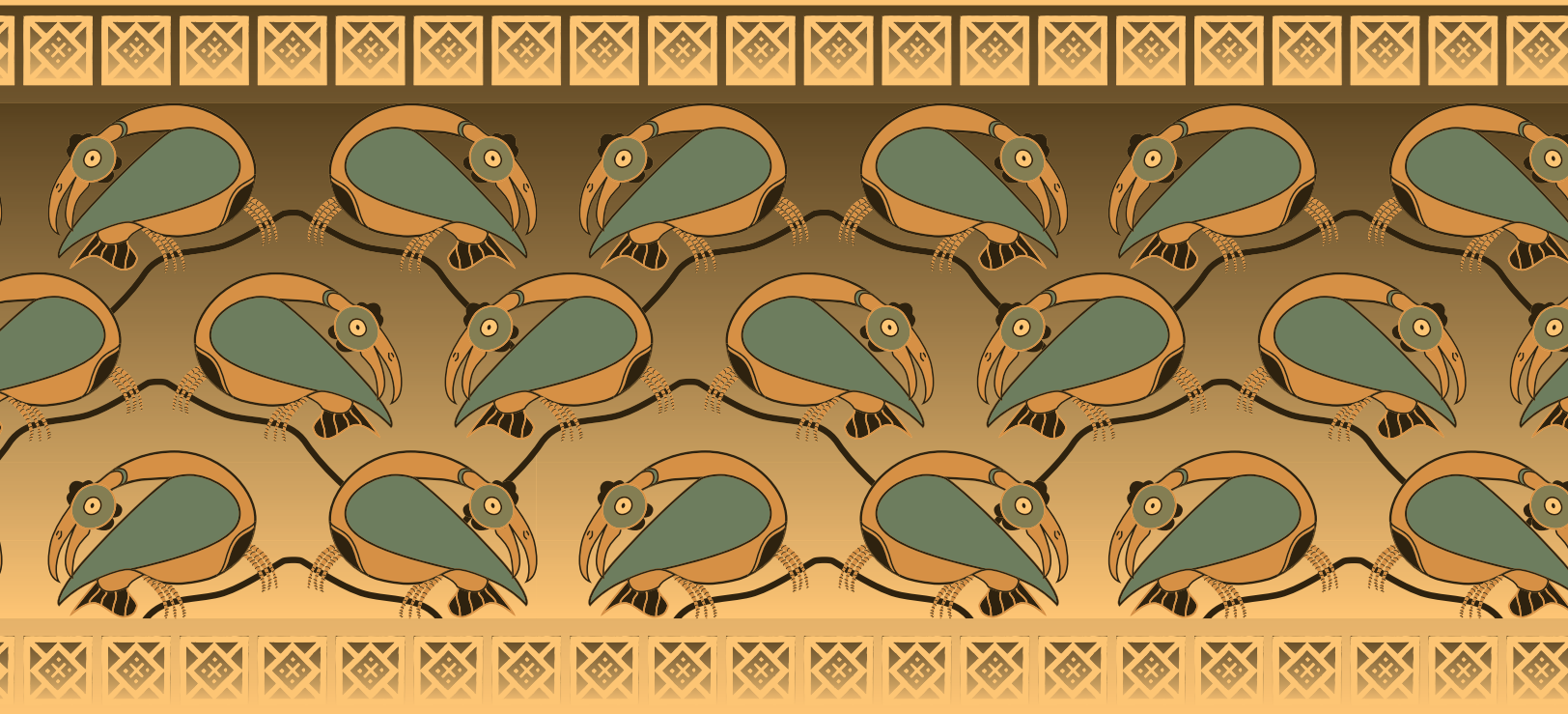
Micronutrients:

Results of the 2010 Tanzania Demographic and Health Survey



MICRONUTRIENTS:

RESULTS OF THE 2010 TANZANIA DEMOGRAPHIC AND HEALTH SURVEY

National Bureau of Statistics
Dar es Salaam, Tanzania

ICF Macro
Calverton, Maryland, USA

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The 2010 Tanzania Demographic and Health Survey (2010 TDHS) was implemented by the National Bureau of Statistics (NBS) from December 19, 2009 to May 23, 2010. Funding for the survey was provided by the Ministry of Health and Social Welfare (MoHSW), Tanzania Food and Nutrition Centre (TFNC), Department for International Development (DFID), World Health Organization (WHO)/Zanzibar), United Nations Population Fund (UNFPA), United Nations Children's Fund (UNICEF), World Food Programme (WFP), United Nations Development Programme (UNDP), and Irish Aid. ICF Macro provided technical assistance for the survey through its MEASURE DHS programme. The opinions expressed herein are those of the authors and do not necessarily reflect the views of the U.S. Agency for International Development or the Government of Tanzania.

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CONTENTS

Page

TABLES AND FIGURES v
ACKNOWLEDGEMENTS vii
SUMMARY OF FINDINGS ix

CHAPTER 1 INTRODUCTION 1
1.1 Vitamin A 1
1.2 Anaemia and Iron 2
1.3 Effect of Infection on Micronutrient Status 3
1.4 Iodine 3
1.5 National Food and Nutrition Policy 3

CHAPTER 2 SURVEY DESIGN AND LABORATORY METHODOLOGY 5
2.1 Objectives and Organisation of the Survey 5
2.2 Survey Methodology 5
2.2.1 Implementing Agency 5
2.2.2 Sampling Design 6
2.2.3 Questionnaires 6
2.3 Biomarkers 7
2.3.1 Rapid Anaemia Testing in the Household 7
2.3.2 Collection, Storage, and Elution of Blood Spot Samples 8
2.3.3 Vitamin A Testing 8
2.3.4 Iron Status Testing 9
2.3.5 Iodine Testing 10
2.4 Data Collection and Processing 11

CHAPTER 3 VITAMIN A STATUS 13
3.1 Coverage of Testing among Children and Women 13
3.2 Characteristics of Children and Women Tested 14
3.3 Micronutrient Intake among Children 17
3.4 Vitamin A Deficiency among Children 18
3.5 Micronutrient Intake among Mothers 21
3.6 Vitamin A Deficiency among Women 23

CHAPTER 4 IRON STATUS 27
4.1 Coverage of Iron Testing among Children and Women 27
4.2 Characteristics of Children and Women Tested 28
4.3 Iron Deficiency among Children 31
4.4 Iron Deficiency among Women 33
4.5 Anaemia and Infection 35

CHAPTER 5 IODINE STATUS 37
5.1 Iodine Content in Household Salt 37
5.2 Urinary Iodine Concentration among Women 40

CHAPTER 6 HOUSEHOLD CONSUMPTION OF MAIZE FLOUR AND OIL 45
6.1 Maize Flour 45
6.2 Cooking Oil 48

REFERENCES 53

APPENDIX A CRP, sTfR and RBP PROTOCOLS 57
Protocol for the Measurement of Retinol Binding Protein (RBP) from Dried Blood Spots ... 57
Elution Protocol 57
Assay Procedure 57
Protocol for the Measurement of Transferrin Receptor (sTfR) from Dried Blood Spots ... 59
Elution Protocol 59
Assay Procedure 59
Protocol for the Measurement of C-Reactive Protein (CRP) from Dried Blood Spots ... 60
Elution Protocol 60
Assay Procedure 60

APPENDIX B PERSONS INVOLVED IN THE MICRONUTRIENT COMPONENT 63

TABLES AND FIGURES

Page

CHAPTER 3 VITAMIN A STATUS
Table 3.1 Coverage of vitamin A testing for children 13
Table 3.2 Coverage of vitamin A testing for women 14
Table 3.3 Background characteristics of children tested for vitamin A 15
Table 3.4 Background characteristics of women tested for vitamin A 16
Table 3.5 Micronutrient intake among children 17
Table 3.6 Unadjusted prevalence of vitamin A deficiency in children 19
Table 3.7 Adjusted prevalence of VAD among children 20
Table 3.8 Micronutrient intake among mothers 22
Table 3.9 Unadjusted prevalence of vitamin A deficiency in women 23
Table 3.10 Adjusted prevalence of VAD among women aged 15-49 24

CHAPTER 4 IRON STATUS
Table 4.1 Coverage of iron status testing for children 27
Table 4.2 Coverage of iron status testing for women 28
Table 4.3 Background characteristics of children tested for iron status 29
Table 4.4 Background characteristics of women tested for iron status 30
Table 4.5 Prevalence of iron deficiency and anaemia in children 31
Table 4.6 Prevalence of anaemia in children 32
Table 4.7 Prevalence of iron deficiency and anaemia in women 34
Table 4.8 Prevalence of anaemia in women 35

Figure 4.1 Infection and Anaemia in Children 36
Figure 4.2 Infection and Anaemia in Women 36

CHAPTER 5 IODINE STATUS
Table 5.1 Presence of iodised salt in household 37
Table 5.2 Coverage of laboratory salt testing 38
Table 5.3 Household iodine levels 39
Table 5.4 Coverage of urine testing for women 40
Table 5.5 Background characteristics of women tested for urine 41
Table 5.6 Urinary iodine concentration in women 42

CHAPTER 6 HOUSEHOLD CONSUMPTION OF MAIZE FLOUR AND OIL
Table 6.1 Type of maize flour 46
Table 6.2 Source of maize flour 47
Table 6.3 Type of cooking oil 49
Table 6.4 Source of cooking oil 50
Table 6.5 Brand of cooking oil 51

Figure 6.1 Brand of Maize Flour 48

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SUMMARY OF FINDINGS

The 2010 Tanzania Demographic and Health Survey (TDHS) provided an opportunity to study the micronutrient status of children under age 5 and women age 15-49. The main impetus for this study came from an initiative by the government of Tanzania and several donors to study the possibility of fortifying foods with micronutrients in order to improve the health status of the Tanzanian population.

In addition to asking women about iron supplementation during recent pregnancies and whether their children under 5 had received vitamin A and iron supplements, the 2010 TDHS collected biomarkers to ascertain the status of vitamin A, iron, and iodine in children and women. At the household level, blood samples were obtained from children and women from a finger prick and the blood was tested on the spot for anaemia using an automated, battery-operated device. Household salt samples were tested for iodine using a rapid iodine testing kit. Because it was not feasible to conduct testing for some biomarkers at the household level, samples were collected from respondents and tested later at a central facility. Blood samples from women and children were collected on filter papers from the same finger prick used for anaemia testing. The samples were tested in the central laboratory for the presence of vitamin A (retinol binding protein) and iron (soluble transferrin receptor). In addition, urine samples were collected from women and tested at the central laboratory for urinary iodine content. A sample of household salt was also collected and re-tested for iodine using a more accurate method than that used in the household test.

Results show that after adjusting for current infection and/or inflammation (by testing for levels of C-reactive protein), which can temporarily lower vitamin A stores in the body, one-third (33 percent) of children age 6-59 months and 37 percent of women age 15-49 are estimated to have vitamin-A deficiency. Vitamin A deficiency shows remarkably little variation by background characteristics of children and women, varying only slightly by urban-rural residence, maternal education, and wealth quintile, though it is higher among boys than girls and declines with age among women. Variation by region is larger, with the highest levels among children and women in Pemba North and the lowest levels in Unguja North.

The survey indicates that three-fifths of children (59 percent) have some anaemia, 41 percent of which is due to iron deficiency. Overall, about one-third of children (35 percent) are iron deficient. Among women age 15-49, 41 percent are anaemic, (35 percent of which is due to iron deficiency) and 30 percent are iron deficient.

With regard to iodine, the TDHS indicates that less than half (47 percent) of households in Tanzania use salt that is adequately iodised, based on laboratory testing. Rapid testing at the household gave somewhat higher levels (60 percent). Testing of urinary iodine among women 15-49 shows a median concentration of 160 μg/L. About one-third of women (36 percent) have urinary iodine concentrations below the recommended level, while another one-third (30 percent) have concentrations that are above the recommended level.

The survey also included questions on consumption of maize flour and cooking oil, the main food products being considered for micronutrient fortification. Results indicate that 85 percent of Tanzanian households cooked maize flour in the week before the survey, though only 29 percent of these households purchased the maize flour. The vast majority of households that purchase maize flour (88 percent) bought the flour at a shop. Eighty percent of households used cooking oil in the week before the survey. The most common type of oil used is red palm oil (37 percent), followed by sunflower oil (31 percent), and cottonseed oil (11 percent). Almost all households (88 percent) purchase their cooking oil, with Korie being the most common brand (36 percent).

INTRODUCTION 1

Vitamin and mineral deficiencies are significant public health problems in many parts of the world but are more prevalent in developing countries. Severe deficiencies of vitamin A, iron, iodine and other micronutrients can lead to adverse health outcomes. Intervention programmes designed to eliminate or reduce the prevalence of vitamin and mineral deficiencies in populations should not only be guided by assessment of dietary intake but also be supplemented by biomarker data. Ideally, the two datasets are collected at the same time.

The 2010 Tanzania Demographic and Health Survey (TDHS) provided an opportunity to study the nutritional status of children under age 5 and women age 15-49. In addition to taking height and weight measurements, women who had a live birth in the previous five years were asked whether they took iron tablets or syrup during the pregnancy for the most recent birth. Women with children under age 5 also were asked whether the child received vitamin A and iron supplementation.

To complement this information, the 2010 TDHS collected biomarkers to ascertain the current status of vitamin A, iron, and iodine in children and women. A limitation that has prevented testing for biomarkers of nutritional status in population-based surveys has been the need to collect venous blood samples, a procedure that poses moderate risks of injury to respondents. Moreover, venous blood samples often need to be processed in the field and stored appropriately during transport to a central laboratory for analysis, which can be a challenge in most developing countries. To overcome these challenges, the Demographic and Health Surveys (DHS) programme has adopted testing modalities that can be used with dried blood spot (DBS) samples collected from a finger or heel prick. This procedure is minimally invasive, poses minimal risks to respondents, and can be done by nonmedical personnel. Furthermore, DBS samples are easier to store in the field and to transport to the laboratory for testing.

1.1 VITAMIN A

Vitamin A is an essential micronutrient for vision, for the maintenance of epithelial cells and for regulation of systemic functions such as cellular differentiation, growth, reproduction, bone development and modulation of the immune system. Vitamin A deficiency (VAD) is well documented as a leading cause of all-cause morbidity and mortality among children (Sommer et al., 1984; Fawzi et al., 1993; Sommer and West, 1996). VAD increases the severity of infections, such as measles and diarrhoeal diseases in children, and slows recovery from illness. Severe VAD can cause keratinisation (loss of epithelial cells) of mucous membranes and eye damage that can result in irreversible blindness.

Vitamin A is found in breast milk, other milks and milk products, liver, eggs, fish, butter, red palm oil, mangoes, papayas, carrots, pumpkins, orange-fleshed sweet potatoes, and dark green leafy vegetables. The immediate causes of VAD are inadequate intake of vitamin A-rich foods and high prevalence of disease. Vitamin A deficiency is of public health importance if 15 percent or more pre-school age children have a plasma retinol concentration that is less than 0.7 μmol/L (Sommer and Davidson, 2002). Because dietary vitamin A is stored in the liver, periodic dosing (usually every six months) with vitamin A supplements is one method of ensuring that children at risk do not develop VAD.

The first national programme for prevention and control of vitamin A deficiency in Tanzania started in 1985. In 1987, vitamin A capsules were incorporated into kits for the Essential Drugs Programme. However, vitamin A supplementation through this channel was both disease-targeted and confined only to government-owned primary-health facilities—dispensaries and health centres—for children with active xerophthalmia, measles, persistent diarrhoea, lower respiratory tract infections,

and moderate to severe protein-energy malnutrition. The disease-targeted vitamin A delivery system was characterised by low coverage among eligible children. An evaluation conducted in 1990-1991 by the Tanzania Food and Nutrition Centre concluded that only 61 percent of children who suffered from those diseases and who attended primary health facilities received vitamin A. Nationwide training was provided to health service workers in 1991 and 1992 on how to diagnose and manage vitamin A deficiency. However, vitamin A supplementation coverage as part of the essential drugs programme for the prevention and treatment of diseases that precipitate vitamin A deficiency among children was less than 67 percent. Health workers' management capabilities were also low. For instance, while vitamin A capsules expired or piled up in certain health-care facilities, they were lacking in many others. A national survey conducted in 1997 revealed low serum retinol (<20µg/dL) among 24 percent of children age 6-71 months and low breast milk retinol (<0.7 µml/L) in 69 percent of lactating women (Ballart et al., 1998).

Due to persistently low vitamin A coverage, supplementation has been integrated as a routine service of the Expanded Programme of Immunisation (EPI) since 1997. Vitamin A supplementation focuses on children under age 2 (9, 15 and 21 months) and on postpartum women who are within four weeks of delivery. Coverage under routine EPI has increased during measles immunisation for children age 9 months, from 55 percent in 1999 to 82 percent in 2002, but has been very low (less than 30 percent) for children ages 15 and 21 months. Most important, the distribution system excludes eligible children between ages 2 and 5. At the same time, the coverage for postpartum women has increased at a slow pace, from 45 percent in 1999 to 62 percent in 2002.

The programme was further modified in selected districts in Mainland Tanzania from 1999 to 2000, when vitamin A supplementation (VAS) was integrated into the measles vaccine campaign that targeted all children age 6-59 months. Data from pilot districts showed that VAS coverage reached 94 percent in 1999 and 99 percent in 2000. The high coverage achieved through the measles campaign to distribute VAS to all Tanzanian pre-schoolers led to the start of the national biannual VAS distribution rounds in 2001. Since 2001, VAS coverage in Tanzania has remained at about 90 percent. To make supplementation more cost effective, VAS was integrated with deworming in 2004.

1.2 Anaemia and Iron

According to the World Health Organization, iron deficiency and iron deficiency anaemia affect over 1.5 billion people worldwide, especially women, pregnant women and pre-school age children (WHO, 2008). Anaemia is defined as a haemoglobin (Hb) level less than the established cut-off levels set by WHO that are specific to age, sex, ethnicity, and physiological status (WHO, 2001).

Anaemia is usually caused by a lack of iron. Iron deficiency ranks number 9 among the 20 highest risk factors for the global burden of disease (WHO, 2002). Iron requirements are greatest between the ages of 6-11 months, when growth is extremely rapid. Iron is critical for cognitive development. Deficiency during the first two years of life can produce long-lasting neural and behavioural effects. Most iron in the body is found in haemoglobin, a component of red blood cells. In addition to iron deficiency, anaemia in many developing countries is due to other nutritional deficiencies such as deficiencies of vitamin B_{12}, folate, and vitamin A (Suharno et al., 1993), malaria (Fleming, 1981), hookworm infestation (Gilles et al., 1964; Roche and Layrisse, 1966) and chronic inflammatory disorders (Yip and Dallman, 1988).

Since 1990, the Tanzania Food and Nutrition Centre (TFNC) has taken the lead in interventions to reduce anaemia prevalence in the country. The ultimate goal is to reduce prevalence until it is no longer a public health concern (Kavishe and Mushi, 2003). In collaboration with the Ministry of Health and Social Welfare (MOHSW), all pregnant women visiting health facilities are supplemented with haematinics and are given nutritional advice to improve dietary intake of iron through a balanced and adequate diet. Starting in 2004, to control worm infestations, a leading cause of anaemia, all children age 1-5 years are provided with deworming drugs at 6-month intervals. The deworming medication is given in combination with vitamin A supplementation.

