
Data were collected on the demographic, household characteristics, social and economic characteristics of participants and their households, as these factors can influence nutritional status and nutrition risk factors. The background characteristics of individuals are summarized in Table 7.

Table 7 below shows the socio-demographic characteristics of pregnant women aged 15–49 years who were interviewed in the Assessment of Nutrition Status of Pregnant Women in Mbeya Region. The results show that more than 55 per cent of the pregnant women were between 20 and 29 years and only 2 per cent were 40 years and above. This reflects that the childbearing age for the majority of women in Mbeya region is below the age of 40.

Out of all respondents, 72 per cent attended primary school, 19.5 per cent attended secondary school and 8.1per cent did not attend school.

Out of all respondents, 57 per cent were married, 32 per cent cohabited and only 10 per cent were single. With respect to occupation,

Figure 3: Flow diagram of study population



84 per cent were self-employed, 4 per cent were formally employed and only 12 per cent were not employed. This shows that the majority of the pregnant women were able to acquire their basic needs.

Table 7: Socio-demographic characteristics of study participants (N= 420)

Percentage distribution of pregnant women by sociodemographic characteristics		
Variables	**N**	**(%)**
Age group		
15–19	82	19.5
20–29	232	55.2
30–39	97	23.1
40–49	9	2.2
Education		
No education	34	8.1
Primary	301	71.7
Secondary	82	19.5
Tertiary	3	0.7
Marital status		
Married	238	56.5
Cohabit	133	31.6
Single	40	9.5
Divorced	10	2.9
Occupation		
Formal employment	15	3.6
Self-employed	355	84.3
Not employed	51	12.1
Total	**420**	**100**

3.3. Pregnancy Information And Antenatal Care Services

Most pregnant women (74 per cent) attended antenatal clinics at 12 to 26 weeks of pregnancy and about half of them visited antenatal clinics only two to three times.

Table 8: Pregnancy information

Percentage distribution of pregnant women by pregnancy information		
Variables	**N**	**(%)**
Trimester		
Less than 12 weeks	109	26.0
12–26 weeks	311	74.1
Gravidity		
Primigravida	104	24.8
Multigravida	316	75.2
Number of abortions		
None	325	77.4
One	77	18.3
Two or more	18	4.3
Number of ANC care visit during this pregnancy		
First visit	163	38.81
2–3 visits	226	53.81
More than 3 visits	31	7.38
Total	**420**	**100**

3.4. Iron and folic acid supplementation

Table 9 presents information on the per cent distribution of pregnant women by the number of days for which they took IFA tablets (Fefol) or syrup. Overall, 53 per cent of pregnant women interviewed used iron-folic acid for less than 60 days. The results also show that there is no relationship between age, level of education and wealth quintile with use of IFA supplements for 90 days or more.

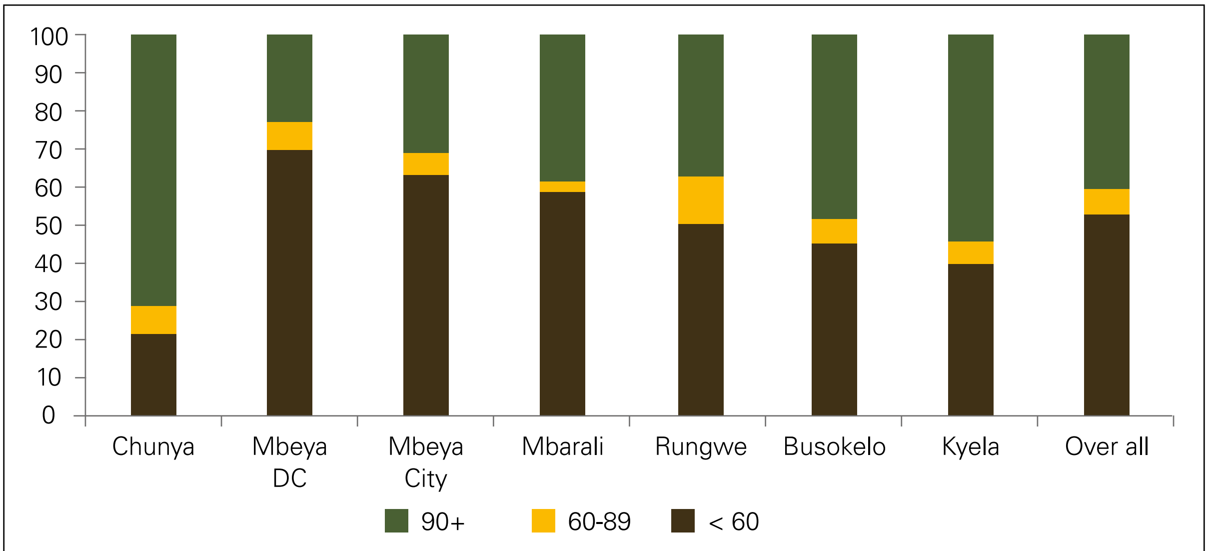
Table 9: IFA intake among pregnant women