1.3 EFFECT OF INFECTION ON MICRONUTRIENT STATUS

The pattern of secretion of proteins by the liver is drastically altered by infection and inflammation. This is referred to as the acute phase response, during which some proteins such as C-reactive protein CRP, α1-acid glycoprotein and α1-antichymotrypsin—called positive acute phase proteins (APPs)—are secreted in higher amounts into the blood. Other proteins, such as retinol binding protein (RBP) and albumin, are produced in lower amounts than normal and are called negative APPs. A decrease in RBP due to the acute phase response is associated with a corresponding decrease in serum retinol (Filteau et al., 1993; Christian et al., 1998) because retinol is transported in the blood by RBP. It is important to measure CRP at the same time as RBP (and retinol) to determine whether a decrease in RBP levels is due to the acute phase response or reflects true vitamin A status. In addition to modulating biomarkers of vitamin A status, infection is associated with anaemia. The anaemia of chronic disease is characterised by reduced haemoglobin levels but differs from iron deficiency anaemia (IDA) in that iron, present in the bone marrow, is not readily available for the production of new red blood cells (Means, 1999).

1.4 IODINE

Iodine deficiency causes a spectrum of disorders known as iodine deficiency disorders (IDDs). The most common visible effect of iodine deficiency is an enlarged thyroid gland (also known as goitre). The most severe effect of iodine deficiency is a condition known as cretinism which is manifested by irreversible mental retardation. Other effects of iodine deficiency are deaf-mutism, dwarfism, coordination abnormalities, and spastic paralysis of the lower limbs. Other known effects include decreased energy and learning ability and hence decreased productivity. Although a deficiency of the mineral has adverse effects on all population groups, women of reproductive age are often the group most affected. Iodine deficiency is related to adverse pregnancy outcomes, including spontaneous abortion, foetal brain damage, and congenital malformation; stillbirth; and perinatal death.

The principal cause of iodine deficiency is inadequate iodine in foods. The fortification of salt with iodine is the most common way to prevent iodine deficiency. In Tanzania, the compound used to fortify salt is potassium iodate (KIO_3). According to WHO, a country's salt iodisation programme is considered to be on track, or poised to attain the goal of eliminating iodine deficiency, when at least 90 percent of households use iodised salt (WHO, 2007). Fortified salt that contains 15 parts of iodine per million parts of salt (ppm) is considered adequate for the prevention of iodine deficiency (WHO/UNICEF/ICCIDD, 2007).

1.5 NATIONAL FOOD AND NUTRITION POLICY

The Ministry of Health of the United Republic of Tanzania adopted a national food and nutrition policy in 1992. The policy provides guidance and coordination for food and nutrition programmes, specifically those related to food insecurity and micronutrient deficiencies (Ministry of Health, 1992). The policy recognises the importance of good health to national development and the link between nutrition and good health. The focus is on the prevention of nutrition-related diseases and conditions through the provision of adequate, nutritionally sound foods.

Three main causes of food and nutrition problems in Tanzania were identified: immediate causes, underlying causes, and basic causes. *Immediate causes* include inadequate quantity and quality of food, which is too poor in micronutrients and energy to meet the nutritional needs of the individual. *Underlying causes* relate to food insecurity, lack of basic health services and care, and education; these are factors that may exacerbate nutrition problems. *Basic causes* of food and nutrition problems affect food intake at the household level; these include a lack of financial resources, customs and traditions that may prohibit consumption of foods with nutritional benefits, and inequitable access to and utilisation of services to ensure good nutrition.

The Tanzania National Food and Nutrition Policy focuses on four major nutritional deficiencies or conditions: (1) protein energy malnutrition, (2) nutritional anaemia, (3) iodine deficiency disorders (IDDs), and (4) vitamin A deficiency. Since adopting a policy, Tanzania has reduced malnutrition and put in place programmes to decrease micronutrient deficiencies (TFNC, World Bank, and UNICEF, 2007). These programmes promote production and consumption of micronutrient-rich foods, supplementation of vulnerable groups with micronutrients, and growth monitoring and rehabilitation of severely malnourished children. They are supported by nutrition education and disease control.

The government of Tanzania then launched National Development Vision 2025, a framework for boosting economic growth and reducing poverty (United Republic of Tanzania, 2003). In recognition that malnutrition and inability to meet food requirements hampers strategies aimed at improving the health, education, and productivity of the population, the government revised the National Nutrition and Food Policy for Tanzania in 2010 (Ministry of Health and Social Welfare, 2010).

The policy ensures that other policies, plans, strategies, and development activities in sectors and institutions embrace nutritional concerns. It is based on the concept that not only is nutrition an indicator or outcome of the development of the nation but also that improvement of community nutrition plays an important role in human development and growth of the nation.

The key objective of the revised policy is to set up a framework to recognise, identify, and prioritise community nutrition problems. It guides stakeholders to address these problems comprehensively and to improve the nutritional status of Tanzanians.

Since adoption of the policy, there have been various political, social, and economic changes and public sector reforms. The reforms include devolution of power from a central government to local government authorities. This translates into greater decision-making power at the district and village levels.

Specific objectives of the policy are:

1. To guide the implementation of nutritional activities in the country.

2. To facilitate participation of various stakeholders in identifying, analysing, and taking measures to improve, monitor, and evaluate the nutrition situation in the country.

3. To include nutritional considerations in development plans and to allocate available resources to improve nutrition at all levels.

4. To develop a system to coordinate nutrition-related activities undertaken by various stakeholders.

5. To facilitate and harmonise the integration of nutrition actions undertaken by the public and the private sectors.

6. To empower communities to recognise the importance of nutrition in human development and to undertake appropriate actions.

7. To promote basic and operational research aimed at solving food and nutrition problems in the country.

SURVEY DESIGN AND LABORATORY METHODOLOGY 2

2.1 OBJECTIVES AND ORGANISATION OF THE SURVEY

The 2010 Tanzania Demographic and Health Survey (TDHS) is the eighth in a series of national sample surveys conducted in Tanzania to measure levels, patterns, and trends in demographic and health indicators. The principal objective of the 2010 TDHS is to collect data on household characteristics, fertility levels and preferences, awareness and use of family planning methods, childhood and adult mortality, maternal and child health, breastfeeding practices, antenatal care, childhood immunisation and diseases, nutritional status of young children and women, malaria prevention and treatment, women's status, female circumcision, sexual activity, knowledge and behaviour regarding HIV/AIDS, and prevalence of domestic violence.

As in prior TDHS surveys, the 2010 survey included anthropometric measurements (height and weight) and anaemia testing of children under 5 and women, as well as questions on infant feeding, vitamin A supplements, and testing of household salt for iodine content. In addition to these components, the 2010 TDHS added questions on consumption of foods that are expected to be fortified with vitamins and requested details on infant feeding and supplementation. Most significantly, the survey included the collection of dried blood spot samples (DBSs) from women and children for testing of vitamin A and iron levels and also collected urine samples from women to test for iodine.

In mainland Tanzania, data on the vitamin A status of children and women were last collected in 1997 (Ballard et al., 1998), data on iodine status were last collected in 2004, and there are no national data on iron status. Updated data can help determine the extent to which existing interventions, such as vitamin A supplementation and iodised salt, are effective in preventing and controlling micronutrient deficiencies. The survey will also be important in establishing baseline measures of micronutrient levels in women and children prior to food fortification with iron and vitamin A.

The specific objectives of the micronutrient component of the 2010 TDHS are to collect data on the following indicators:

- Prevalence of vitamin A deficiency (indicated by retinol binding protein—RBP) in children age 6-59 months and women age 15-49 years
- Prevalence of iron deficiency (indicated by serum transferrin receptor—sTfR) in children age 6-59 months and women age 15-49 years
- Prevalence of iodine deficiency (indicated by urinary iodine excretion) in women age 15-49 years
- Proportion of households consuming adequately iodised salt (indicated by rapid test kits, with one-third of samples retested using a quantitative method such as titration or checker machine).

2.2 SURVEY METHODOLOGY

2.2.1 Implementing Agency

The 2010 TDHS was implemented by the National Bureau of Statistics (NBS) and the Office of the Chief Government Statistician-Zanzibar in collaboration with the Ministry of Health and Social

Welfare (MoHSW) and the Tanzania Food and Nutrition Centre (TFNC). TFNC participated in the planning of the survey and in formulating questions for the micronutrient biomarker component. TFNC was actively involved in the training of field staff and provided laboratory staff and services for the testing of blood, urine, and salt samples.

Funding for the survey was provided by the Tanzania government through the MoHSW, the Tanzania Food and Nutrition Centre (TFNC), the Department for International Development (DFID), the World Health Organisation (WHO)/Zanzibar, the United Nations Population Fund (UNFPA), the United Nations Children's Fund (UNICEF), the World Food Programme (WFP), the United Nations Development Programme (UNDP), and Irish Aid. ICF Macro provided technical assistance for the survey through the MEASURE DHS programme, with funding from the United States Agency for International Development (USAID) and UNICEF/Tanzania.

2.2.2 Sampling Design

The 2010 TDHS sample was designed to provide estimates for the entire country, for urban and rural areas in the mainland, and for Zanzibar. For specific indicators, such as contraceptive use, the sample design allowed the estimation of indicators for each of the then 26 regions.

To estimate geographic differentials for certain demographic indicators, the regions of mainland Tanzania were collapsed into seven geographic zones. This classification is used by the Reproductive and Child Health Section of the MoHSW; these are not official administrative zones.

Western:	Tabora, Shinyanga, Kigoma
Northern:	Kilimanjaro, Tanga, Arusha, Manyara
Central:	Dodoma, Singida
Southern Highlands:	Mbeya, Iringa, Rukwa
Lake:	Kagera, Mwanza, Mara
Eastern:	Dar es Salaam, Pwani, Morogoro
Southern:	Lindi, Mtwara, Ruvuma
Zanzibar:	Unguja North, Unguja South, Town West, Pemba North, Pemba South

A representative probability sample of 10,300 households was selected for the 2010 TDHS. The sample was selected in two stages. In the first stage, 475 clusters were selected from a list of enumeration areas in the 2002 Population and Housing Census. Twenty-five sample points were selected in Dar es Salaam, and 18 were selected in each of the other 20 regions in mainland Tanzania. In Zanzibar, 18 clusters were selected in each region for a total of 90 sample points.

In the second stage, a complete household listing was carried out in all selected clusters between July and August 2009. Households were then systematically selected for participation in the survey. Twenty-two households were selected from each of the clusters in all regions, except for Dar es Salaam where 16 households were selected.

All women age 15-49 who were either permanent residents in the households included in the 2010 TDHS sample or visitors present in the household on the night before the survey were eligible to be interviewed. In a subsample of one-third of all the households selected for the survey, all men age 15-49 were eligible to be interviewed if they were either permanent residents or visitors present in the household on the night before the survey.

2.2.3 Questionnaires

Three questionnaires were used for the 2010 TDHS: the Household Questionnaire, the Woman's Questionnaire, and the Man's Questionnaire. The content of these questionnaires was based on the model questionnaires developed by the MEASURE DHS programme. To reflect relevant issues in population and health in Tanzania, the questionnaires were adapted. Contributions were solicited

from various stakeholders representing government ministries and agencies, nongovernmental organisations, and international donors.

The Household Questionnaire was used to list all the usual members and visitors in the selected households. Some basic information was collected on the characteristics of each person listed, including age, sex, education, and relationship to the head of the household. The Household Questionnaire was also used to record height, weight, and haemoglobin measurements of women age 15-49 and children under age 5, household use of cooking salt, responses to requests for blood samples to measure vitamin A and iron in women and children, and whether salt and urine samples were provided.

The Woman's Questionnaire was used to collect information from all women age 15-49. These women were asked questions on various topics such as birth history and childhood mortality; pregnancy, delivery, and postnatal care; knowledge and use of family planning methods; child care; vaccinations and childhood illnesses; marriage and sexual activity; and knowledge, attitudes, and behaviour related to HIV/AIDS and other sexually transmitted infections (STIs). Women were also asked about their experiences in domestic violence, female genital cutting, and fistula of the reproductive and urinary tracts.

The Man's Questionnaire was administered to all men age 15-49 living in every third household in the 2010 TDHS sample. The Man's Questionnaire collected much of the same information as the Woman's Questionnaire, but it was shorter because it did not contain a detailed reproductive history, questions on maternal and child health or nutrition, questions about fistula, or questions about siblings for the calculation of maternal mortality.

2.3 BIOMARKERS

To provide estimates of the prevalence of anaemia, iron deficiency (ID), iodine deficiency (IDD), and vitamin A deficiency (VAD) in the Tanzanian population, the 2010 TDHS collected samples that were tested either at the household level or in a central laboratory. At the household level, blood samples were obtained from respondents by either a finger or heel prick, and the blood was tested on the spot for anaemia using an automated, battery-operated device. Salt samples were tested for iodine in the household using a rapid iodine testing kit. Because it was not feasible to conduct testing for some biomarkers at the household level, samples were collected from respondents and tested later at a central facility. Blood samples were collected from women and children from the same finger prick as that used to collect blood for anaemia testing, and the samples were dried and later tested in the central laboratory for the presence of iron (sTfR), C-reactive protein (CRP), and vitamin A (RBP). In addition to the dried blood spots (DBS), urine samples were collected from women and tested at the central laboratory for the urinary iodine content (UIC). A sample of household salt was also collected and re-tested for iodine using a more accurate method than that used in the household.

2.3.1 Rapid Anaemia Testing in the Household

All children age 6-59 months and women age 15-49 were eligible for anaemia testing. Individuals eligible for anaemia testing and the parents/guardians of eligible children were advised about the objectives, potential risks, voluntary nature, and confidentiality of the anaemia testing procedures as part of the informed consent process. Parents or guardians of never-married adolescents age 15-17 were asked for permission to test each adolescent before consent of the adolescent was sought. After obtaining informed consent, a finger (or a heel in the case of very young children or those with small fingers) was cleaned with a swab impregnated with 70 percent isopropyl alcohol, allowed to air dry, and pricked with a disposable self-retracting lancet. The first two blood drops were wiped away; the third drop was collected with a microcuvette for measurement of haemoglobin for anaemia testing. Haemoglobin analysis was carried out on site using a battery-operated portable HemoCue analyser.

The parents or guardians of children who had anaemia requiring treatment (haemoglobin under 7 g/dl) were provided with a written referral to a health facility for treatment. Women with severe anaemia (haemoglobin less than 7g/dl for nonpregnant women or less than 9 g/dl for pregnant women) were also provided with a written referral form. Results of the anaemia test were recorded in the Household Questionnaire, and the findings were reported in the 2010 TDHS main report (NBS and ICF Macro, 2011).

2.3.2 Collection, Storage, and Elution of Blood Spot Samples

After obtaining blood for anaemia testing, blood drops were allowed to fall in the centre of five pre-printed circles on a filter paper card (Whatman 903). The filter paper card for each respondent was labelled with a bar code identification sticker prior to blood collection. The card was then placed in a specially designed box where it was protected from sunlight, dirt, and moisture while drying overnight.

The next day, once the blood spots on each filter paper card were determined to be completely dry (chocolate brown), each filter paper card with the DBS was packed in a low gas-permeable Ziploc bag with desiccants and a humidity indicator card and placed in a larger re-sealable plastic bag. These plastic bags were placed in a portable, battery-operated refrigerator for storage until samples were delivered to NBS headquarters to be registered along with the completed questionnaires from the same cluster. The DBS samples were then delivered to the TFNC laboratory. The testing was done at the National Public Health Laboratory under TFNC oversight.

To measure micronutrients in the dried blood spots (DBS), a process of elution first had to be performed on the samples in order to remove the dried blood from the filter paper. A disc of specific size was punched from the centre of the dried blood in the pre-printed circle on the filter paper card. Discs were placed in micro centrifuge tubes—one tube per respondent—and an appropriate volume of pre-prepared buffer was added. The tubes were placed in a refrigerator overnight to allow the blood to elute. Samples were eluted separately to test for retinol binding protein (RBP), soluble transferrin receptor (sTfR), and C-reactive protein (CRP).

The elution process does not extract all of the RBP, CRP, or sTfR from the dried blood spot on the filter paper card. Thus, it is necessary to use a correction factor that adjusts the concentration of RBP, CRP, and sTfR measured in the DBS sample to the concentration of the same biomarkers measured in a serum sample collected from the same individual. The TFNC laboratory personnel performed a validation comparing RBP, CRP, and sTfR from paired DBS (obtained by finger prick) and serum samples (obtained from venous blood) for 80 individuals and obtained a correction factor for each biomarker. The correction factors were then applied to all individual RBP, CRP, and sTfR results in the 2010 TDHS. This approach has been used in previous studies (Baingana et al., 2008; Craft, 2001).

2.3.3 Vitamin A Testing

To assess the vitamin A status of women and children, retinol binding protein (RBP), a proxy indicator for serum retinol, was measured in the DBS by enzyme immunoassay (EIA). Because RBP is not completely eluted from the filter paper card, it was necessary to conduct a study to determine the amount of RBP that was eluted from the DBS to derive an adjustment factor to correct the RBP values from DBS to match the RBP values in serum.

To establish this adjustment factor to correct for the incomplete elution of RBP from filter paper cards, a study was implemented that involved taking both venous blood samples and DBS samples from a small group of about 80 individuals. Comparison of results from the two samples for the same individuals was used to calculate the adjustment factor that was applied to all DBS RBP measurements. To adjust the RBP levels for the influence of infection, a test for C-reactive protein was conducted on a subsample of approximately 25 percent.

For RBP testing, two 6 mm discs were punched from the centre of two separate spots on a filter paper card using a standard punch. The punched discs were placed in a tube and 300 µL of sample buffer was added to each tube. The tubes were placed in a refrigerator overnight to allow the blood to elute from the discs. The following day, the concentration of retinol binding protein in the eluted blood samples was determined using a commercial enzyme immunoassay kit manufactured by Scimedx Corporation, Denville, New Jersey, USA. All reagents, with the exception of de-ionised water, were provided as part of the assay kit. RBP values less than 17.325 µg/mL indicate vitamin A deficiency. All samples were tested in duplicate. Samples whose optical density had a coefficient of variation of more than 10 percent between duplicates were repeated.

To obtain a correction factor to adjust the RBP levels for the effects of infection and inflammation, about 25 percent of the DBS samples were tested for CRP. To measure CRP in the DBS, one 3.2 mm (1/8 inch) disc was punched from the centre of the DBS. The punched disc was placed into a micro-centrifuge tube, and 500 µL of CRP assay buffer was added. The tubes were vortexed for 15 seconds and centrifuged at 5,000 rpm for 2 minutes. Samples were incubated overnight at 4°C. The following day, samples were removed from the refrigerator and rotated at 350 rpm at room temperature for 1 hour. The eluted samples were then tested in duplicate using a commercial test kit (Bender MedSystems GmbH, Vienna, Austria). The cut-off used to define infection or inflammation was set at 3 mg/L of CRP: CRP of >3 mg/L means that the person has infection/inflammation, and CRP of ≤3 mg/L means that the person does not have infection/ inflammation.