Percentage distribution of pregnant women aged 15–49, by number of days they took iron tablets or syrup				
Background characteristics	**<60 N (%)**	**60–89 N (%)**	**90+ N (%)**	**N**
Age				
15–19	43 (52.4)	5 (6.1)	34 (41.5)	82
20–29	119 (51.7)	15 (6.5)	96 (41.7)	240
30–39	57 (58.8)	7 (7.2)	33 (34.0)	97
40–49	4 (44.4)	0 (0.0)	5 (55.6)	9
Education				
No education	15 (6.7)	1 (3.7)	18 (10.7)	34
Primary	167 (74.9)	16 (59.3)	118 (70.2)	301
Secondary	40 (17.9)	9 (33.3)	31 (18.5)	80
Tertiary	1 (0.4)	1 (3.7)	1 (0.6)	3
Wealth quintile				
Lowest	45 (52.3)	2 (2.3)	39 (45.4)	86
Second	46 (55.4)	4 (4.8)	33 (39.7)	83
Middle	46 (54.7)	2 (2.4)	36 (42.9)	84
Fourth	44 (53.0)	9 (10.8)	30 (36.1)	83
Highest	42 (51.2)	10 (12.2)	30 (36.6)	82
Total	**223 (53.4)**	**27 (6.5)**	**168 (40.2)**	***418**

* 2 cases did not remember

However, pregnant women in Chunya (71 per cent) are more likely to take IFA supplements for 90 days or more. The lowest use of IFA supplementation was found in Mbeya DC (23 per cent) (Figure 4).

Figure 4: Percentage distribution of number of days pregnant women took IFA, by council



3.5. Life styles

3.5.1. Alcohol consumption

Table 10 below shows the percentage of pregnant women aged 15–49 years who were using alcohol. Overall, 17 per cent of pregnant women were taking alcohol. There seems to be no relationship between alcohol consumption and wealth.

Table 10: Alcohol consumption among pregnant women aged 15–49

Percentage of pregnant women age 15–49 who use alcohol by background characteristic		
Variables	**N**	**(%)**
Age		
15–19	9	11
20–29	34	14.7
30–39	26	26.8
40–49	1	11.1
Wealth quintile		
Lowest	15	17.4
Second	13	15.7
Middle	11	13.1
Fourth	13	15.7
Highest	18	21
Total	**70**	**16.7**

3.6. Nutritional status

3.6.1. Nutritional status measured by MUAC

Table 11 presents information on the nutritional status of pregnant women measured by using MUAC. Majority of the pregnant women (91 per cent) had a normal nutritional status. Out of all the respondents, 5 per cent were overweight/obese and 4 per cent were thin/malnourished. Pregnant women aged 15–19 were more likely to be thin (11 per cent) while those aged 40–49 were more likely to be overweight/obese (11 per cent). The results also show that there is a relationship between wealth and overweight/obesity as 11 per cent of pregnant women found in the highest wealth quintile were found to be overweight/obese. Results also showed that 2 per cent of pregnant women had short stature which is a risk factor for obstetric complication and poor birth outcomes.

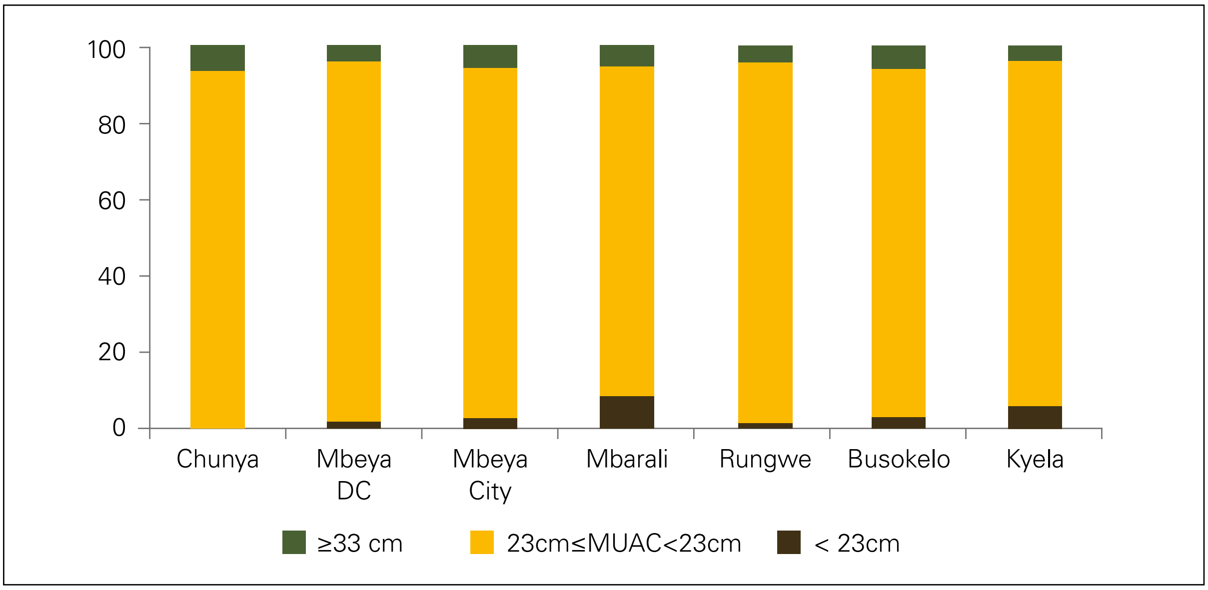
Table 11: Nutritional status of pregnant women

Percentage of pregnant women aged 15–49 with height under 145 cm, nutritional status by using MUAC according to background characteristics						
Variables	**Height**	**MUAC**				
	% below 145 cm	**Mean (±SD)**	**Thin (MUAC) <23cm)**	**Normal (23≤MUAC<33)**	**Overweight/ Obesity (MUAC ≥33 cm)**	**Number of women**
Age						
15–19	2.4	25.6 (2.6)	9 (11.0)	71 (86.6)	2 (2.4)	82
20–29	2.2	27.0 (2.9)	6 (2.6)	217 (93.5)	9 (3.9)	232
30–39	2.1	28.8 (3.2)	1 (1.0)	87 (89.7)	9 (9.3)	97
40–49	0	27.2 (3.4)	0 (0.0)	8 (88.9)	1 (11.1)	9
Education						
No education	5.9	26.9 (2.4)	1 (2.9)	32 (94.1)	1 (2.9)	34
Primary	1.3	27.4 (3.1)	11 (3.7)	273 (90.7)	17 (5.7)	301
Secondary	3.7	26.7 (3.1)	4 (4.9)	75 (91.5)	3 (3.7)	82
Tertiary	0	26.8 (4.2)	0 (0.0)	3 (100)	0 (0.0)	3
Wealth quintile						
Lowest	3.49	26.9 (2.4)	5 (5.8)	79 (91.9)	2 (2.3)	86
Second	3.61	26.3 (3.0)	4 (4.8)	76 (91.6)	3 (3.6)	83
Middle	2.38	27.1 (2.9)	6 (7.1)	75 (89.3)	3 (3.6)	84
Fourth	0	27.3 (3.0)	0 (0.0)	79 (95.2)	4 (4.8)	83
Highest	1.19	28.3 (3.7)	1 (1.2)	74 (88.1)	9 (10.7)	84
Total	**2.1**	**27.2 (3.1)**	**16 (3.8)**	**383 (91.2)**	**21 (5)**	**420**