The adjustment method was suggested by Thurnham, et al. (2003). Based on the CRP level, women and children were classified into two groups, the healthy group (A, CRP ≤3 mg/L) and the group with infection or inflammation (B; CRP >3 mg/L). The correction factors were then calculated separately for women and children as the ratio of the geometric mean of the RBP concentrations for the healthy group versus the group with raised CRP (the difference between mean log RBP value for Group A and mean log RBP for Group B is back-transformed to give the correction factor). RBP values for the group with raised CRP were then multiplied by the correction factor to give the corrected RBP values.

To adjust the prevalence of VAD for women and children who were not tested for CRP, the VAD prevalence was determined after increasing their RBP values by the difference between the means of the RBP values of the CRP sub-samples (Thurnham, 2011). First, the mean RBP values of the CRP subsample for women and children were calculated. Next, the RBP values of 'Group B' were multiplied by 1.255, added to the 'Group A' RBP values and, a new mean RBP value for the subsample was calculated.[1] Then, all RBP values of the women and children who were not tested for CRP were adjusted by the difference between the new mean and the original mean. The prevalence of VAD among all women and children was calculated using the newly adjusted RBP values.

When vitamin A status is assessed using serum retinol, the concentration of retinol used to indicate VAD in children is 0.7 µmol/L. Current research suggests that a concentration of 0.7 µmol/L of retinol is equivalent to a concentration of 0.825 µmol/L of RBP (Gorstein et al., 2008). Thus, the cut-off to define VAD in children in the TDHS 2010 is 0.825 µmol/L or 17.325 µg/mL of RBP. For women, the cut-off is 1.24 µmol/L of RBP. The cut-offs for the different levels of VAD were calculated on the same basis; marginal VAD is 0.82-1.24 µmol/L of RBP, moderate VAD is 0.41-0.81 µmol/L of RBP, and severe VAD is <0.41 µmol/L of RBP.

2.3.4 Iron Status Testing

Iron status was assessed in the TDHS 2010 by measuring haemoglobin directly in blood obtained from a finger or heel prick using the portable HemoCue unit as well as by the determination of sTfR levels in DBS. Anaemia testing was conducted on children age 6-59 months and women age

[1] The multiplication factor (1.255) is an estimate of the percent reduction of RBP (and vitamin A) in the presence of infection, based on CRP results from previous studies (Thurnham, et al., 2003).

15-49 and is presented here as part of the assessment of iron status because of the contribution of iron deficiency to anaemia. sTfR testing helps to differentiate iron deficiency from other causes of anaemia such as malaria and intestinal parasites.

In addition to the rapid test conducted at the homes of respondents using the HemoCue methodology, the 2010 TDHS included testing for soluble, serum transferrin receptor (sTfR), a measure of iron-deficiency. Prior to performing the sTfR assay, the filter paper cards with the DBS were removed from the freezer and allowed to come to room temperature. Then, one disc 6 mm in diameter (1/4 inch) was punched with a standard hole punch from the centre of a blood spot representing a single respondent. Each disc was placed in a separate micro-centrifuge tube, and 500 µL sample diluent was added to each tube. Samples were placed in a refrigerator overnight to allow the blood to elute from the filter paper discs. Next day, the eluted blood samples were tested in duplicate for sTfR using a commercial enzyme immunoassay (TF-94, Ramco Laboratories, Stafford, Texas, USA) adapted by McDade and Shell-Duncan (2002) for DBS. All necessary reagents apart from de-ionised water are included in the assay kit. Iron deficiency was defined as sTfR concentration >8.3 µg/mL as recommended by the kit manufacturer.

2.3.5 Iodine Testing

The 2010 TDHS included several tests related to iodine. First, in all households, interviewers asked for a teaspoon of the salt used for cooking. The salt was tested for iodine using a simple, rapid test kit manufactured by MBI Madras, India. Salt that turned to blue or purple, after a drop of the test solution was dripped on the salt, was considered to be iodised. Adequately iodised salt was defined as salt with an iodine content of ≥15 parts per million (ppm) of iodine.

Second, in every third household, TDHS field teams asked for a slightly larger sample of household salt that was put into a screw-capped plastic container, appropriately labelled and transported to the TFNC lab, where it was tested for iodine content. Laboratory analysis of these salt samples was performed using the titration method described in the training manual, Laboratory and Quality Assurance Procedures for Universal Salt Iodisation Programme (WHO, 2007; MI and ICCIDD, 2009). The iodine content in iodated salt is estimated by a process called iodometric titration, in which free iodine from the potassium iodate compound in salt reacts with sodium thiosulfate using starch as an external indicator. Four basic reagents were used during the titration procedure: sodium thiosulfate, 2 Normal sulphuric acid, potassium iodide, saturated sodium chloride, and soluble chemical starch (as an external indicator).

To perform the analysis, 10 grams of salt were weighed and put in a stoppered, conical flask. To the salt was added 50 mL of distilled water, and the flask was shaken gently on a laboratory shaker to dissolve the salt. To the salt solution, 1 mL of 2N sulphuric acid was added followed by 1 mL of potassium iodide using a dispenser. The flask was re-stoppered. A change in colour of the salt solution from colourless to yellow indicated the presence of iodine. The flask containing the salt/acid mixture was kept in the dark for 10 minutes to avoid exposure to light. Then, the mixture was titrated with 0.005N sodium thiosulfate that was delivered from a burette. As soon as the yellow colour of the mixture turned pale yellow, one to two drops of a starch solution was added to the solution, turning the solution purple. Titration with 0.005N sodium thiosulfate was continued until the purple colour became colourless. The volume of sodium thiosulfate used in the titration was read off the burette, and the reading was compared to volumes in a table with pre-calculated volumes that corresponded with iodine values.[2]

The recommended iodine levels in a household should be 15 ppm and above (WHO, 2007). Tanzania's salt iodation standard requires 20 to 80 ppm. This range is based on the fact that iodation levels at the site of production are 40-80 ppm and the assumption that at least 50 percent may be lost before reaching the consumer (United Republic of Tanzania, 2010). However in this survey, results

[2] One mL of 0.005N sodium thiosulfate is equal to 0.1058 mg of iodine. Thus, the volume of sodium thiosulfate multiplied by 0.1058, will give the amount of iodine in 10 gm of salt.

will be expressed according to the WHO standards to allow their comparison with other countries globally. Furthermore, contribution of iodine levels in the range of 10 ppm to less than 15 ppm will also be discussed in this report.

Third, interviewing teams requested that women respondents provide a urine sample to be tested at a laboratory for iodine levels. Women who consented were provided with a small plastic cup in which to urinate. While in the household, urine was transferred from the large plastic container, via a vacuum method, into small plastic tubes with tightly fitting caps. The method of urine collection ensured that interviewers were not exposed to any possibility of contaminating the urine samples with iodine. Once the urine was voided into wide-mouth plastic receptacles, the lid was sealed and the vacuum seal in the tubes was broken by inserting the needle attached to the plastic receptacle into the cap on the tube. Urine was drawn into the tube via vacuum. After filling the tube with the required volume of urine, the tube was withdrawn from the needle, resulting in the hole in the cap sealing automatically. No spillage of urine was observed or reported by the teams. These tubes were then sent to a specialised testing laboratory at Muhimbili University, Dar es Salaam, and tested for iodine under the direct supervision of TFNC.

The iodine concentration of urine was determined by ammonium persulfate digestion with spectrophotometry, based on the Sandal Kolthoff reaction (Pino et al., 1996; WHO, 2007). This method requires a heating block, a spectrophotometer, and chemical reagents.

For each urine sample, an aliquot of 0.25-0.5 mL was digested with ammonium persulfate at 110 °C for 1 hour; arsenious acid and ceric ammonium sulphate were then added. The decrease in yellow colour over a fixed time period was followed by measuring the absorbance of the solution at 405 nm spectrophotometrically. The most common absorbances observed using this method ranged between 0.300 and 1.800 for standards with concentrations between 300 µg/L and 0 µg/L. All specimens that have absorbance values lower than the acceptable standard curve (or calculated concentration >300 µg/L) were re-assayed using a dilution of 1:3 or 1:5.

The absorbance data were then entered into the computer with the Multi-Calc programme, which plotted them against a standard curve with known amounts of iodine to obtain iodine concentration in µg/L of each specimen. To ascertain the reliability of the results, reference materials (urine samples) supplied by the Centers for Disease Prevention and Control (CDC), USA, were used concurrently during the analysis.

2.4 Data Collection and Processing

Field staff training took place between 9 November 2009 and 5 December 2009. A total of 59 female nurses, 15 male nurses, 17 field editors, and 14 supervisors were trained. The training included field practice in anthropometric measurements, biomarker testing at the household, and sample collection for biomarker testing at the central laboratory. All participants were trained to administer the questionnaires, take height and weight measurements, and collect blood and urine samples. Staff assigned as team supervisors and field editors took additional training in methods of field editing, data quality control procedures, and fieldwork coordination.

Data collection began on 19 December 2009 and was completed on 23 May 2010. Data were collected by 14 teams, each consisting of four female interviewers, one male interviewer, a supervisor, a field editor, and a driver. The field editors and supervisors reviewed all questionnaires for completeness, quality, and consistency before the team's departure from the cluster. The DBS, urine, and salt samples were temporarily stored in freezers in nearby health facilities before they were transported to Dar es Salaam.

The processing of the 2010 DHS data began shortly after the fieldwork commenced. Completed questionnaires were returned to the NBS head office in Dar es Salaam, where they were entered and edited by data processing personnel who were specially trained for this task. The DBS, urine, and salt samples received from the field were logged in at NBS, checked, and delivered to

TFNC to be tested. Before testing, each sample was given a laboratory number and logged into a specially developed CSPro Test Tracking System (CHTTS) database. The processing of DBS samples for the vitamin A testing was handled by three laboratory technicians; anaemia testing was handled by three laboratory technicians; and iodine testing was done by four laboratory technicians.

VITAMIN A STATUS 3

3.1 COVERAGE OF TESTING AMONG CHILDREN AND WOMEN

Response rates are important because a high rate of nonresponse may affect the results. As shown in Table 3.1, a total of 7,175 children age 6-59 months were eligible for vitamin A testing. Blood samples were collected for 93 percent of these children; 2 percent refused to be tested, 1 percent was absent when the team visited the household for blood collection, and 3 percent were missing information for some other reason. The test did not give a valid result for 4 percent of children who were tested. Refusal rates varied across residence; they were higher for urban children than for rural children (5 and 2 percent, respectively). There were no refusals in Ruvuma and Unguja North regions; on the other hand, children in Dar es Salaam had the highest refusal rate (13 percent).

Table 3.1 Coverage of vitamin A testing for children

Percent distribution of children age 6-59 months eligible for vitamin A testing by testing status, according to residence and region (unweighted), Tanzania, 2010

Background characteristic	Tested for vitamin A: Valid result	Tested for vitamin A: Result not valid	Refused to give blood	Absent at the time of blood collection	Other/ missing	Total	Number
Residence							
Urban	86.4	4.1	4.6	1.1	3.8	100.0	1,312
Rural	89.6	4.5	1.9	1.3	2.7	100.0	5,863
Mainland/Zanzibar							
Mainland	88.5	4.7	2.7	1.3	2.8	100.0	5,726
Urban	85.7	4.6	5.3	1.3	3.2	100.0	952
Rural	89.1	4.7	2.2	1.3	2.7	100.0	4,774
Zanzibar	90.8	3.2	1.3	1.1	3.5	100.0	1,449
Unguja	91.7	4.2	0.9	0.7	2.5	100.0	806
Pemba	89.7	2.0	1.9	1.6	4.8	100.0	643
Region							
Dodoma	93.4	4.8	0.7	0.4	0.7	100.0	272
Arusha	86.2	4.1	4.6	0.9	4.1	100.0	218
Kilimanjaro	91.6	3.2	1.3	0.6	3.2	100.0	154
Tanga	88.2	5.4	4.9	0.5	1.0	100.0	204
Morogoro	87.3	3.8	2.8	2.3	3.8	100.0	213
Pwani	86.2	5.6	3.9	3.0	1.3	100.0	232
Dar es Salaam	73.6	5.6	12.9	1.7	6.2	100.0	178
Lindi	82.4	10.9	2.6	2.1	2.1	100.0	193
Mtwara	84.4	3.2	1.1	5.4	5.9	100.0	186
Ruvuma	90.8	5.9	0.0	1.3	2.1	100.0	239
Iringa	91.3	4.3	1.4	1.9	1.0	100.0	208
Mbeya	81.9	4.2	6.9	0.8	6.2	100.0	260
Singida	92.7	3.8	1.2	0.6	1.7	100.0	344
Tabora	89.9	1.6	3.4	1.6	3.6	100.0	444
Rukwa	83.3	7.0	6.0	1.0	2.7	100.0	299
Kigoma	85.7	4.0	3.7	3.0	3.7	100.0	300
Shinyanga	88.8	5.2	1.6	1.3	3.1	100.0	446
Kagera	89.0	4.0	1.1	1.5	4.4	100.0	273
Mwanza	94.6	3.5	0.2	0.2	1.5	100.0	404
Mara	92.1	5.3	0.3	0.3	2.0	100.0	394
Manyara	92.1	6.0	1.5	0.0	0.4	100.0	265
Unguja North	94.5	4.5	0.0	0.3	0.7	100.0	290
Unguja South	90.4	4.3	0.4	1.7	3.0	100.0	230
Town West	89.9	3.8	2.1	0.3	3.8	100.0	286
Pemba North	88.1	2.8	1.8	2.4	4.9	100.0	327
Pemba South	91.5	1.3	1.9	0.6	4.7	100.0	316
Total	89.0	4.4	2.4	1.3	2.9	100.0	7,175

Table 3.2 shows the response rates for vitamin A testing of women. Of the 10,522 women age 15-49 who were eligible for vitamin A testing, blood samples were collected for 93 percent, while 2 percent refused to be tested and 5 percent were either not interviewed, were absent when the team visited the household for blood collection, or were not tested because of another reason. For 6 percent of women who were tested, the test did not give a valid result. As is the case for children, there were no refusals among women in Ruvuma. Women in Dar es Salaam have the highest refusal rate (7 percent).

Table 3.2 Coverage of vitamin A testing for women

Percent distribution of women aged 15-49 eligible for vitamin A testing by testing and interview status, according to residence and region (unweighted), Tanzania, 2010

Background characteristic	Tested for vitamin A		Refused to provide blood	Absent at the time of blood collection	Other/ missing	Not interviewed	Total	Number of women
	Valid result	Result not valid						
Residence								
Urban	85.8	5.4	2.9	0.0	1.9	4.1	100.0	2,700
Rural	88.6	5.5	1.2	0.1	1.1	3.4	100.0	7,822
Mainland/Zanzibar								
Mainland	87.4	5.6	1.8	0.1	1.2	3.8	100.0	8,055
Urban	85.9	5.0	3.6	0.1	1.3	4.3	100.0	1,967
Rural	87.9	5.7	1.3	0.1	1.2	3.7	100.0	6,088
Zanzibar	89.4	5.3	1.1	0.0	1.4	2.9	100.0	2,467
Unguja	90.3	5.6	0.5	0.0	1.7	1.9	100.0	1,485
Pemba	88.1	4.8	1.8	0.0	0.9	4.4	100.0	982
Region								
Dodoma	93.2	4.9	0.3	0.0	0.0	1.5	100.0	324
Arusha	85.1	6.5	3.5	0.0	2.4	2.5	100.0	368
Kilimanjaro	89.6	3.6	1.2	0.0	3.3	2.4	100.0	338
Tanga	88.2	5.9	2.4	0.3	0.0	3.3	100.0	340
Morogoro	86.9	6.6	1.1	0.0	0.9	4.5	100.0	351
Pwani	82.9	7.6	2.1	0.0	1.5	5.8	100.0	327
Dar es Salaam	82.9	5.4	7.4	0.2	0.2	3.8	100.0	462
Lindi	85.0	8.0	1.0	0.0	0.0	6.1	100.0	313
Mtwara	86.9	7.4	0.3	0.0	1.7	3.7	100.0	351
Ruvuma	92.2	3.8	0.0	0.0	0.0	4.1	100.0	370
Iringa	88.7	4.1	2.2	0.0	0.0	5.1	100.0	363
Mbeya	79.7	5.8	2.6	0.0	2.6	9.2	100.0	380
Singida	92.3	3.2	1.2	0.0	0.5	2.6	100.0	401
Tabora	93.3	1.8	1.0	0.2	0.4	3.2	100.0	493
Rukwa	86.1	5.3	3.0	0.0	0.0	5.7	100.0	338
Kigoma	83.3	3.6	4.6	0.0	1.8	6.7	100.0	389
Shinyanga	86.9	7.8	1.0	0.8	1.7	1.9	100.0	525
Kagera	81.7	8.5	1.3	0.0	4.2	4.2	100.0	377
Mwanza	90.0	4.4	0.6	0.0	2.7	2.3	100.0	482
Mara	88.0	6.7	0.5	0.0	1.2	3.7	100.0	433
Manyara	91.2	7.6	0.6	0.0	0.3	0.3	100.0	330
Unguja North	92.4	4.5	0.4	0.0	0.2	2.4	100.0	487
Unguja South	90.8	6.4	0.7	0.0	0.9	1.1	100.0	422
Town West	88.2	5.9	0.5	0.0	3.5	1.8	100.0	576
Pemba North	89.1	4.9	2.3	0.0	1.1	2.6	100.0	470
Pemba South	87.1	4.7	1.4	0.0	0.8	6.1	100.0	512
Total	87.9	5.5	1.7	0.1	1.3	3.6	100.0	10,522

3.2 CHARACTERISTICS OF CHILDREN AND WOMEN TESTED

Table 3.3 shows the percent distribution by background characteristics of the children who were tested for vitamin A, including those in the whole sample as well as those in the subsample tested for CRP. The number of children who were actually tested (unweighted) and the number of children after the sample weighting factors have been applied (weighted) are also shown.

Close to 6,400 children age 6-59 months were tested for vitamin A, and 1,457 were selected to be tested for CRP. The proportions of children in each category of background characteristics in the CRP sample mimic those in the whole sample. For example, about 10-11 percent of children are age 6-11 months, about half are boys, and 97-98 percent live in the Mainland. The distribution of children

by region in the CRP sample also resembles that in the whole sample. The same can be said about the children's distribution by their mother's education and wealth quintile. These figures confirm that the samples for the CRP testing represent the entire sample.