National Department of Health, South Africa. Guidelines for Maternity Care in South Africa: A Manual for Clinics, Community Health Centers and District Hospitals. 4th ed. Pretoria: NDoH, 2014.

Figure 5 below indicate that Mbarali Council has a high percentage (9 per cent) of pregnant women who are thin while Chunya Council had the lowest percentage (0 per cent). However, Chunya Council was found to have high percentage of pregnant women with obesity (7 per cent) as compared to the other councils.

Figure 5: Distribution of nutritional status using MUAC among pregnant women aged 15–49 by council (%)



3.7. Dietary quality

3.7.1. Dietary quality using PDQS

Dietary quality measured by the PDQS contains 13 "healthy" food groups (dark green leafy vegetables, cruciferous vegetables, dark orange vegetables and fruits, other vegetables, citrus fruits, other fruits, legumes, nuts and seeds, poultry, fish, whole grains, liquid oils, white roots and tubers) and 7 "unhealthy" food groups (red meat as a main dish, processed meats, refined grains and baked products, sugar-sweetened beverages, fried foods away from home, sweets and ice cream, low-fat dairy). Scores was allocated according to consumption frequency. Adequate dietary diversity represents those women meeting the minimum dietary diversity (MDD). A higher prevalence of MDD-W is a proxy for better micronutrient adequacy among women of reproductive age in the population.

Results from the PDQS which is a 21 food-based score, showed that more than half (57.2 per cent) of the respondents consumed more than two servings of liquid oil out of the 14 healthy foods identified. Furthermore, the healthy foods which were not consumed at all were cruciferous vegetables (93.4 per cent), whole citrus fruits (93 per cent) and poultry (92 per cent).

Table 12: PDQS food groups consumed by pregnant women attending antenatal clinics

Food groups	0 serving/ day N (%)	One servings/ day N (%)	≥2 servings/ day N (%)
Healthy foods			
Dark leafy green vegetables	142 (33.7)	156 (37.1)	123 (29.2)
Cruciferous vegetables	393 (93.4)	20 (4.8)	8 (1.9)
Dark orange vegetables and fruits	263 (62.5)	105 (24.9)	53 (12.6)
Other vegetables	266 (63.2)	93 (22.1)	62 (14.7)
Whole citrus fruits	391 (92.9)	25 (5.9)	5 (1.2)
Other whole fruits	308 (73.2)	78 (18.5)	35 (8.3)
Legumes	259 (61.5)	104 (24.7)	58 (13.9)
Nuts and seeds	275 (65.3)	107 (25.4)	39 (9.3)
Poultry	389 (92.4)	21 (5.0)	11 (2.6)
Fish	277 (65.8)	98 (23.3)	46 (10.9)
Whole grains	324 (77.0)	68 (16.1)	29 (6.9)
Liquid oils	46 (10.9)	134 (31.8)	241 (57.2)
White roots and tubers	189 (44.9)	161 (38.2)	71 (16.9)
Low-fat diary	349 (82.9)	56 (13.3)	16 (3.8)
Unhealthy foods			
Red meats	311 (73.9)	85 (20.2)	25 (5.9)
Sweets and ice cream	349 (82.9)	58 (13.8)	14 (3.3)
Fried foods obtained away from home	348 (82.7)	65 (15.4)	8 (1.9)
Processed meat	412 (97.9)	8 (1.9)	1 (0.2)
Refined grains and baked goods	74 (17.6)	145 (34.4)	202 (48.0)
Sugar-sweetened beverages	249 (59.1)	146 (34.7)	26 (6.2)

PDQS: Prime Diet Quality Score.