Table 3.3 Background characteristics of children tested for vitamin A

Percent distribution of children age 6-59 months tested for RBP in the whole sample and for whom CRP analysis was done, by background characteristics, Tanzania 2010

	Whole sample			CRP sub-sample		
Background characteristic	Weighted percent	Weighted number	Unweighted number	Weighted percent	Weighted number	Unweighted number
Age in months						
6-11	10.8	677	670	9.8	147	151
12-23	22.9	1,440	1,476	21.5	324	321
24-35	21.4	1,349	1,377	20.3	305	297
36-47	23.5	1,482	1,491	24.3	366	343
48-59	21.4	1,347	1,370	24.2	365	345
Child's sex						
Male	48.9	3,077	3,130	49.6	747	721
Female	51.1	3,216	3,254	50.4	760	736
Residence						
Urban	18.7	1,174	1,133	18.7	281	260
Rural	81.3	5,119	5,251	81.3	1,226	1,197
Mainland/Zanzibar						
Mainland	97.3	6,122	5,068	98.0	1,477	1,220
Urban	17.7	1,116	816	17.9	270	200
Rural	79.5	5,005	4,252	80.1	1,207	1,020
Zanzibar	2.7	172	1,316	2.0	30	237
Unguja	1.6	103	739	1.2	18	135
Pemba	1.1	69	577	0.8	12	102
Region						
Dodoma	6.3	398	254	6.3	96	64
Arusha	3.5	217	188	3.6	54	46
Kilimanjaro	2.8	176	141	3.3	49	38
Tanga	4.2	266	180	4.3	64	44
Morogoro	4.1	259	186	3.9	59	42
Pwani	2.5	158	200	2.2	33	42
Dar es Salaam	4.0	249	131	3.8	57	30
Lindi	1.6	100	159	1.3	20	32
Mtwara	2.9	183	157	2.1	31	30
Ruvuma	3.3	206	217	2.9	44	47
Iringa	4.1	260	190	3.1	47	35
Mbeya	5.7	359	213	6.1	92	55
Singida	4.0	253	319	4.4	67	84
Tabora	5.8	363	399	6.3	96	99
Rukwa	3.1	193	249	3.3	49	62
Kigoma	5.1	321	257	5.3	79	63
Shinyanga	10.0	627	396	9.5	143	94
Kagera	6.1	381	243	7.0	105	67
Mwanza	10.5	663	382	11.2	168	95
Mara	5.1	319	363	5.7	86	94
Manyara	2.7	170	244	2.5	38	57
Unguja North	0.5	29	274	0.4	6	50
Unguja South	0.2	15	208	0.2	3	43
Town West	0.9	59	257	0.6	10	42
Pemba North	0.6	35	288	0.4	5	47
Pemba South	0.5	34	289	0.4	7	55
Mother's education						
No education	23.7	1,490	1,501	23.6	356	348
Primary incomplete	13.1	822	887	13.2	199	190
Primary complete	48.2	3,037	2,734	47.3	712	633
Secondary+	5.2	325	647	5.9	89	143
Wealth quintile						
Lowest	21.9	1,379	1,310	21.5	325	307
Second	23.7	1,490	1,441	23.4	352	320
Middle	23.1	1,451	1,377	23.6	355	335
Fourth	18.7	1,175	1,334	18.2	274	280
Highest	12.7	799	922	13.3	201	215
Total	100.0	6,294	6,384	100.0	1,507	1,457

RBP = retinol binding protein; CRP = C-reactive protein

Table 3.4 presents the distribution of women who were tested for vitamin A (RBP) and for C-reactive protein (CRP) by background characteristics. More than 9,200 women age 15-49 were tested for vitamin A, and 2,393 were selected to be tested for CRP. The percent distribution of women in each category of background characteristics in the CRP sample also mimics that in the whole sample. For example, 22 percent of women are age 15-19, 35 percent are age 20-29, 10 percent are pregnant, and 96-97 percent live in the Mainland. These figures confirm that the samples for the CRP testing for women represent the entire sample.

Table 3.4 Background characteristics of women tested for vitamin A

Percent distribution of women aged 15-49 tested for RBP in the whole sample and for whom CRP analysis was done, by background characteristics (weighted), Tanzania 2010

	Whole sample			CRP sub-sample		
Background characteristic	Weighted percent	Weighted number	Unweighted number	Weighted percent	Weighted number	Unweighted number
Age						
15-19	21.7	1,988	2,054	22.1	506	536
20-29	34.9	3,191	3,127	34.9	800	806
30-39	26.7	2,447	2,409	26.3	602	610
40-49	16.7	1,525	1,655	16.7	382	441
Pregnancy status						
Pregnant	9.7	891	883	9.8	224	235
Breastfeeding	27.9	2,554	2,499	27.7	634	615
Neither	62.4	5,707	5,863	62.6	1,433	1,543
Residence						
Urban	27.9	2,553	2,316	28.1	644	594
Rural	72.1	6,598	6,929	71.9	1,647	1,799
Mainland/Zanzibar						
Mainland	96.7	8,853	7,039	96.3	2,206	1,770
Urban	26.6	2,435	1,689	26.7	611	422
Rural	70.1	6,419	5,350	69.6	1,595	1,348
Zanzibar	3.3	298	2,206	3.7	85	623
Unguja	2.1	192	1,341	2.4	54	377
Pemba	1.2	106	865	1.3	30	246
Region						
Dodoma	5.1	467	302	5.1	117	73
Arusha	3.8	349	313	3.9	88	80
Kilimanjaro	4.2	386	303	3.8	88	72
Tanga	4.9	450	300	4.7	108	72
Morogoro	4.8	438	305	5.0	114	80
Pwani	2.5	231	271	2.8	64	73
Dar es Salaam	8.1	741	383	7.8	180	93
Lindi	1.9	178	266	2.3	53	78
Mtwara	3.9	360	305	4.5	102	85
Ruvuma	3.6	333	341	3.5	81	85
Iringa	4.9	452	322	5.6	127	91
Mbeya	6.0	546	303	5.1	117	68
Singida	3.3	298	370	3.2	74	91
Tabora	4.7	431	460	4.5	104	114
Rukwa	2.6	234	291	2.5	56	70
Kigoma	4.6	424	324	4.8	110	88
Shinyanga	7.9	725	456	8.2	188	116
Kagera	5.5	500	308	5.1	117	72
Mwanza	8.3	763	434	8.3	190	109
Mara	3.7	343	381	3.5	80	90
Manyara	2.2	204	301	2.1	48	70
Unguja North	0.5	48	450	0.6	13	134
Unguja South	0.3	28	383	0.3	7	97
Town West	1.3	117	508	1.5	34	146
Pemba North	0.6	51	419	0.7	16	127
Pemba South	0.6	55	446	0.6	15	119
Education						
No education	19.3	1,764	1,745	18.8	430	442
Primary incomplete	14.6	1,332	1,397	14.2	326	366
Primary complete	50.4	4,609	3,971	51.5	1,181	1,018
Secondary+	15.8	1,446	2,132	15.5	354	567
Wealth quintile						
Lowest	16.9	1,545	1,472	18.0	411	386
Second	19.3	1,766	1,734	19.5	446	452
Middle	20.0	1,835	1,766	18.9	434	440
Fourth	20.9	1,913	2,102	20.0	459	541
Highest	22.9	2,092	2,171	23.6	541	574
Total	100.0	9,152	9,245	100.0	2,291	2,393

CRP = C-reactive protein

3.3 MICRONUTRIENT INTAKE AMONG CHILDREN

In the 2010 TDHS, women who had children age 6-35 months living with them were asked whether in the 24 hours before the interview, the children had consumed anything in a list of specific food groups and types of liquids. The groups included vitamin A-rich fruits and vegetables, eggs, and dark green, leafy vegetables.

Results show that 62 percent of the youngest children age 6-35 months who were living with their mothers were reported to have consumed foods rich in vitamin A in the 24 hours prior to the interview (Table 3.5). The proportion of children consuming vitamin A-rich foods increases with age from 53 percent at 6-8 months to 87 percent at 18-23 months, but declines to 22 percent of children age 24-35 months. Children in Mara region are the most likely to consume vitamin A-rich foods (80 percent) and those in Arusha are the least likely (42 percent). Education and wealth of the mother do not seem to be related to children's consumption of vitamin A-rich foods.

Mothers of children under age five were asked if their children had received vitamin A supplements in the six months before the survey. Results show that 61 percent of children aged 6-59 months were reported to be given vitamin A supplements in the 6 months preceding the survey. The proportion of children receiving supplements is exceptionally low in Shinyanga and Tabora (12 and 28 percent, respectively) and highest in Pemba North and Unguja South (87 and 90 percent, respectively).

Table 3.5 Micronutrient intake among children

Among the youngest children age 6-35 months who are living with their mother, the percentage who consumed vitamin A-rich foods in the day or night preceding the survey, and among all children 6-59 months, the percentage who were given vitamin A supplements in the six months preceding the survey, by background characteristics, Tanzania 2010

Background characteristic	Percentage who consumed foods rich in vitamin A in past 24 hours[1]	Number of youngest children age 6-35 months living with the mother	Percentage given vitamin A supplements in past 6 months	Number of children age 6-59 months
Age in months				
6-8	52.8	387	39.5	391
9-11	75.3	408	61.8	410
12-17	85.8	773	68.5	802
18-23	86.9	714	66.2	774
24-35	22.3	995	60.5	1,450
36-47	na	na	60.9	1,567
48-59	na	na	59.2	1,430
Sex				
Male	60.6	1,608	61.8	3,375
Female	62.4	1,669	59.8	3,449
Residence				
Urban	60.5	705	65.4	1,367
Rural	61.8	2,572	59.6	5,457
Mainland/Zanzibar				
Mainland	61.5	3,191	60.3	6,638
Urban	60.1	674	64.9	1,302
Rural	61.9	2,517	59.2	5,336
Zanzibar	63.1	86	78.7	186
Unguja	62.3	52	78.8	109
Pemba	64.3	34	78.6	76

Continued...

Table 3.5—*Continued*

Background characteristic	Percentage who consumed foods rich in vitamin A in past 24 hours[1]	Number of youngest children age 6-35 months living with the mother	Percentage given vitamin A supplements in past 6 months	Number of children age 6-59 months
Region				
Dodoma	60.8	184	63.3	386
Arusha	42.3	117	69.9	250
Kilimanjaro	62.9	84	60.5	171
Tanga	59.4	155	57.6	292
Morogoro	51.7	151	77.1	299
Pwani	66.5	79	58.2	171
Dar es Salaam	62.1	197	67.4	341
Lindi	63.1	67	57.0	125
Mtwara	59.4	94	69.6	203
Ruvuma	65.4	110	79.8	216
Iringa	56.8	129	81.9	268
Mbeya	58.3	203	62.6	428
Singida	67.5	119	66.2	262
Tabora	65.8	173	27.5	368
Rukwa	76.3	112	52.4	235
Kigoma	49.1	180	65.3	354
Shinyanga	77.6	318	12.1	683
Kagera	55.4	194	77.0	426
Mwanza	54.7	304	76.9	662
Mara	80.1	139	69.4	321
Manyara	51.1	84	60.1	176
Unguja North	54.1	14	83.7	30
Unguja South	70.8	7	90.3	16
Town West	64.1	30	73.6	64
Pemba North	74.7	18	87.4	38
Pemba South	53.0	16	69.9	38
Mother's education				
No education	62.0	801	48.7	1,733
Primary incomplete	62.1	472	57.9	1,002
Primary complete	61.0	1,758	66.1	3,649
Secondary+	63.1	246	71.3	439
Wealth quintile				
Lowest	62.5	690	53.3	1,461
Second	65.8	752	54.2	1,602
Middle	58.0	712	62.7	1,511
Fourth	58.5	608	68.7	1,271
Highest	62.5	515	69.5	978
Total	61.5	3,277	60.8	6,824

Note: Data on vitamin A supplements are based on mother's recall and child health card (if available)
na = Not applicable
[1] Includes meat (and organ meat), fish, poultry, eggs, pumpkin, red or yellow yams or squash, carrots, red sweet potatoes, dark green leafy vegetables, mango, papaya, and other vitamin A-rich fruits and vegetables.

3.4 VITAMIN A DEFICIENCY AMONG CHILDREN

Table 3.6 shows the prevalence of vitamin A deficiency (VAD) among children using RBP as a surrogate marker for retinol to assess vitamin A status. On the basis of the whole sample and without adjustment for infection/inflammation, 38 percent of children have VAD (RBP <0.825 µmol/L).

Because RBP levels decrease during infection/inflammation and, if not corrected for, may overestimate the prevalence of VAD, CRP was used to correct RBP values for the influence of infection or inflammation. As mentioned before, roughly one-quarter of children were tested for CRP. Table 3.7 shows, among those children 6-59 months who were tested for CRP, the percentage who had raised CRP and the percentage with VAD both before and after correction for infection/inflammation, according to background characteristics. Among children with CRP measurement, 35 percent have a raised CRP, indicating likely infection or inflammation. After correcting for infection/inflammation, the overall prevalence of VAD among children 6-59 months who were tested for CRP is reduced from 36 percent to 34 percent.

Table 3.6 Unadjusted prevalence of vitamin A deficiency in children

Percentage of all children age 6-59 months tested for retinol binding protein (RBP) who have any vitamin A deficiency (VAD), by background characteristics, Tanzania 2010

Background characteristic	Any VAD (RBP <0.825 umol/L)	Number of children with a valid RBP test
Age in months		
6-11	39.5	677
12-23	36.6	1,440
24-35	39.0	1,349
36-47	36.9	1,482
48-59	37.7	1,347
Child's sex		
Male	39.9	3,077
Female	35.7	3,216
Residence		
Urban	35.7	1,174
Rural	38.2	5,119
Mainland/Zanzibar		
Mainland	37.7	6,122
Urban	35.5	1,116
Rural	38.2	5,005
Zanzibar	38.1	172
Unguja	31.3	103
Pemba	48.1	69
Region		
Dodoma	35.5	398
Arusha	31.0	217
Kilimanjaro	38.6	176
Tanga	38.9	266
Morogoro	40.9	259
Pwani	47.6	158
Dar es Salaam	38.2	249
Lindi	35.5	100
Mtwara	42.9	183
Ruvuma	40.6	206
Iringa	40.8	260
Mbeya	31.9	359
Singida	26.6	253
Tabora	36.7	363
Rukwa	34.6	193
Kigoma	40.9	321
Shinyanga	41.5	627
Kagera	50.9	381
Mwanza	30.5	663
Mara	31.5	319
Manyara	47.6	170
Unguja North	20.2	29
Unguja South	26.1	15
Town West	38.1	59
Pemba North	57.3	35
Pemba South	38.7	34
Mother's education[1]		
No education	38.0	1,490
Primary incomplete	39.4	822
Primary complete	37.9	3,037
Secondary+	31.3	325
Wealth quintile		
Lowest	38.3	1,379
Second	39.2	1,490
Middle	38.6	1,451
Fourth	35.2	1,175
Highest	36.3	799
Total	37.8	6,294

[1] Children whose mothers were interviewed

Table 3.7 also shows the adjusted prevalence of VAD for all children in the right-hand columns. After correcting for infection/inflammation, the overall prevalence of VAD among all children 6-59 months is reduced from 38 percent to 33 percent.

Table 3.7 Adjusted prevalence of VAD among children

Among children 6-59 months tested for CRP and RBP, percentage with raised CRP and percentage with vitamin A deficiency (VAD) before and after adjusting for infection/inflammation, and among all children 6-59 months tested for RBP, percentage of children with any VAD before and after adjustment, by background characteristics, Tanzania 2010

	Children tested for CRP and RBP				All children tested for RBP		
	Percentage of children with:				Percentage of children with:		
Background characteristic	Raised CRP (>3mg/L)	VAD before adjustment	VAD after adjustment	Number of children with CRP	VAD before adjustment	VAD after adjustment	Number of children
Age in months							
6-11	43.1	41.0	35.9	147	39.5	34.2	677
12-23	39.8	34.8	31.1	324	36.6	31.8	1,440
24-35	34.0	41.5	38.1	305	39.0	34.4	1,349
36-47	31.2	32.0	31.7	366	36.9	31.9	1,482
48-59	31.5	34.0	32.6	365	37.7	33.7	1,347
Child's sex							
Male	32.3	38.5	36.4	747	39.9	35.3	3,077
Female	37.3	33.4	30.6	760	35.7	30.9	3,216
Residence							
Urban	29.8	36.1	33.7	281	35.7	31.9	1,174
Rural	36.0	35.9	33.4	1,226	38.2	33.3	5,119
Mainland/Zanzibar							
Mainland	34.8	36.0	33.6	1,477	37.7	33.0	6,122
Urban	29.5	36.6	34.1	270	35.5	31.8	1,116
Rural	36.0	35.9	33.5	1,207	38.2	33.3	5,005
Zanzibar	35.7	29.0	28.4	30	38.1	32.8	172
Unguja	35.0	22.2	21.9	18	31.3	26.3	103
Pemba	36.6	39.2	38.2	12	48.1	42.6	69
Region							
Dodoma	35.3	39.4	36.3	96	35.5	30.3	398
Arusha	(22.7)	(25.0)	(25.0)	54	31.0	30.0	217
Kilimanjaro	(18.6)	(31.8)	(29.0)	49	38.6	34.2	176
Tanga	(40.1)	(30.6)	(28.3)	64	38.9	32.2	266
Morogoro	(24.6)	(39.7)	(37.4)	59	40.9	36.3	259
Pwani	(30.9)	(48.4)	(48.4)	33	47.6	44.8	158
Dar Es Salaam	(31.6)	(40.3)	(37.3)	57	38.2	34.2	249
Lindi	(44.6)	(44.8)	(44.8)	20	35.5	30.8	100
Mtwara	(27.4)	(25.4)	(22.7)	31	42.9	36.3	183
Ruvuma	(32.1)	(38.2)	(38.2)	44	40.6	32.1	206
Iringa	(21.2)	(22.4)	(20.4)	47	40.8	35.1	260
Mbeya	42.2	26.2	21.1	92	31.9	25.6	359
Singida	28.3	30.5	25.7	67	26.6	20.7	253
Tabora	23.6	40.3	39.4	96	36.7	32.8	363
Rukwa	32.7	35.0	31.5	49	34.6	26.4	193
Kigoma	40.5	37.6	37.6	79	40.9	38.7	321
Shinyanga	41.5	48.6	43.9	143	41.5	36.8	627
Kagera	34.7	48.9	46.6	105	50.9	46.7	381
Mwanza	51.5	34.2	31.8	168	30.5	27.4	663
Mara	35.3	16.7	14.5	86	31.5	25.8	319
Manyara	22.1	43.4	43.4	38	47.6	43.9	170
Unguja North	27.8	21.5	20.4	6	20.2	15.3	29
Unguja South	(35.5)	(10.8)	(10.8)	3	26.1	19.9	15
Town West	(39.3)	(26.3)	(26.3)	10	38.1	33.2	59
Pemba North	(25.8)	(47.0)	(47.0)	5	57.3	51.0	35
Pemba South	45.4	32.8	30.9	7	38.7	34.0	34
Mother's education[1]							
No education	40.3	33.1	32.1	356	38.0	33.4	1,490
Primary incomplete	40.9	44.1	38.5	199	39.4	34.3	822
Primary complete	32.5	36.7	34.1	712	37.9	33.3	3,037
Secondary+	26.7	30.7	29.7	89	31.3	27.2	325
Wealth quintile							
Lowest	37.8	38.2	36.0	325	38.3	33.1	1,379
Second	39.1	34.3	32.8	352	39.2	35.0	1,490
Middle	31.0	36.7	33.9	355	38.6	33.5	1,451
Fourth	38.3	33.7	30.0	274	35.2	30.7	1,175
Highest	24.8	36.6	34.7	201	36.3	31.8	799
Total	34.9	35.9	33.5	1,507	37.8	33.0	6,294

Note: Figures in parentheses are based on 25-49 unweighted cases.
CRP = C-reactive protein
RBP = retinol binding protein
[1] Children whose mothers were interviewed

The prevalence of VAD does not vary much by the child's age. Boys have a slightly higher prevalence of VAD than girls (35 percent compared with 31 percent after adjustment), and children in urban areas are almost equally likely to have VAD as children in rural areas (32 and 33 percent, respectively). At 51 percent, Pemba North has the highest rate of VAD, followed by Kagera (47 percent). At the other extreme, Unguja North has the lowest rate (15 percent). VAD varies by the mother's educational level; children whose mothers have at least some secondary education have the lowest prevalence of VAD (27 percent) compared with the level of 33-34 percent among children whose mothers have less education. Variation in VAD by wealth quintile does not show a uniform pattern, being only slightly lower at the higher quintiles. Comparison of data in Tables 3.5 and 3.7 by background characteristics shows there is little association between either the consumption of vitamin A-rich foods or vitamin A supplementation and vitamin A deficiency by the children's characteristics.