3.8. Prevalence of anaemia

3.8.1. Anaemia by heamocue measurements

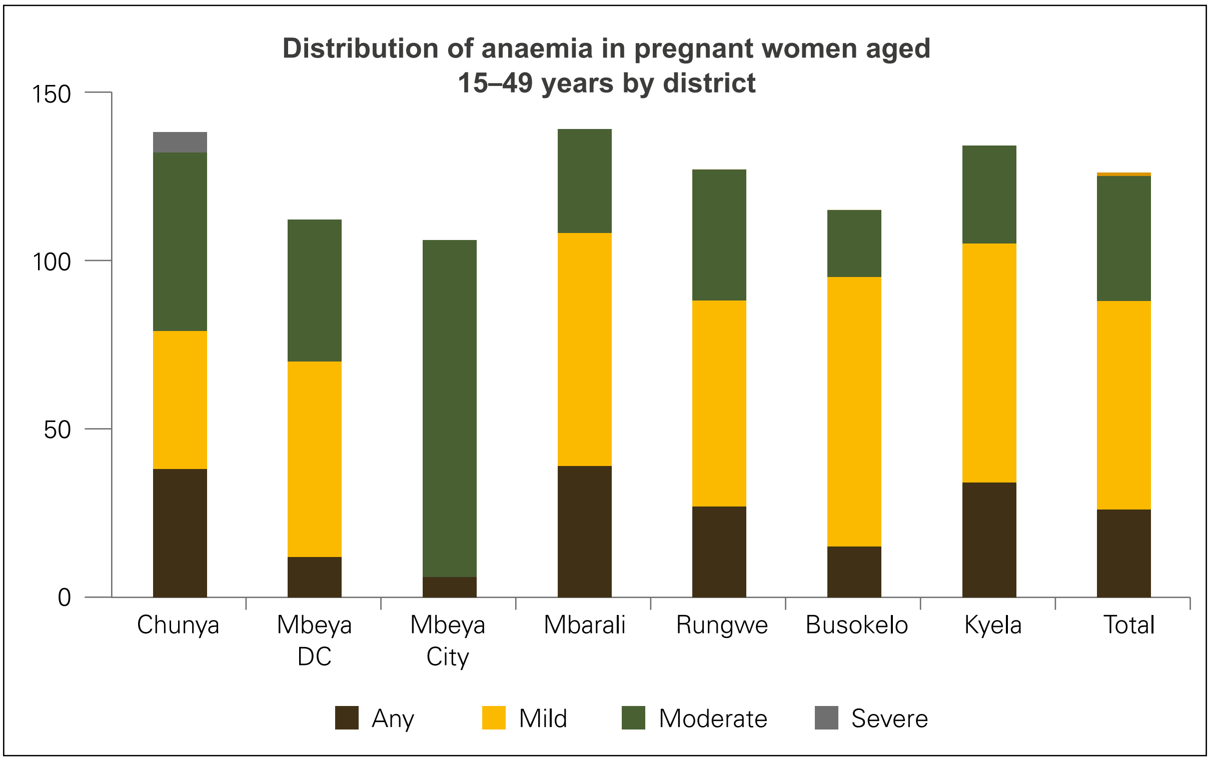
Table 13 below shows the percentage of pregnant women aged 15– 49 years with anaemia according to background characteristics. Results showed that 62 per cent, 37 per cent and 1 per cent of the pregnant women had mild, moderate and severe anaemia respectively. Sixty-four per cent of primigravida were found to have mild anaemia while severe anaemia (2per cent) was found in pregnant women who had two or more live births.