3.5 Micronutrient Intake among Mothers

Table 3.8 presents results regarding women's intake of micronutrients. Women with a child under age 3 living with them were asked about their own consumption of various food groups in the 24 hours before the survey. Women who had a birth in the 5 years before the survey were asked if they had received a vitamin A supplement after their most recent birth and if they took iron supplements during their most recent pregnancy and if so, for how many days.

The findings show that 72 percent of women with a child under age 3 consumed vitamin A-rich foods in the 24 hours before the survey. The consumption decreases progressively with age, from 83 percent among women age 15-19 to 59 percent among women age 40-49. Consumption of vitamin A-rich foods is highest in Mara (87 percent) and lowest in Arusha (56 percent). Consumption of vitamin A-rich foods is not correlated with education level or wealth quintile.

Thirty-five percent of women consumed iron-rich foods in the 24 hours preceding the survey. The proportion is higher in urban areas (46 percent) than rural areas (32 percent) and is much higher in Zanzibar (62 percent) than in the mainland (34 percent). Consumption of iron-rich foods varies considerably by region and correlates positively with education of the mother, ranging from 27 percent among mothers with no formal education to 58 percent of those with at least some secondary education.

The policy of the Ministry of Health and Social Welfare is to provide a single high-dose vitamin A capsule (200,000 IU) to women within the first four weeks after childbirth, aimed to increase the mother's vitamin A status and the content of the vitamin in breast milk for the benefit of the child. Table 3.8 shows that only one of four women who gave birth in the five years before the survey received vitamin A supplementation within two months after childbirth. Women with at least some secondary education are more than twice as likely as mothers with no education to have received a vitamin A supplement within two months after childbirth (41 and 18 percent, respectively).

Survey data show that almost 60 percent of pregnant women take iron supplements, though the vast majority of these women take iron for less than 60 days during their pregnancy.

Table 3.8 Micronutrient intake among mothers

Among women age 15-49 with a child under age 3 living with her, the percentages who consumed vitamin A-rich and iron-rich foods in the 24 hours preceding the survey; among women age 15-49 with a child born in the last five years, the percentage who received a vitamin A dose in the first two months after the birth of the last child; among mothers age 15-49 who during the pregnancy of the last child born in the five years prior to the survey, the percentage who took iron tablets or syrup for specific numbers of days, by background characteristics, Tanzania 2010

	Among women with a child under age 3 living with her				Number of days women took iron tablets or syrup during pregnancy of last birth					
Background characteristic	Percentage consumed vitamin A-rich foods[1]	Percentage consumed iron-rich foods[2]	Number of women	Percentage who received vitamin A dose postpartum[3]	None	<60	60-89	90+	Don't know/ missing	Number of women
Age										
15-19	82.8	48.2	347	19.4	47.2	46.3	3.3	2.1	1.1	373
20-29	73.5	37.3	2,121	25.6	40.6	49.2	5.1	3.6	1.3	2,698
30-39	69.6	30.4	1,353	26.7	39.3	49.2	6.2	3.4	1.9	1,905
40-49	59.3	24.5	293	27.5	41.5	48.2	5.7	3.9	0.8	543
Residence										
Urban	72.6	46.4	867	35.6	34.5	52.7	6.1	4.5	2.3	1,273
Rural	71.8	32.0	3,247	22.8	42.6	47.8	5.2	3.2	1.2	4,246
Mainland/Zanzibar										
Mainland	72.0	34.3	4,007	25.4	41.2	49.1	5.1	3.1	1.5	5,378
Urban	72.4	45.4	829	35.3	35.0	53.2	5.7	3.8	2.4	1,222
Rural	71.9	31.4	3,178	22.5	43.1	47.9	4.9	2.9	1.2	4,156
Zanzibar	72.3	61.9	106	38.9	20.0	42.6	20.3	16.4	0.7	141
Unguja	72.9	64.8	64	45.1	18.9	41.4	17.3	21.7	0.7	89
Pemba	71.3	57.6	42	28.3	21.8	44.7	25.5	7.3	0.7	52
Region										
Dodoma	76.1	13.3	239	33.2	23.3	64.9	6.4	5.5	0.0	316
Arusha	55.5	24.3	150	22.4	48.5	44.8	1.4	2.2	3.3	232
Kilimanjaro	76.6	55.1	98	32.8	34.5	63.6	0.7	1.2	0.0	162
Tanga	69.4	36.2	182	30.2	38.3	57.0	1.2	0.5	2.9	255
Morogoro	63.8	25.6	181	28.9	39.8	44.0	8.1	7.1	1.0	262
Pwani	80.0	29.5	103	22.0	30.7	34.2	24.4	10.8	0.0	149
Dar es Salaam	73.5	54.3	223	39.8	29.9	57.7	6.2	4.5	1.7	333
Lindi	69.2	20.7	82	37.2	26.5	51.6	6.7	11.7	3.5	121
Mtwara	74.1	39.2	115	37.0	22.4	62.2	3.4	8.9	3.1	197
Ruvuma	73.1	27.4	133	16.2	37.9	55.1	4.9	1.5	0.6	196
Iringa	66.7	30.5	156	27.9	34.9	60.4	2.0	1.4	1.3	237
Mbeya	72.7	42.9	258	15.4	48.5	36.7	8.3	4.1	2.4	347
Singida	78.3	22.3	147	31.7	29.1	56.4	5.3	7.6	1.6	187
Tabora	74.7	27.7	232	20.7	51.8	40.8	6.0	1.3	0.0	289
Rukwa	82.9	47.9	146	6.8	50.1	43.6	4.7	1.6	0.0	177
Kigoma	57.4	28.5	225	29.5	30.8	64.2	3.6	0.7	0.7	262
Shinyanga	86.0	31.0	426	8.9	61.1	31.6	6.2	1.1	0.0	492
Kagera	65.5	41.2	246	26.5	37.0	59.7	2.0	0.5	0.8	323
Mwanza	62.9	37.7	389	32.1	56.3	37.0	3.1	1.3	2.3	480
Mara	87.4	60.3	175	18.8	48.1	45.4	3.6	1.6	1.3	229
Manyara	61.6	16.2	102	25.8	40.3	46.8	2.9	1.2	8.9	134
Unguja North	64.2	52.8	18	49.8	12.1	43.9	18.0	24.4	1.5	23
Unguja South	74.8	59.2	9	64.4	9.6	35.1	21.5	33.8	0.0	14
Town West	76.6	71.9	37	37.9	24.3	42.0	15.8	17.3	0.6	53
Pemba North	80.5	73.5	22	28.8	27.2	40.8	26.5	5.1	0.4	26
Pemba South	61.1	40.1	20	27.7	16.4	48.6	24.6	9.5	0.9	26
Education										
No education	72.1	27.4	1,026	18.4	45.7	43.3	6.4	2.4	2.2	1,313
Primary incomplete	71.6	30.2	606	21.3	41.6	48.6	4.5	4.7	0.7	777
Primary complete	71.7	36.8	2,187	28.0	39.3	51.1	5.0	3.3	1.3	3,015
Secondary+	75.2	58.2	295	40.7	33.5	51.4	7.6	5.9	1.7	414
Wealth quintile										
Lowest	71.6	23.3	847	22.4	41.7	48.4	4.9	3.7	1.3	1,087
Second	75.7	31.7	968	19.9	47.0	43.1	6.4	2.3	1.2	1,222
Middle	68.2	32.6	908	23.7	43.3	49.2	3.5	2.6	1.3	1,175
Fourth	70.1	40.1	777	28.0	33.8	53.8	7.2	3.5	1.7	1,111
Highest	74.6	53.9	613	37.5	36.1	51.1	5.2	5.7	1.9	924
Total	72.0	35.0	4,113	25.8	40.7	48.9	5.4	3.5	1.5	5,519

[1] Includes meat, liver, fish, poultry, eggs, pumpkin, carrots, red sweet potatoes, ripe mango or papaya, passion fruit, any dark green leafy vegetables (spinach/amaranth/cassava), and other locally grown yellow/orange colour fruits or vegetables.
[2] Includes meat (and organ meat), fish, poultry, eggs
[3] In the first two months after delivery

3.6 VITAMIN A DEFICIENCY AMONG WOMEN

Table 3.9 shows the unadjusted prevalence of VAD in the whole sample of women age 15-49. Without correcting for infection/inflammation, 42 percent of women have VAD—29 percent have marginal VAD, 9 percent have moderate VAD, and 3 percent have severe VAD.

Table 3.9 Unadjusted prevalence of vitamin A deficiency in women

Percentage of women aged 15-49 with any, marginal, moderate, and severe vitamin A deficiency, according to background characteristics, Tanzania 2010

Background characteristic	Any VAD (<1.24 μmol/L)	Level of VAD: Marginal VAD (0.82-1.24 μmol/L)	Level of VAD: Moderate VAD (0.41-0.81 μmol/L)	Level of VAD: Severe VAD (<0.41 μmol/L)	Number of women with a valid RBP test
Age					
15-19	46.4	31.9	10.4	4.1	1,988
20-29	42.8	29.4	10.3	3.1	3,191
30-39	40.8	28.9	8.5	3.4	2,447
40-49	36.6	26.3	7.4	2.9	1,525
Pregnancy status					
Pregnant	44.5	30.9	10.9	2.6	891
Breastfeeding	40.1	28.5	8.2	3.4	2,554
Neither	42.4	29.4	9.6	3.4	5,707
Residence					
Urban	45.5	31.3	10.6	3.7	2,553
Rural	40.6	28.5	8.9	3.2	6,598
Mainland/Zanzibar					
Mainland	41.9	29.2	9.3	3.4	8,853
Urban	45.3	31.0	10.5	3.8	2,435
Rural	40.6	28.5	8.9	3.2	6,419
Zanzibar	44.8	31.4	10.7	2.7	298
Unguja	40.1	28.5	9.4	2.3	192
Pemba	53.2	36.7	13.0	3.5	106
Region					
Dodoma	37.7	28.4	7.6	1.8	467
Arusha	43.9	29.5	12.7	1.8	349
Kilimanjaro	45.8	35.4	8.7	1.8	386
Tanga	38.1	29.9	7.0	1.2	450
Morogoro	43.1	31.0	9.6	2.5	438
Pwani	50.8	39.1	9.5	2.2	231
Dar es Salaam	51.7	32.6	14.2	4.9	741
Lindi	39.8	26.1	10.7	3.0	178
Mtwara	44.4	30.3	8.2	5.8	360
Ruvuma	45.6	33.9	7.4	4.3	333
Iringa	42.3	26.2	13.8	2.4	452
Mbeya	40.3	28.8	9.9	1.6	546
Singida	37.3	27.8	6.8	2.7	298
Tabora	37.9	26.8	7.2	3.9	431
Rukwa	36.1	25.1	8.6	2.5	234
Kigoma	39.9	27.4	7.9	4.7	424
Shinyanga	43.4	27.3	9.1	7.0	725
Kagera	42.5	27.3	10.4	4.8	500
Mwanza	32.5	25.0	6.0	1.5	763
Mara	39.4	31.8	6.9	0.7	343
Manyara	53.5	29.7	14.4	9.4	204
Unguja North	21.3	16.3	4.0	1.0	48
Unguja South	32.0	26.3	4.6	1.2	28
Town West	49.8	34.0	12.7	3.1	117
Pemba North	62.5	43.1	15.2	4.1	51
Pemba South	44.5	30.6	11.0	2.9	55
Education					
No education	39.0	27.5	8.2	3.3	1,764
Primary incomplete	41.5	27.8	9.5	4.2	1,332
Primary complete	41.7	29.5	9.3	2.9	4,609
Secondary+	47.0	32.1	10.8	4.1	1,446
Wealth quintile					
Lowest	38.4	27.0	8.7	2.7	1,545
Second	39.6	27.5	8.1	4.0	1,766
Middle	40.9	30.3	8.2	2.4	1,835
Fourth	41.9	27.9	10.5	3.6	1,913
Highest	47.6	32.8	11.0	3.9	2,092
Total	42.0	29.3	9.4	3.3	9,152

VAD = Vitamin A deficiency

As with children, the data on vitamin A deficiency were adjusted to correct for those who had high levels of C-reactive protein (CRP) caused by current infections or inflammation. Table 3.10 shows the test results for the subsample of women (approximately one in four) who were tested for CRP. Overall, 28 percent of women have raised CRP. Among the women tested for CRP, the proportion with VAD is 37 percent before correction and 36 percent after correction.

Table 3.10 Adjusted prevalence of VAD among women aged 15-49

Among women aged 15-49 tested for CRP and RBP, percentage with raised CRP and percentage with vitamin A deficiency (VAD) before and after adjusting for infection/ inflammation, and among all women 15-49, percentage with VAD before and after adjustment, by background characteristics, Tanzania 2010

	Women tested for CRP and RBP			All women			
		Percentage with VAD			Percentage with VAD		
Background characteristic	Percentage of women with raised CRP (>3 mg/L)	Before adjustment	After adjustment	Number of women with CRP measurement	Before adjustment	After adjustment	Number of women
Age							
15-19	20.3	42.1	41.5	506	46.4	40.4	1,988
20-29	28.2	37.3	36.6	800	42.8	37.9	3,191
30-39	31.8	37.7	35.3	602	40.8	35.5	2,447
40-49	30.7	28.9	28.0	382	36.6	31.5	1,525
Pregnancy status							
Pregnant	49.9	43.5	42.2	224	44.5	39.0	891
Breastfeeding	26.7	37.3	35.4	634	40.1	35.1	2,554
Neither	24.8	35.9	35.2	1,433	42.4	37.1	5,707
Residence							
Urban	31.2	41.9	39.7	644	45.5	39.9	2,553
Rural	26.5	35.2	34.4	1,647	40.6	35.5	6,598
Mainland/Zanzibar							
Mainland	27.9	37.0	35.9	2,206	41.9	36.6	8,853
Urban	31.2	41.7	39.5	611	45.3	39.6	2,435
Rural	26.6	35.3	34.5	1,595	40.6	35.5	6,419
Zanzibar	25.4	37.5	36.8	85	44.8	39.8	298
Unguja	26.7	36.3	35.4	54	40.1	35.6	192
Pemba	23.0	39.6	39.2	30	53.2	47.4	106
Region							
Dodoma	38.6	33.4	33.4	117	37.7	32.8	467
Arusha	34.9	30.5	28.2	88	43.9	38.3	349
Kilimanjaro	27.1	48.0	44.6	88	45.8	37.6	386
Tanga	21.4	34.0	34.0	108	38.1	32.4	450
Morogoro	23.5	37.1	35.5	114	43.1	37.5	438
Pwani	33.2	44.5	43.1	64	50.8	44.9	231
Dar es Salaam	28.6	48.8	46.6	180	51.7	46.8	741
Lindi	20.8	29.8	28.5	53	39.8	35.8	178
Mtwara	27.9	32.0	31.0	102	44.4	37.1	360
Ruvuma	23.0	42.7	40.0	81	45.6	41.4	333
Iringa	13.1	38.4	36.2	127	42.3	38.9	452
Mbeya	26.5	27.8	27.8	117	40.3	33.3	546
Singida	21.5	31.9	28.7	74	37.3	29.8	298
Tabora	28.3	42.9	40.9	104	37.9	31.9	431
Rukwa	29.6	21.6	21.6	56	36.1	31.8	234
Kigoma	31.4	34.0	34.0	110	39.9	34.4	424
Shinyanga	29.2	42.6	41.9	188	43.4	39.1	725
Kagera	30.4	34.8	34.8	117	42.5	39.7	500
Mwanza	33.0	32.7	32.7	190	32.5	28.0	763
Mara	29.1	30.2	28.1	80	39.4	33.5	343
Manyara	29.4	51.1	51.1	48	53.5	49.1	204
Unguja North	11.4	13.9	13.1	13	21.3	16.6	48
Unguja South	27.8	18.9	18.9	7	32.0	25.6	28
Town West	32.6	48.9	47.8	34	49.8	45.7	117
Pemba North	21.9	53.0	52.1	16	62.5	54.9	51
Pemba South	24.2	25.2	25.2	15	44.5	40.4	55
Education							
No education	31.5	36.7	36.1	430	39.0	34.0	1,764
Primary incomplete	26.4	35.6	34.3	326	41.5	36.3	1,332
Primary complete	28.8	35.7	34.1	1,181	41.7	36.3	4,609
Secondary+	21.3	43.3	43.2	354	47.0	41.8	1,446
Wealth quintile							
Lowest	26.8	31.4	30.3	411	38.4	32.9	1,545
Second	24.9	35.3	34.4	446	39.6	34.7	1,766
Middle	26.7	38.8	38.4	434	40.9	35.5	1,835
Fourth	30.5	35.3	34.9	459	41.9	37.3	1,913
Highest	29.4	42.9	40.4	541	47.6	41.8	2,092
Total	27.8	37.1	35.9	2,291	42.0	36.7	9,152

CRP = C-reactive protein

When adjustment is made for all women—including those who were not tested for CRP—the prevalence of VAD is reduced from 42 percent to 37 percent. The adjusted prevalence of VAD for all women varies by their background characteristics. The level of VAD declines with age from 40 percent among women age 15-19 to 32 percent among women aged 40-49. Pregnant women have a higher prevalence of VAD (39 percent) than mothers who are breastfeeding but not pregnant (35 percent) or women who are neither pregnant nor breastfeeding (37 percent). Surprisingly, VAD prevalence is higher in urban areas than in rural areas (40 and 36 percent, respectively). As observed for children, Pemba North has the highest proportion of women with any VAD (55 percent), while Unguja North has the lowest (17 percent). VAD increases with women's educational attainment; women with no education have the lowest prevalence of VAD (34 percent), and women with a secondary or higher education have the highest (42 percent). Similarly, women in the lowest wealth quintile have the lowest VAD prevalence (33 percent), and women in the highest wealth quintile have the highest (42 percent).

IRON STATUS 4

4.1 COVERAGE OF IRON TESTING AMONG CHILDREN AND WOMEN

Table 4.1 shows the response rates for iron status testing of children. Of the 7,175 children age 6-59 months who were eligible for this test, 94 percent were tested; 90 percent had a valid result, and 4 percent were tested but did not have valid results. Dar es Salaam has the lowest proportion of children with a valid result for the iron status deficiency test (74 percent); this is due to the relatively high rate of refusal (13 percent) and missing data (7 percent). Mwanza and Dodoma regions have the highest levels of children with valid test results (96 percent).