Table 13: The prevalence of anaemia by background characteristics

Percentage of pregnant women aged 15–49 with anaemia, according to background characteristics					
Variables	**Anaemia status by haemoglobin level**				**Number of women**
	Any	**Mild**	**Moderate**	**Severe**	
	<11.0 g/dl N (%)	**10.0–10.9 g/dl N (%)**	**7.0–9.9 g/dl N (%)**	**<7.0 g/dl N (%)**	
Age					
15–19	21 (25.9)	13 (61.9)	8 (38.1)	0 (0.0)	21
20–29	60 (25.9)	37 (61.7)	23 (38.3)	0 (0.0)	60
30–39	23 (23.7)	14 (60.9)	8 (34.8)	1 (4.4)	23
40–49	3 (33.3)	2 (66.7)	1 (33.3)	0 (0.0)	3
Number of children ever born					
0	33 (25.8)	21 (63.6)	12 (36.4)	0 (0.0)	33
1	24 (20.3)	14 (58.3)	10 (41.7)	0 (0.0)	24
≥2	50 (29.1)	31 (62.0)	18 (36.0)	1 (2.0)	50
Alcohol use					
Yes	19 (27.1)	11 (57.9)	8 (42.1)	0 (0.0)	19
No	88 (25.3)	55 (62.5)	32 (36.4)	1 (1.1)	88
Wealth quintile					
Lowest	16 (18.8)	11 (68.8)	5 (31.3)	0 (0.0)	16
Second	24 (28.9)	12 (50.0)	12 (50.0)	0 (0.0)	24
Middle	31 (36.9)	24 (77.4)	7 (22.6)	0 (0.0)	31
Fourth	22 (26.5)	11 (50.0)	10 (45.5)	1 (4.6)	22
Highest	14 (16.9)	8 (57.1)	6 (42.9)	0 (0.0)	14
Total	**107 (25.6)**	**66 (61.7)**	**40 (37.4)**	**1 (0.9)**	**107**

Note: Prevalence is adjusted for altitude using formulas in CDC, 1998.

Figure 6: Distribution of anaemia in pregnant women aged 15–49 years by council



Anaemia ranged from 39 per cent in Mbarali to 6 per cent in Mbeya City. Also, severe anaemia (1 per cent) was found in pregnant women in the age group of 30–39 years.

3.9. Micronutrient status

Results in Figure 7 below indicate that;

- Overall, 61 per cent of pregnant women aged 15–49 years had found with depleted iron stores (IDA) as defined by inflammation adjusted levels of serum ferritin.
- Overall, 42 per cent of women of women aged 15–49 years were found with Vitamin B12 deficiency.
- Overall, 46.2 per cent of pregnant women aged 15–49 years were found with Vitamin A Deficiency as defined by the levels of serum retinol and MRDR.
- Overall, 17.14 per cent of pregnant women aged 15–49 years were found with low medium urine iodine levels.
- Overall, 33.7 per cent of pregnant women aged 15–49 years were found with decreased levels of folate (folate insufficient).

Figure 7: The per cent distribution of micronutrients deficiencies among pregnant women aged 15–49 years

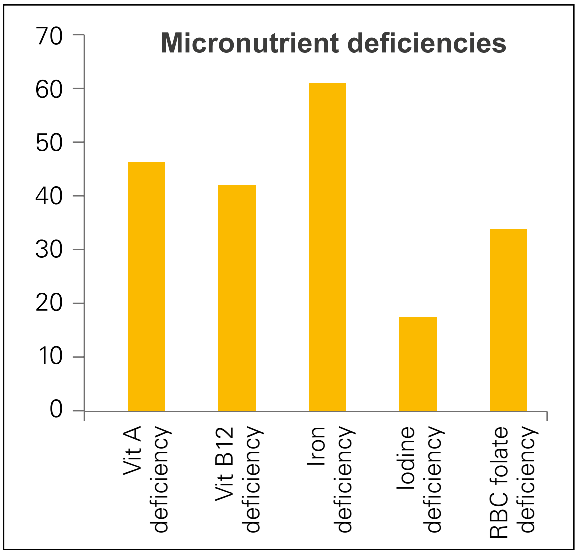


Table 14: The per cent distribution of micronutrients deficiencies among pregnant women aged 15–49 years by background characteristics

Variables	Deficiencies				
	Vit A deficiency	Vit B12 deficiency	Iron deficiency	Iodine deficiency	RBC folate deficiency
Age					
15 – 19	45 (54.9)	37 (45.7)	28 (34.2)	16 (19.3)	24 (29.3)
20– 29	102 (44.0)	94 (40.9)	96 (41.7)	36 (15.5)	77 (33.3)
30+	47 (44.3)	44 (42.3)	35 (33.0)	20 (18.9)	40 (37.7)
Marital Status					
Married	101(42.4)	85 (36.3)	82 (34.6)	44 (18.5)	77 (32.5)
Cohabit	70 (52.6)	69 (52.3)	56 (42.4)	20 (14.9)	50 (37.6)
Single	19 (48.7)	15 (38.5)	15 (38.5)	7 (18.0)	12 (30.8)
Divorced	4 (40.0)	6 (60.0)	6 (60.0)	19 (10.0)	2 (20.0)
Education level					
No education	15 (44.1)	15 (44.1)	13 (38.0)	9 (26.5)	13 (38.2)
Primary	137 (45.5)	129 (43.6)	113 (37.8)	47 (15.6)	104 (34.7)
Secondary	42 (49.4)	30 (35.7)	33 (38.8)	16 (18.8)	24 (28.6)
Occupation					
Formal employment	8 (53.3)	4 (26.7)	9 (60.0)	3 (20.0)	3 (20.0)
Self employed	163 (45.9)	149 (42.6)	131 (37.0)	62 (17.4)	119 (33.6)
Not employed	23 (46.0)	22 (44.0)	19 (38.8)	7 (14.0)	19 (38.0)
Wealth Quintile					
Lowest	48 (34.0)	59 (42.8)	46 (33.1)	30 (21.3)	49 (35.0)
Middle	72 (51.8)	70 (51.1)	59 (42.5)	21 (15.1)	53 (38.1)
Highest	74 (52.9)	45 (32.4)	54 (38.6)	21 (15.0)	39 (28.1)

CHAPTER 4

CONCLUSION

Pregnant women aged 15–49 years in Mbeya region had low PDQS scores due to high intake of refined grains and consumption of red meats, and low intakes of healthy cruciferous vegetables, whole citrus fruits and poultry. These findings suggest that public health action is needed to promote higher consumption of healthy cruciferous vegetables, whole citrus fruits and poultry, and a higher variety of fruits and vegetables.

One fourth of the pregnant women (25.6 per cent) attending ANC in Mbeya Region have anaemia and that anaemia in pregnancy in Mbeya Region is a moderate public health problem. Pregnant women affected by anaemia among were the ones having a low frequency (at least once a day) of eating dark green leafy vegetables and vegetable liquid oils. To combat anaemia there is a need to improve ANC services and have interventions that will integrate health and nutrition education.

The MUIC was 279.4 µg/L. The value ranged from 26.1 to 1915 µg/L. According to the criteria recommended by WHO/UNICEF/ICCIDD [14], 72 (17.14 per cent), pregnant women had a MUIC below 150 µg/L indicating insufficient iodine intake. Only 24.29 per cent had a recommended adequate iodine level at 150–249 µg/L and 39.52 per cent of the women had a slightly excessive iodine level (250–499 µg/L) while 18.81 per cent had a non-recommended excessive level (500 µg/L).

Multiple micronutrient deficiencies among pregnant women in Mbeya remain highly prevalent, which may contribute to the higher burden of low birth weight, preterm and SGA in Tanzania.

CHAPTER 5

RECOMMENDATIONS

Having observed the findings of the survey the following actions are recommended:

1. Promote maternal nutrition counselling on appropriate dietary intake, importance of ANC attendance and compliance with IFA supplementation
2. Strengthen the health systems to ensure weight gain monitoring and appropriate supplementary feeding to support undernourished women during pregnancy
3. Optimize community health systems and platforms to provide follow-up support during pregnancy
4. Undertake social and behaviour change communication on addressing micronutrient deficiencies during pregnancy
5. Introduce social protection measures to improve affordability and accessibility of quality diets and transport to health facilities for ANC visits.

CHAPTER

6

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