Table 4.1 Coverage of iron status testing for children

Percent distribution of children age 6-59 months eligible for iron status testing by testing status, according to residence and region (unweighted), Tanzania, 2010

Background characteristic	Tested for sTfR[1]		Refused to provide blood	Absent at the time of blood collection	Other/missing	Total	Number
	Result valid	Result not valid					
Residence							
Urban	86.8	4.3	4.6	1.1	3.2	100.0	1,312
Rural	91.2	3.5	1.9	1.3	2.1	100.0	5,863
Mainland/Zanzibar							
Mainland	90.3	3.5	2.7	1.3	2.2	100.0	5,726
Urban	86.8	3.5	5.3	1.3	3.3	100.0	952
Rural	91.0	3.5	2.2	1.3	2.0	100.0	4,774
Zanzibar	90.9	4.1	1.3	1.1	2.6	100.0	1,449
Unguja	92.3	4.7	0.9	0.7	1.4	100.0	806
Pemba	89.1	3.4	1.9	1.6	4.0	100.0	643
Region							
Dodoma	95.6	2.6	0.7	0.4	0.7	100.0	272
Arusha	91.3	1.4	4.6	0.9	1.8	100.0	218
Kilimanjaro	88.3	9.1	1.3	0.6	0.6	100.0	154
Tanga	90.7	2.9	4.9	0.5	1.0	100.0	204
Morogoro	88.3	2.8	2.8	2.3	3.8	100.0	213
Pwani	87.1	4.7	3.9	3.0	1.3	100.0	232
Dar es Salaam	74.2	4.5	12.9	1.7	6.7	100.0	178
Lindi	89.6	2.1	2.6	2.1	3.6	100.0	193
Mtwara	87.1	2.7	1.1	5.4	3.8	100.0	186
Ruvuma	93.3	3.3	0.0	1.3	2.1	100.0	239
Iringa	92.8	2.9	1.4	1.9	1.0	100.0	208
Mbeya	81.2	3.1	6.9	0.8	8.1	100.0	260
Singida	94.8	1.7	1.2	0.6	1.7	100.0	344
Tabora	89.2	2.3	3.4	1.6	3.6	100.0	444
Rukwa	85.6	4.7	6.0	1.0	2.7	100.0	299
Kigoma	88.0	1.7	3.7	3.0	3.7	100.0	300
Shinyanga	91.7	4.0	1.6	1.3	1.3	100.0	446
Kagera	91.9	4.0	1.1	1.5	1.5	100.0	273
Mwanza	95.8	3.2	0.2	0.2	0.5	100.0	404
Mara	93.9	5.6	0.3	0.3	0.0	100.0	394
Manyara	92.8	5.3	1.5	0.0	0.4	100.0	265
Unguja North	95.2	3.8	0.0	0.3	0.7	100.0	290
Unguja South	94.8	1.3	0.4	1.7	1.7	100.0	230
Town West	87.4	8.4	2.1	0.3	1.7	100.0	286
Pemba North	87.8	4.6	1.8	2.4	3.4	100.0	327
Pemba South	90.5	2.2	1.9	0.6	4.7	100.0	316
Total	90.4	3.6	2.4	1.3	2.3	100.0	7,175

[1] sTfR = soluble transferrin receptor

Table 4.2 presents the response rates for iron status testing for women age 15-49. Of the 10,522 women who were eligible for this test, 94 percent were tested; 90 percent had a valid result and 4 percent were tested but did not have a valid result. There are no significant variations in Mainland and Zanzibar by testing status. Mbeya had the lowest proportion of women with a valid result for the iron status deficiency test (82 percent), probably because many women were not interviewed, and Unguja South had the highest (96 percent).

Table 4.2 Coverage of iron status testing for women

Percent distribution of women age 15-49 eligible for iron status testing by testing and interview status, according to residence and region (unweighted), Tanzania, 2010

Background characteristic	Tested for sTfR[1]		Refused to provide blood	Absent at the time of blood collection	Other/missing	Not interviewed	Total	Number of women
	Result valid	Result not valid						
Residence								
Urban	87.4	4.6	2.9	0.0	1.0	4.1	100.0	2,700
Rural	90.9	3.9	1.2	0.1	0.4	3.4	100.0	7,822
Mainland/Zanzibar								
Mainland	89.5	4.1	1.8	0.1	0.6	3.8	100.0	8,055
Urban	87.0	4.1	3.6	0.1	1.0	4.2	100.0	1,967
Rural	90.4	4.1	1.3	0.1	0.4	3.6	100.0	6,088
Zanzibar	91.4	4.2	1.1	0.0	0.4	2.9	100.0	2,467
Unguja	92.9	4.3	0.5	0.0	0.4	1.9	100.0	1,485
Pemba	89.3	4.0	1.8	0.0	0.5	4.4	100.0	982
Region								
Dodoma	94.4	3.7	0.3	0.0	0.0	1.5	100.0	324
Arusha	92.1	1.6	3.5	0.0	0.3	2.5	100.0	368
Kilimanjaro	86.4	9.8	1.2	0.0	0.3	2.4	100.0	338
Tanga	90.6	3.2	2.4	0.3	0.3	3.3	100.0	340
Morogoro	90.6	2.8	1.1	0.0	0.9	4.5	100.0	351
Pwani	85.3	5.8	2.1	0.0	0.9	5.8	100.0	327
Dar es Salaam	85.7	1.9	7.4	0.2	0.9	3.8	100.0	462
Lindi	90.1	2.2	1.0	0.0	0.6	6.1	100.0	313
Mtwara	90.9	4.3	0.3	0.0	0.9	3.7	100.0	351
Ruvuma	94.6	1.4	0.0	0.0	0.0	4.1	100.0	370
Iringa	90.1	2.5	2.2	0.0	0.3	5.1	100.0	363
Mbeya	82.4	2.4	2.6	0.0	3.4	9.2	100.0	380
Singida	92.3	3.2	1.2	0.0	0.5	2.5	100.0	401
Tabora	90.7	4.5	1.0	0.2	0.4	3.2	100.0	493
Rukwa	85.8	5.6	3.0	0.0	0.0	5.7	100.0	338
Kigoma	85.9	0.8	4.6	0.0	2.1	6.7	100.0	389
Shinyanga	89.9	6.3	1.0	0.8	0.2	1.9	100.0	525
Kagera	88.9	5.3	1.3	0.0	0.3	4.2	100.0	377
Mwanza	91.7	5.2	0.6	0.0	0.2	2.3	100.0	482
Mara	89.4	6.5	0.5	0.0	0.0	3.7	100.0	433
Manyara	93.0	6.1	0.6	0.0	0.0	0.3	100.0	330
Unguja North	93.6	3.3	0.4	0.0	0.2	2.4	100.0	487
Unguja South	96.0	2.1	0.7	0.0	0.0	1.1	100.0	422
Town West	89.9	6.8	0.5	0.0	0.9	1.8	100.0	576
Pemba North	89.1	5.7	2.3	0.0	0.2	2.6	100.0	470
Pemba South	89.5	2.3	1.4	0.0	0.8	6.1	100.0	512
Total	90.0	4.1	1.7	0.1	0.6	3.6	100.0	10,522

[1] sTfR = soluble transferrin receptor

4.2 CHARACTERISTICS OF CHILDREN AND WOMEN TESTED

Table 4.3 shows the distribution of children for whom the soluble transferrin receptor (sTfR) test was done as well as the weighted (after applying the sample weighting factors) and unweighted number of children. Close to 6,500 children age 6-59 months were tested. The distribution of children by background characteristics is the same as that tested for vitamin A (Table 3.3).

Table 4.3 Background characteristics of children tested for iron status

Percent distribution of children age 6-59 months tested for iron status, by background characteristics, Tanzania 2010

Background characteristic	Weighted percent	Weighted number	Unweighted number
Age in months			
6-11	10.9	703	695
12-23	22.8	1,464	1,495
24-35	21.3	1,366	1,386
36-47	23.4	1,504	1,507
48-59	21.6	1,386	1,403
Child's sex			
Male	49.3	3,166	3,208
Female	50.7	3,257	3,278
Residence			
Urban	18.6	1,195	1,139
Rural	81.4	5,228	5,347
Mainland/Zanzibar			
Mainland	97.3	6,253	5,169
Urban	17.7	1,138	826
Rural	79.6	5,114	4,343
Zanzibar	2.7	171	1,317
Unguja	1.6	102	744
Pemba	1.1	69	573
Region			
Dodoma	6.3	405	260
Arusha	3.6	229	199
Kilimanjaro	2.7	171	136
Tanga	4.3	274	185
Morogoro	4.1	261	188
Pwani	2.5	159	202
Dar es Salaam	4.0	255	132
Lindi	1.7	110	173
Mtwara	3.0	191	162
Ruvuma	3.3	214	223
Iringa	4.1	265	193
Mbeya	5.5	353	211
Singida	4.0	258	326
Tabora	5.6	362	396
Rukwa	3.1	197	256
Kigoma	5.1	328	264
Shinyanga	10.1	651	409
Kagera	6.2	395	251
Mwanza	10.5	675	387
Mara	5.1	330	370
Manyara	2.7	171	246
Unguja North	0.5	29	276
Unguja South	0.2	15	218
Town West	0.9	57	250
Pemba North	0.5	35	287
Mother's education			
No education	23.8	1,528	1,538
Primary incomplete	13.2	851	914
Primary complete	48.1	3,087	2,771
Secondary+	5.2	334	637
Wealth quintile			
Lowest	21.9	1,407	1,340
Second	23.4	1,503	1,449
Middle	23.1	1,481	1,405
Fourth	18.7	1,203	1,360
Highest	12.9	829	932
Total	100.0	6,423	6,486

Table 4.4 presents a similar distribution of women tested for iron status. Nearly 9,500 women age 15-49 were tested. The percent distribution of women in each group is similar to that tested for vitamin A (Table 3.4).

Table 4.4 Background characteristics of women tested for iron status

Percent distribution of de facto interviewed women age 15-49 tested for iron status, by background characteristics, Tanzania 2010

Background characteristic	Weighted percent	Weighted number	Unweighted number
Age			
15-19	21.6	2,039	2,096
20-29	35.0	3,302	3,235
30-39	26.8	2,523	2,457
40-49	16.5	1,559	1,681
Pregnancy status			
Pregnant	9.7	916	900
Breastfeeding	27.8	2,622	2,550
Neither	62.4	5,884	6,019
Residence			
Urban	27.8	2,615	2,360
Rural	72.2	6,807	7,109
Mainland/Zanzibar			
Mainland	96.8	9,117	7,213
Urban	26.5	2,492	1,712
Rural	70.3	6,625	5,501
Zanzibar	3.2	305	2,256
Unguja	2.1	198	1,379
Pemba	1.1	107	877
Region			
Dodoma	5.1	478	306
Arusha	4.0	375	339
Kilimanjaro	3.9	364	292
Tanga	4.9	466	308
Morogoro	4.8	453	318
Pwani	2.5	238	279
Dar es Salaam	8.1	767	396
Lindi	2.0	189	282
Mtwara	4.1	386	319
Ruvuma	3.7	346	350
Iringa	5.0	467	327
Mbeya	6.0	568	313
Singida	3.2	299	370
Tabora	4.4	415	447
Rukwa	2.5	234	290
Kigoma	4.6	434	334
Shinyanga	7.9	749	472
Kagera	5.8	549	335
Mwanza	8.4	788	442
Mara	3.7	345	387
Manyara	2.2	206	307
Unguja North	0.5	49	456
Unguja South	0.3	29	405
Town West	1.3	120	518
Pemba North	0.5	51	419
Pemba South	0.6	56	458
Education			
No education	19.1	1,801	1,783
Primary incomplete	14.6	1,371	1,428
Primary complete	50.4	4,751	4,081
Secondary+	15.9	1,499	2,177
Wealth quintile			
Lowest	16.8	1,587	1,516
Second	19.6	1,844	1,784
Middle	19.8	1,868	1,796
Fourth	20.8	1,960	2,149
Highest	23.0	2,163	2,224
Total	100.0	9,422	9,469

4.3 IRON DEFICIENCY AMONG CHILDREN

Table 4.5 shows that 35 percent of children are iron deficient, and 59 percent have anaemia. The overall prevalence of iron deficiency anaemia (IDA) among children is 24 percent, while the rate of iron deficiency without anaemia is 11 percent. While iron deficiency is a major cause of anaemia in children, the contribution of other causes such as malaria and hookworm infestation must be

Table 4.5 Prevalence of iron deficiency and anaemia in children

Percentage of children age 6-59 months by iron deficiency (ID) and anaemia status, by background characteristics, Tanzania, 2010

Background characteristic	Percentage of children with iron deficiency (ID)[1]	Percentage of children with anaemia[2]	Percentage of children with: ID, no anaemia	ID with anaemia (IDA)[3]	Anaemia, no ID	Neither ID nor anaemia	Number of children	Percentage of anaemia that is IDA[3]
Age in months								
6-11	42.1	79.5	6.7	35.4	44.1	13.8	701	44.6
12-23	42.1	70.5	9.2	33.0	37.5	20.4	1,461	46.8
24-35	34.8	59.9	12.0	22.8	37.1	28.1	1,358	38.0
36-47	31.8	51.9	11.4	20.4	31.5	36.7	1,502	39.2
48-59	29.0	41.8	15.3	13.8	28.0	42.9	1,375	32.9
Child's sex								
Male	36.3	61.2	10.7	25.6	35.6	28.1	3,150	41.9
Female	34.3	56.3	11.9	22.4	33.9	31.8	3,247	39.8
Residence								
Urban	41.4	61.0	13.4	28.0	33.0	25.6	1,180	45.9
Rural	33.9	58.2	10.9	23.1	35.1	31.0	5,217	39.7
Mainland/Zanzibar								
Mainland	35.3	58.4	11.4	24.0	34.5	30.2	6,226	41.0
Urban	41.3	60.6	13.5	27.9	32.7	25.9	1,123	46.0
Rural	34.0	57.9	10.9	23.1	34.8	31.1	5,103	39.9
Zanzibar	34.7	68.5	9.7	25.0	43.5	21.8	170	36.5
Unguja	43.3	68.0	12.0	31.3	36.7	20.0	102	46.0
Pemba	21.9	69.3	6.2	15.7	53.6	24.5	69	22.7
Region								
Dodoma	28.9	47.2	10.8	18.1	29.1	42.0	404	38.3
Arusha	52.1	63.6	13.5	38.6	25.0	22.9	225	60.7
Kilimanjaro	45.1	43.2	20.8	24.3	18.9	36.0	171	56.3
Tanga	36.5	52.2	16.6	19.9	32.3	31.2	274	38.2
Morogoro	31.5	59.8	9.3	22.2	37.6	30.8	259	37.1
Pwani	29.7	70.6	8.4	21.3	49.3	21.0	158	30.1
Dar es Salaam	45.3	67.8	12.5	32.8	35.0	19.6	253	48.3
Lindi	22.6	76.3	4.7	17.8	58.4	19.0	110	23.4
Mtwara	13.3	66.8	2.4	10.9	56.0	30.8	191	16.3
Ruvuma	18.6	59.4	6.2	12.4	47.0	34.4	214	20.8
Iringa	18.6	45.6	9.0	9.6	36.0	45.4	263	21.1
Mbeya	29.8	56.4	9.4	20.4	36.0	34.2	353	36.2
Singida	49.6	43.4	26.4	23.2	20.2	30.2	256	53.4
Tabora	48.7	68.3	13.0	35.7	32.6	18.7	360	52.3
Rukwa	22.1	42.1	10.8	11.3	30.8	47.1	197	26.9
Kigoma	49.7	62.5	16.8	32.9	29.6	20.7	319	52.7
Shinyanga	47.6	74.7	8.8	38.8	35.9	16.5	651	52.0
Kagera	25.2	50.0	10.0	15.2	34.8	40.0	395	30.4
Mwanza	34.2	63.0	8.5	25.7	37.3	28.5	673	40.8
Mara	24.8	47.1	7.8	16.9	30.1	45.1	330	36.0
Manyara	44.8	52.0	21.2	23.6	28.4	26.8	171	45.4
Unguja North	47.8	77.8	8.9	38.9	38.8	13.4	29	50.1
Unguja South	36.7	59.0	14.6	22.1	36.9	26.4	15	37.5
Town West	42.8	65.4	13.0	29.9	35.6	21.6	57	45.7
Pemba North	15.7	70.0	3.1	12.6	57.5	26.9	35	17.9
Pemba South	28.3	68.6	9.4	18.9	49.6	22.0	34	27.6
Mother's education								
No education	36.3	63.0	9.2	27.2	35.8	27.8	1,522	43.1
Primary incomplete	34.2	64.1	9.3	24.9	39.2	26.7	850	38.9
Primary complete	35.2	56.4	12.2	23.0	33.4	31.4	3,072	40.7
Secondary+	36.3	63.2	11.8	24.6	38.7	25.0	334	38.8
Wealth quintile								
Lowest	38.2	60.5	12.0	26.2	34.3	27.5	1,405	43.3
Second	35.3	62.3	10.0	25.3	37.1	27.6	1,501	40.6
Middle	31.1	55.5	11.3	19.8	35.8	33.1	1,473	35.6
Fourth	32.2	55.3	10.1	22.1	33.2	34.6	1,193	40.0
Highest	42.3	59.5	14.4	28.0	31.5	26.1	825	47.0
Total	35.3	58.7	11.3	24.0	34.7	30.0	6,397	40.9

[1] Iron deficiency is defined as sTfR > 8.3 μg/mL
[2] Anaemia is defined as haemoglobin < 11 g/dL
[3] IDA = Iron deficiency anaemia

assessed in order to establish appropriate control measures. The need for research into other causes of anaemia is shown by the fact that 35 percent of children have anaemia but are not iron-deficient.

Children age 6-11 and age 12-23 months have the highest prevalences of iron deficiency and anaemia, but the prevalence of both declines with age. This may indicate that when infants reach the weaning age of 6 months they may have inadequate iron stores, suggesting that they may have been iron deficient since birth. Boys are more likely than girls to have iron deficiency, anaemia, and IDA. The proportion of children with these conditions is higher in urban areas than in rural areas. Fifty percent or more of children age 6-59 months in Arusha, Singida, and Kigoma are iron deficient, compared with only 13 percent of children in Mtwara.

The proportion of children with IDA is highest in Arusha, Shinyanga, and Unguja North (39 percent), while the lowest IDA is found in Iringa (10 percent). The highest prevalence of anaemia without iron deficiency is in Lindi, Mtwara, and Pemba North (56-58 percent). Anaemia in these areas may be contributed to by other causes, such as malaria and helminth infestation. Children's iron status does not show any particular pattern relative to their mother's education status. Iron status trends by wealth quintile are interesting: the middle and fourth quintiles have the lowest rates of iron deficiency, anaemia, and IDA, while the lowest and highest quintiles have the highest rates. The percentages of children with iron deficiency, iron deficiency without anaemia, and IDA are highest in the highest wealth quintile.

Table 4.6 shows more details about levels of anaemia among children age 6-59 months, with categories broken into mild anaemia, moderate anaemia, and severe anaemia (see also NBS and ICF Macro, 2011). As mentioned previously, 59 percent of children have anaemia; however, almost half of the anaemia is mild (27 percent of children) and half is moderate. Only 2 percent of children have severe anaemia.

Table 4.6 Prevalence of anaemia in children

Percentage of children age 6-59 months classified as having anaemia as measured with HemoCue, by background characteristics, Tanzania 2010

Background characteristic	Anaemia status by haemoglobin level: Mild (10.0-10.9 g/dl)	Moderate (7.0-9.9 g/dl)	Severe (below 7.0 g/dl)	Any anaemia (11.0 g/dl)	Number of children
Age in months					
6-8	36.1	40.1	1.7	77.9	334
9-11	31.3	44.2	5.5	81.1	388
12-17	25.9	43.1	3.1	72.0	770
18-23	26.5	40.1	2.1	68.7	758
24-35	30.3	28.3	1.2	59.8	1,431
36-47	25.5	25.0	1.3	51.8	1,578
48-59	24.4	15.7	1.5	41.7	1,431
Sex					
Male	27.0	32.0	1.8	60.9	3,294
Female	27.6	26.8	1.9	56.4	3,396
Residence					
Urban	28.6	30.5	1.9	60.9	1,247
Rural	27.0	29.1	1.9	58.1	5,442
Mainland/Zanzibar					
Mainland	27.2	29.2	1.9	58.3	6,508
Urban	28.0	30.6	1.9	60.6	1,185
Rural	27.0	28.9	1.9	57.8	5,323
Zanzibar	32.2	34.9	1.4	68.5	181
Unguja	32.7	33.8	1.4	67.9	109
Pemba	31.6	36.5	1.4	69.4	72

Continued...

Table 4.6—*Continued*

Background characteristic	Anaemia status by haemoglobin level: Mild (10.0-10.9 g/dl)	Moderate (7.0-9.9 g/dl)	Severe (below 7.0 g/dl)	Any anaemia (11.0 g/dl)	Number of children
Region					
Dodoma	27.1	19.3	1.4	47.8	414
Arusha	20.6	38.3	4.1	63.1	233
Kilimanjaro	20.3	20.9	0.7	41.8	188
Tanga	25.5	25.3	2.2	53.0	288
Morogoro	26.6	27.0	5.5	59.2	272
Pwani	28.8	41.3	0.8	70.9	168
Dar es Salaam	29.9	37.5	1.6	69.1	269
Lindi	34.1	41.0	1.6	76.8	114
Mtwara	31.0	34.7	1.5	67.2	202
Ruvuma	28.5	29.9	0.4	58.9	222
Iringa	30.2	15.1	0.3	45.6	271
Mbeya	27.7	26.2	0.7	54.6	380
Singida	28.3	15.1	0.8	44.2	264
Tabora	31.6	34.3	2.9	68.9	369
Rukwa	27.0	14.3	0.3	41.7	208
Kigoma	32.4	26.6	3.4	62.3	326
Shinyanga	28.7	43.9	2.1	74.7	679
Kagera	22.6	25.6	1.1	49.2	416
Mwanza	25.8	34.2	2.8	62.8	697
Mara	23.0	23.0	1.2	47.1	349
Manyara	24.1	26.2	1.8	52.1	181
Unguja North	29.4	45.8	2.9	78.2	30
Unguja South	27.8	31.0	0.5	59.2	16
Town West	35.4	28.8	0.8	65.1	63
Pemba North	26.0	41.6	2.1	69.6	37
Pemba South	37.5	31.1	0.7	69.3	35
Mother's education[2]					
No education	30.0	31.2	2.2	63.4	576
Primary incomplete	31.0	29.0	2.1	62.1	604
Primary complete	29.4	30.0	1.6	61.0	434
Secondary+	28.3	33.9	1.8	64.0	147
Wealth quintile					
Lowest	27.2	30.6	3.1	60.9	1,453
Second	28.9	31.4	1.5	61.8	1,581
Middle	26.6	27.3	1.4	55.4	1,538
Fourth	26.9	26.7	1.7	55.3	1,243
Highest	26.6	31.1	1.7	59.4	876
Total	27.3	29.4	1.9	58.6	6,689

Note: Table is based on children who slept in the household the night before the interview. Prevalence of anaemia, based on haemoglobin levels, is adjusted for altitude using formulas in CDC, 1998. Haemoglobin is in grams per decilitre (g/dl).
[1] For women not interviewed, information is taken from the Household Questionnaire.
[2] Excludes children whose mothers are not listed in the Household Questionnaire

4.4 IRON DEFICIENCY AMONG WOMEN

Table 4.7 shows that 30 percent of women age 15-49 are iron deficient, while 41 percent have anaemia. The prevalence of iron deficiency without anaemia is 16 percent, while the prevalence of IDA with anaemia is 14 percent. Considering just the women with anaemia, 35 percent also have iron deficiency. This means that 65 percent have anaemia that is due to other causes. The contribution of other causes such as malaria and hookworm infestation needs to be assessed in order to establish appropriate anaemia control measures.

The prevalence of ID, anaemia, and their combination varies by women's characteristics. Women age 20-29 years have the highest prevalences of iron deficiency and iron deficiency with or without anaemia. Pregnant women have the highest rate of iron deficiency, and anaemia with or without ID. The proportion of women with these conditions is higher in urban areas than in rural areas. The highest rates of iron deficiency are in Tabora (50 percent), Shinyanga (46 percent), and Kigoma and Arusha (45 percent each). Regions with the lowest ID prevalence are Mtwara (7 percent) and Pemba North (10 percent). The prevalence of anaemia that is IDA is 50 percent or higher in Arusha, Tabora, Shinyanga, and Manyara. On the other hand, the highest prevalence of anaemia without iron deficiency is in Lindi and Pemba (North and South), similar to the pattern found among children. Anaemia in these areas may be contributed to by other causes such as malaria and helminth infestation.

Table 4.7 Prevalence of iron deficiency and anaemia in women

Percentage of de facto interviewed women age 15-49 by iron deficiency and anaemia status, by background characteristics, Tanzania, 2010

Background characteristic	Percentage of women with iron deficiency (ID)[1]	Percentage of women with anaemia[2]	Percentage of women with: ID, but not anaemia	ID with anaemia (IDA)[3]	Anaemia, no ID	Neither ID nor anaemia	Number of women	Percentage of anaemia that is IDA[3]
Age								
15-19	27.6	42.5	14.7	12.9	29.6	42.8	2,031	30.4
20-29	32.8	40.6	16.7	16.0	24.6	42.7	3,294	39.5
30-39	28.9	39.4	15.5	13.4	26.0	45.1	2,520	34.0
40-49	28.4	39.4	14.3	14.0	25.4	46.2	1,556	35.5
Pregnancy status								
Pregnant	32.9	53.0	12.6	20.3	32.7	34.4	916	38.3
Breastfeeding (not pregnant)	31.2	39.8	17.3	13.9	25.9	42.9	2,615	35.0
Neither	28.9	38.9	15.3	13.6	25.3	45.9	5,871	34.9
Residence								
Urban	31.3	44.0	15.7	15.6	28.5	40.3	2,608	35.3
Rural	29.4	39.2	15.5	13.9	25.3	45.3	6,794	35.4
Mainland/Zanzibar								
Mainland	29.9	39.9	15.7	14.2	25.7	44.4	9,097	35.6
Urban	31.1	43.3	15.8	15.3	28.0	40.9	2,486	35.3
Rural	29.5	38.6	15.7	13.8	24.8	45.8	6,611	35.8
Zanzibar	29.9	59.3	11.8	18.1	41.2	28.8	305	30.5
Unguja	36.7	58.0	15.2	21.5	36.5	26.8	198	37.1
Pemba	17.3	61.9	5.6	11.8	50.1	32.5	107	19.0
Region								
Dodoma	27.7	28.7	18.4	9.3	19.4	53.0	478	32.4
Arusha	45.2	33.0	26.9	18.3	14.7	40.1	375	55.5
Kilimanjaro	28.6	19.3	19.5	9.1	10.2	61.2	364	47.1
Tanga	38.6	35.5	21.4	17.2	18.2	43.2	466	48.6
Morogoro	30.3	45.3	14.4	15.9	29.4	40.3	452	35.0
Pwani	21.7	51.9	7.0	14.7	37.2	41.1	238	28.4
Dar Es Salaam	27.0	56.6	9.4	17.5	39.1	33.9	767	30.9
Lindi	16.3	55.3	6.5	9.7	45.6	38.2	189	17.6
Mtwara	6.7	39.7	2.2	4.5	35.2	58.1	386	11.3
Ruvuma	16.3	33.2	7.9	8.5	24.8	58.9	346	25.5
Iringa	15.3	28.7	9.8	5.5	23.2	61.4	461	19.3
Mbeya	22.4	32.0	14.1	8.3	23.7	53.9	559	26.0
Singida	39.9	29.0	25.9	14.1	15.0	45.1	298	48.4
Tabora	50.0	54.9	22.0	28.0	26.9	23.1	414	51.1
Rukwa	21.4	22.8	14.4	7.0	15.7	62.8	234	30.8
Kigoma	45.0	34.9	30.8	14.2	20.7	34.3	434	40.6
Shinyanga	45.6	54.1	18.0	27.5	26.6	27.8	749	50.9
Kagera	25.8	29.8	15.2	10.6	19.2	55.0	549	35.5
Mwanza	27.4	52.1	12.3	15.1	37.0	35.6	788	29.0
Mara	21.5	37.1	10.1	11.4	25.7	52.8	345	30.6
Manyara	42.0	28.6	27.8	14.3	14.3	43.6	204	49.9
Unguja North	44.4	61.8	16.4	28.0	33.8	21.8	49	45.3
Unguja South	32.8	46.9	15.6	17.1	29.7	37.5	29	36.6
Town West	34.5	59.1	14.6	19.9	39.2	26.3	120	33.7
Pemba North	9.6	64.7	1.7	8.0	56.8	33.6	51	12.3
Pemba South	24.4	59.3	9.1	15.2	44.1	31.6	56	25.7
Education								
No education	34.2	44.0	17.1	17.1	26.9	38.9	1,795	38.8
Primary incomplete	27.1	42.1	12.3	14.8	27.2	45.7	1,370	35.3
Primary complete	30.1	37.9	16.4	13.6	24.3	45.6	4,741	35.9
Secondary+	26.8	43.1	14.0	12.8	30.3	42.9	1,496	29.8
Wealth quintile								
Lowest	33.2	42.2	16.6	16.6	25.6	41.2	1,585	39.3
Second	29.6	40.4	16.2	13.4	26.9	43.5	1,838	33.2
Middle	27.3	37.7	14.0	13.2	24.5	48.2	1,863	35.1
Fourth	28.9	38.4	15.8	13.1	25.3	45.8	1,956	34.2
Highest	30.9	43.7	15.4	15.5	28.2	40.9	2,160	35.4
Total	29.9	40.5	15.6	14.3	26.2	43.9	9,402	35.4

[1] Iron deficiency is defined as sTfR > 8.3 μg/mL.
[2] Anaemia is defined as haemoglobin < 11 g/dL for pregnant women and <12 g/dL for non-pregnant women.
[3] IDA = Iron deficiency anaemia

Women's iron status is somewhat related to their education; women with no education have the highest rate of iron deficiency (34 percent) and women with some secondary or higher education have the lowest rate (27 percent), though the pattern does not decrease linearly. Women in the middle and fourth wealth quintile have the lowest rates of iron deficiency and anaemia.

Table 4.8 presents anaemia prevalence among women age 15-49, based on haemoglobin levels, obtained using the HemoCue instrument and adjusted by altitude and smoking status. Data in the table shows that 40 percent of women age 15-49 are anaemic, with one percent being severely anaemic. When compared with the 2004-05 TDHS, the prevalence of anaemia has declined by 17 percent (NBS and ORC Macro, 2005).

Pregnancy has an association with anaemia. Pregnant women are more likely to be anaemic (53 percent) than women who are breastfeeding and women who are neither pregnant nor breastfeeding (39 percent). This could be due to the high demand for iron and folate during pregnancy. Anaemia also varies by urban and rural areas; it is more prevalent in urban areas (44 percent) compared with rural areas (39 percent). The disparity between women in the Mainland and Zanzibar is large (40 and 59 percent, respectively). Education and wealth of women do not appear to have much relationship with the likelihood of having anaemia.

Table 4.8 Prevalence of anaemia in women

Percentage of women age 15-49 with anaemia as measured with HemoCue, by background characteristics, Tanzania 2010

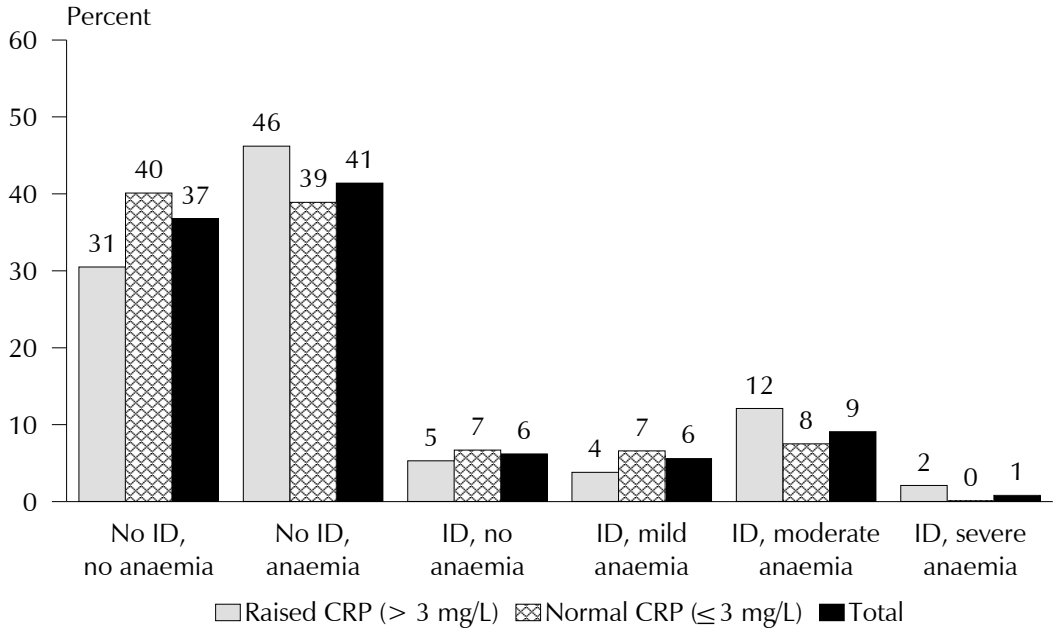
Background characteristic	Anaemia status by haemoglobin level: Mild anaemia	Moderate anaemia	Severe anaemia	Any anaemia	Number of women
Age					
15-19	32.1	9.4	0.7	42.2	2,127
20-29	27.9	11.7	0.9	40.4	3,463
30-39	27.8	9.5	1.5	38.8	2,640
40-49	29.4	8.6	0.9	38.9	1,646
Number of children ever born					
0	30.1	10.6	0.8	41.4	2,470
1	30.4	12.2	0.7	43.3	1,352
2-3	26.0	10.4	1.2	37.6	2,551
4-5	29.2	9.1	1.5	39.7	1,744
6+	30.5	8.3	0.9	39.7	1,758
Maternity status					
Pregnant	23.2	27.7	1.8	52.7	958
Breastfeeding	30.9	7.4	1.0	39.2	2,752
Neither	29.1	8.5	0.9	38.6	6,166
Residence					
Urban	30.2	12.3	0.9	43.5	2,758
Rural	28.5	9.2	1.0	38.8	7,118
Mainland/Zanzibar					
Mainland	28.6	9.9	1.0	39.5	9,553
Urban	29.8	12.1	0.9	42.8	2,625
Rural	28.1	9.1	1.0	38.2	6,928
Zanzibar	42.3	14.3	2.1	58.7	322
Unguja	41.0	14.2	2.1	57.3	210
Pemba	44.8	14.5	2.0	61.3	112
Region					
Dodoma	21.4	6.8	0.6	28.8	493
Arusha	22.4	7.3	3.0	32.7	382
Kilimanjaro	11.7	5.2	1.0	17.9	406
Tanga	22.4	11.7	1.1	35.2	484
Morogoro	34.8	10.2	0.0	45.0	472
Pwani	33.9	15.1	2.0	51.0	253
Dar es Salaam	37.8	17.9	0.5	56.2	787
Lindi	41.4	13.5	0.7	55.6	196
Mtwara	29.2	8.2	1.5	39.0	406
Ruvuma	26.2	6.9	0.0	33.1	350
Iringa	23.7	4.2	0.5	28.3	473
Mbeya	26.5	4.6	0.9	32.1	594
Singida	21.3	6.5	1.5	29.3	312
Tabora	36.5	17.7	0.5	54.7	440
Rukwa	13.7	6.3	1.7	21.7	249
Kigoma	28.1	6.4	0.4	34.8	442
Shinyanga	36.8	15.8	1.3	53.9	802
Kagera	21.5	6.3	1.1	28.9	582
Mwanza	39.1	11.9	0.9	51.9	839
Mara	26.8	8.0	1.3	36.1	374
Manyara	18.0	7.6	1.5	27.1	217
Unguja North	45.0	15.7	1.5	62.2	50
Unguja South	35.9	9.4	1.3	46.5	30
Town West	40.7	14.7	2.5	58.0	130
Pemba North	46.1	15.4	2.7	64.2	54
Pemba South	43.5	13.7	1.4	58.6	58
Education					
No education	29.4	12.8	1.5	43.7	1,891
Primary incomplete	31.8	9.2	0.9	41.9	1,456
Primary complete	27.2	9.3	0.9	37.4	4,959
Secondary+	31.8	10.0	0.8	42.6	1,570
Wealth quintile					
Lowest	31.1	9.5	1.5	42.0	1,652
Second	29.7	9.2	1.1	40.1	1,917
Middle	27.3	9.6	0.8	37.7	1,960
Fourth	27.5	9.5	0.7	37.7	2,062
Highest	29.8	12.1	1.1	43.0	2,284
Total	29.0	10.1	1.0	40.1	9,875

Note: Prevalence is adjusted for altitude and for smoking status if known using formulas in CDC, 1998.
Figures in parentheses are based on 25-49 unweighted cases.

4.5 Anaemia and Infection

Infection is known to modulate iron status and anaemia. Chronic infection causes anaemia of chronic disease (ACD), a condition in which iron is present in the bone marrow but is not readily available for the production of new red blood cells. Iron status and anaemia were assessed in the sub-sample of children and women who were also tested for C-reactive protein (CRP) for infection/inflammation status in order to determine the contribution of infection to anaemia. The results of this analysis in children are presented in Figure 4.1. Children with normal CRP are more likely than children with raised CRP to have neither iron deficiency nor anaemia (40 percent compared with 31 percent). On the other hand, children with raised CRP are more likely than children with normal CRP to have anaemia without iron deficiency (46 percent compared with 39 percent). Children with raised CRP are also more likely than children with normal CRP to have iron deficiency anaemia, especially mild and severe anaemia. Taken together, these results suggest that infection also contributes to anaemia in children.

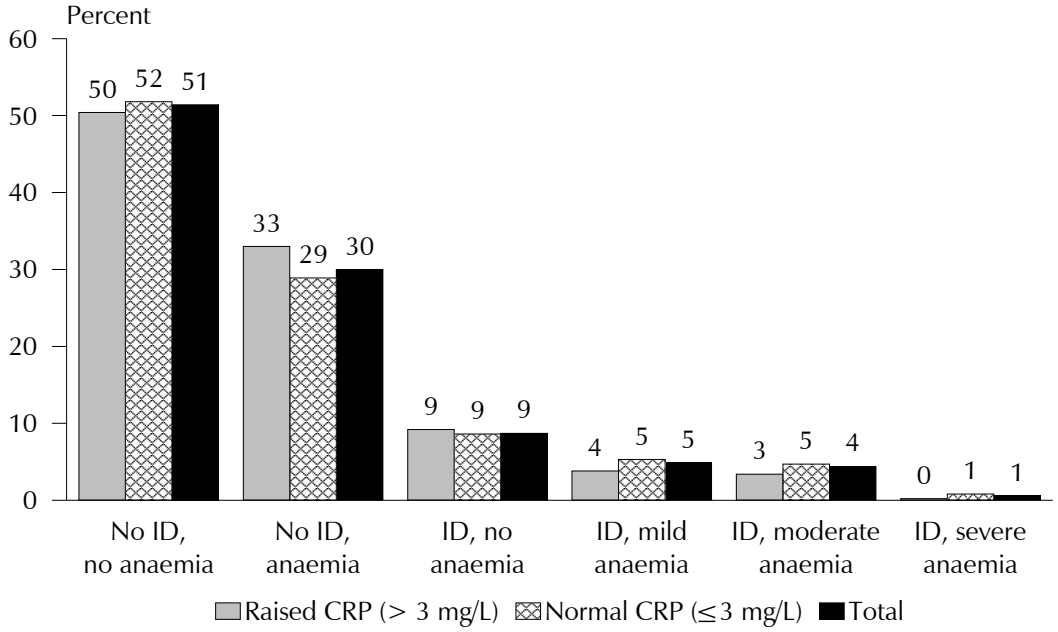
Figure 4.1 Infection and Anaemia in Children



Tanzania 2010

While the patterns seen in children are not as distinctive in women, there is some indication of an association between infection and anaemia (Figure 4.2). Women with normal CRP are slightly more likely than women with raised CRP to have neither iron deficiency nor anaemia (52 percent and 50 percent, respectively). Women with raised CRP are more likely than women with normal CRP to have anaemia without iron deficiency (33 percent compared with 29 percent).

Figure 4.2 Infection and Anaemia in Women



Tanzania 2010

IODINE STATUS 5

5.1 IODINE CONTENT IN HOUSEHOLD SALT

As shown in Table 5.1 and reported in the main report for the 2010 TDHS (NBS and ICF Macro, 2011), 94 percent of the households interviewed provided a teaspoon of salt for the rapid test. Of those, 59 percent of households were using salt that was adequately iodised (15+ ppm), while 23 percent were using salt that was not adequately iodised (<15 ppm) and 18 percent were using salt with no iodine. Use of adequately iodised salt is much higher in urban than rural households (81 and 51 percent, respectively). Iodised salt is more common in Mainland than in Zanzibar (59 compared with 49 percent). In Mainland, use of iodised salt ranges from 90 percent or higher in Arusha, Dar es Salaam, and Mara to 6 percent in Lindi. It also increases dramatically with household wealth, from 41 percent of households in the lowest wealth quintile to 86 percent of those in the highest quintile.

Table 5.1 Presence of iodised salt in household

Among all households, percentage of households tested for iodine content and percentage of households with no salt; and among households with salt tested, the percent distribution by level of iodine in salt (parts per million or ppm), according to background characteristics, Tanzania 2010

Background characteristic	Among all households, the percentage		Number of households	Among households with tested salt, the percent distribution by iodine content of salt			Total	Number of households
	With salt tested	With no salt		None (0 ppm)	Inadequate (<15 ppm)	Adequate (15+ ppm)		
Residence								
Urban	92.2	7.8	2,507	6.7	12.8	80.5	100.0	2,312
Rural	95.2	4.8	7,116	22.2	26.8	50.9	100.0	6,775
Mainland/Zanzibar								
Mainland	94.5	5.5	9,377	18.0	23.3	58.7	100.0	8,858
Urban	92.1	7.9	2,417	6.6	12.7	80.8	100.0	2,227
Rural	95.3	4.7	6,959	21.8	26.9	51.3	100.0	6,631
Zanzibar	92.7	7.3	246	29.7	21.0	49.3	100.0	228
Unguja	92.3	7.7	157	14.5	21.8	63.7	100.0	145
Pemba	93.4	6.6	89	56.4	19.5	24.1	100.0	83
Region								
Dodoma	98.3	1.7	580	15.1	51.1	33.8	100.0	570
Arusha	90.5	9.5	411	0.2	2.7	97.0	100.0	372
Kilimanjaro	97.3	2.7	460	11.4	14.8	73.8	100.0	448
Tanga	94.6	5.4	551	21.1	42.7	36.2	100.0	521
Morogoro	93.5	6.5	499	7.8	19.4	72.8	100.0	466
Pwani	84.8	15.2	269	17.0	6.8	76.2	100.0	229
Dar es Salaam	88.4	11.6	730	1.3	5.8	92.9	100.0	645
Lindi	95.2	4.8	219	70.8	23.4	5.8	100.0	208
Mtwara	95.9	4.1	425	42.0	40.1	18.0	100.0	408
Ruvuma	96.2	3.8	361	39.2	35.2	25.6	100.0	347
Iringa	95.2	4.8	498	20.4	23.0	56.7	100.0	474
Mbeya	94.4	5.6	591	15.1	26.3	58.6	100.0	558
Singida	98.4	1.6	302	45.6	28.5	25.9	100.0	297
Tabora	94.5	5.5	365	7.5	34.0	58.5	100.0	345
Rukwa	97.2	2.8	278	13.9	30.1	56.0	100.0	271
Kigoma	93.4	6.6	417	10.6	13.7	75.6	100.0	389
Shinyanga	95.3	4.7	607	31.0	20.9	48.1	100.0	579
Kagera	95.3	4.7	556	12.3	21.0	66.7	100.0	530
Mwanza	96.6	3.4	699	8.0	23.2	68.9	100.0	675
Mara	96.0	4.0	326	0.5	1.9	97.6	100.0	313
Manyara	91.7	8.3	233	39.8	5.7	54.5	100.0	213
Unguja North	87.7	12.3	41	33.5	27.0	39.5	100.0	36
Unguja South	94.3	5.7	27	18.3	28.0	53.7	100.0	26
Town West	93.9	6.1	89	5.3	17.7	77.0	100.0	84
Pemba North	93.0	7.0	45	78.0	9.5	12.5	100.0	42
Pemba South	93.9	6.1	44	34.1	29.8	36.1	100.0	41
Wealth quintile								
Lowest	94.3	5.7	1,931	30.3	28.8	40.9	100.0	1,821
Second	94.3	5.7	1,917	23.7	28.7	47.6	100.0	1,808
Middle	95.7	4.3	1,946	20.3	26.2	53.5	100.0	1,862
Fourth	94.3	5.7	1,911	12.5	22.6	64.9	100.0	1,803
Highest	93.4	6.6	1,918	4.2	9.9	85.9	100.0	1,792
Total	94.4	5.6	9,623	18.3	23.3	58.5	100.0	9,087

In the subsample of households eligible to provide salt for laboratory testing, more than 3,000 households provided the larger salt samples for titration in the laboratory to determine the actual iodine content in salt consumed by household members (Table 5.2). For 94 percent of these households, the salt samples were successfully tested, 4 percent of households had no salt, and 1 percent had missing information. Small variations in salt testing coverage were found across residence and regions. Whereas Dodoma and Rukwa had complete coverage, 85 percent or less of salt samples from Pwani, Kigoma and Manyara were tested.

Table 5.2 Coverage of laboratory salt testing

Percent distribution of households eligible to provide salt for laboratory testing by salt testing status, according to residence and region (unweighted), Tanzania 2010

Background characteristic	Salt tested	No salt in household	Other/ missing	Total	Number
Residence					
Urban	93.7	4.3	2.0	100.0	698
Rural	94.5	4.4	1.1	100.0	2,346
Mainland/Zanzibar					
Mainland	94.3	4.3	1.4	100.0	2,446
Urban	92.8	4.8	2.4	100.0	544
Rural	94.7	4.2	1.2	100.0	1,902
Zanzibar	94.6	4.7	0.7	100.0	598
Unguja	93.9	5.5	0.6	100.0	363
Pemba	95.7	3.4	0.9	100.0	235
Region					
Dodoma	100.0	0.0	0.0	100.0	119
Arusha	94.9	5.1	0.0	100.0	117
Kilimanjaro	99.2	0.0	0.8	100.0	118
Tanga	98.3	0.0	1.7	100.0	119
Morogoro	91.7	6.7	1.7	100.0	120
Pwani	81.7	15.6	2.8	100.0	109
Dar es Salaam	90.1	7.4	2.5	100.0	121
Lindi	95.5	4.5	0.0	100.0	110
Mtwara	95.5	3.6	0.9	100.0	111
Ruvuma	99.2	0.8	0.0	100.0	120
Iringa	97.3	2.7	0.0	100.0	110
Mbeya	93.4	0.8	5.8	100.0	121
Singida	97.5	0.0	2.5	100.0	121
Tabora	95.9	3.3	0.8	100.0	123
Rukwa	100.0	0.0	0.0	100.0	121
Kigoma	82.1	11.6	6.3	100.0	112
Shinyanga	93.3	5.9	0.8	100.0	119
Kagera	92.7	4.5	2.7	100.0	110
Mwanza	98.4	1.6	0.0	100.0	123
Mara	96.5	3.5	0.0	100.0	115
Manyara	84.1	15.0	0.9	100.0	107
Unguja North	93.4	6.6	0.0	100.0	122
Unguja South	95.0	4.2	0.8	100.0	119
Town West	93.4	5.7	0.8	100.0	122
Pemba North	94.9	4.3	0.9	100.0	117
Pemba South	96.6	2.5	0.8	100.0	118
Total	94.3	4.4	1.3	100.0	3,044

Table 5.3 shows results from two different tests for the same households—the first done in the household using a teaspoon of salt with a rapid test kit and the other done in the laboratory. According to the rapid test conducted at the household, 17 percent of the households in the laboratory subsample used salt that did not contain iodine, 23 percent used salt with inadequate iodine content, and 60 percent used salt with iodine levels required for optimal iodine nutrition, i.e., at least 15 parts of iodine per million parts of salt. These results for the subsample of households are very similar to those for the entire sample of households shown in Table 5.1.

Laboratory testing indicates generally lower levels of adequately iodised salt than the rapid test yields. For example, the laboratory test results of the salt samples demonstrate that only 47 percent of the household salt samples have an iodine content of 15 ppm or higher, compared with 60 percent based on the rapid test for the same subsample of households. The laboratory testing shows that the overall median iodine content in salt samples is 14 ppm, ranging from less than 4 ppm in Ruvuma to 58 ppm in Dar es Salaam. Rural households have salt with a lower median iodine content than urban households (10 ppm compared with 38 ppm). The median iodine content of salt consumed by households in Mainland is higher than that of salt consumed in the Zanzibar Islands—15 ppm vs. 5

ppm. Based on these findings, Tanzania has a long way to go to achieve the WHO recommended coverage of at least 90 percent of households using adequately iodised salt.

Although the lab test results show the same pattern as the rapid test results, there are wide variations with regard to the difference between the two test results, with no clear pattern. For example, the rapid test result for urban households with adequately iodised salt is 7 percent higher than the laboratory test, but the rapid test result for rural households is 16 percent higher than the laboratory test. For Dodoma, the rapid test result is 14 percent higher than the laboratory test, while for Tanga the rapid test result is 17 percent lower than the laboratory test.

The laboratory test results show that 32 percent of households use salt that has an iodine content of less than 10 ppm and 11 percent use salt that has 10 to 15 ppm. The contribution of these households cannot be neglected in the analysis of iodine consumption, because the amount of iodine consumed depends on the frequency of salt intake directly or indirectly with other salt-treated foods. The manufacture of salt-treated foods is now a growing industry in Tanzania.

According to the laboratory tests, 94 percent of households in Dar es Salaam used adequately iodised salt. On the other hand, Singida has the highest proportion of households that used salt with no iodine (42 percent).

Table 5.3 Household iodine levels

Percent distribution of households by iodine level in salt samples by rapid test and by titration methods, and the median salt iodine content according to laboratory results, by background characteristics, Tanzania 2010

	Rapid testing of salt				Laboratory testing of salt						
	Distribution of households by iodine level in salt				Distribution of households by iodine level in salt						
						Inadequate					
Background characteristic	None (0 ppm)	Inadequate (<15 ppm)	Adequate (15+ ppm)	Total	None (0 ppm)	(<10 ppm)	(10-15 ppm)	Adequate (15+ ppm)	Total	Median salt iodine content (ppm)	Number of households
Residence											
Urban	5.3	14.0	80.7	100.0	2.8	15.0	8.7	73.5	100.0	37.6	745
Rural	20.8	25.9	53.3	100.0	12.9	37.3	12.3	37.5	100.0	9.5	2,139
Mainland/Zanzibar											
Mainland	16.4	22.9	60.7	100.0	10.0	31.1	11.4	47.4	100.0	14.6	2,811
Urban	5.0	13.9	81.2	100.0	2.5	14.2	8.5	74.8	100.0	38.8	718
Rural	20.4	25.9	53.7	100.0	12.6	37.0	12.4	38.0	100.0	11.1	2,093
Zanzibar	29.8	21.7	48.5	100.0	20.2	46.4	9.9	23.5	100.0	4.9	73
Unguja	16.1	21.5	62.4	100.0	16.1	43.6	10.5	29.9	100.0	7.2	46
Pemba	53.5	22.0	24.5	100.0	27.3	51.2	9.1	12.4	100.0	4.5	27
Region											
Dodoma	13.0	47.7	39.3	100.0	15.5	47.6	11.4	25.5	100.0	7.1	182
Arusha	0.7	4.3	95.0	100.0	0.7	3.2	10.0	86.0	100.0	51.4	124
Kilimanjaro	10.6	14.2	75.2	100.0	0.0	16.0	8.5	75.5	100.0	25.7	144
Tanga	25.9	47.0	27.1	100.0	3.1	30.2	22.1	44.5	100.0	14.3	176
Morogoro	9.4	19.1	71.6	100.0	7.1	33.5	9.5	49.8	100.0	14.8	151
Pwani	7.7	7.7	84.6	100.0	9.0	19.1	2.9	69.0	100.0	28.6	69
Dar es Salaam	0.0	8.9	91.1	100.0	0.0	2.2	4.0	93.8	100.0	57.8	211
Lindi	73.2	21.8	5.0	100.0	19.0	62.3	8.9	9.7	100.0	4.7	65
Mtwara	44.3	32.3	23.4	100.0	7.2	70.5	7.6	14.7	100.0	4.8	125
Ruvuma	35.5	36.6	27.9	100.0	14.7	66.8	5.4	13.2	100.0	3.8	114
Iringa	20.0	18.3	61.6	100.0	12.3	25.8	3.1	58.8	100.0	32.6	146
Mbeya	12.2	26.4	61.4	100.0	2.5	19.3	16.2	62.0	100.0	21.8	176
Singida	41.1	30.5	28.4	100.0	41.8	25.2	6.9	26.1	100.0	4.7	93
Tabora	3.8	28.6	67.6	100.0	9.6	43.5	20.8	26.1	100.0	7.9	110
Rukwa	17.1	19.6	63.4	100.0	4.7	36.9	13.3	45.1	100.0	13.8	92
Kigoma	6.4	13.6	80.1	100.0	1.5	29.2	24.7	44.5	100.0	14.4	116
Shinyanga	27.1	16.1	56.8	100.0	19.1	50.6	10.1	20.1	100.0	7.0	180
Kagera	11.9	19.0	69.2	100.0	7.6	34.6	15.2	42.6	100.0	11.9	158
Mwanza	3.9	31.0	65.2	100.0	23.2	29.5	11.6	35.7	100.0	7.9	223
Mara	0.0	0.8	99.2	100.0	0.9	6.6	10.3	82.3	100.0	30.3	97
Manyara	37.1	4.9	58.0	100.0	27.0	11.6	13.3	48.1	100.0	14.8	59
Unguja North	32.5	25.5	42.0	100.0	20.0	54.8	14.6	10.6	100.0	4.8	12
Unguja South	14.7	26.2	59.1	100.0	22.8	45.6	6.9	24.7	100.0	6.0	8
Town West	9.2	18.2	72.6	100.0	12.3	38.0	9.7	40.1	100.0	8.8	26
Pemba North	72.8	14.3	12.9	100.0	30.3	59.2	2.4	8.1	100.0	4.3	13
Pemba South	34.3	29.6	36.1	100.0	24.4	43.2	15.7	16.7	100.0	4.9	13
Wealth quintile											
Lowest	28.5	27.4	44.0	100.0	16.8	44.4	13.8	24.9	100.0	7.2	576
Second	22.4	30.2	47.4	100.0	15.4	40.0	13.3	31.3	100.0	7.7	572
Middle	19.1	21.3	59.6	100.0	10.1	36.8	12.3	40.8	100.0	11.5	560
Fourth	11.0	24.1	64.9	100.0	8.1	26.2	8.5	57.1	100.0	21.4	579
Highest	3.6	11.5	84.9	100.0	1.4	11.1	9.0	78.5	100.0	40.7	597
Total	16.8	22.8	60.4	100.0	10.3	31.5	11.3	46.8	100.0	14.4	2,884

5.2 URINARY IODINE CONCENTRATION AMONG WOMEN

Table 5.4 shows the response rates for the urine testing of women. Of the 10,522 women age 15-49 who were eligible for urine testing, 94 percent gave urine samples, 2 percent refused to provide a sample, and 4 percent were either not interviewed, absent when the team visited the household for blood collection, or not tested for some other reason. Refusal rates were highest among women in Dar es Salaam (6 percent) and Kigoma (5 percent). The lowest refusal rates were found in Ruvuma, Mara and Unguja South.

Table 5.4 Coverage of urine testing for women

Percent distribution of women age 15-49 eligible for urine testing by interview and testing status, according to residence and region (unweighted), Tanzania, 2010

Background characteristic	Interviewed: Tested for urine	Interviewed: Refused to provide urine	Interviewed: Other/missing	Not interviewed	Total	Number
Residence						
Urban	92.8	2.6	0.6	3.9	100.0	2,700
Rural	94.8	1.3	0.4	3.5	100.0	7,822
Mainland/Zanzibar						
Mainland	93.8	1.8	0.5	3.8	100.0	8,055
Urban	91.9	3.2	0.7	4.3	100.0	1,967
Rural	94.4	1.4	0.5	3.7	100.0	6,088
Zanzibar	95.9	1.0	0.3	2.8	100.0	2,467
Unguja	97.7	0.4	0.0	1.9	100.0	1,485
Pemba	93.1	1.8	0.7	4.4	100.0	982
Region						
Dodoma	98.1	0.3	0.0	1.5	100.0	324
Arusha	94.3	3.3	0.0	2.5	100.0	368
Kilimanjaro	96.2	1.2	0.3	2.4	100.0	338
Tanga	94.4	2.4	0.0	3.3	100.0	340
Morogoro	94.0	1.1	0.3	4.6	100.0	351
Pwani	91.1	2.1	0.9	5.8	100.0	327
Dar es Salaam	89.6	5.6	0.9	3.9	100.0	462
Lindi	93.3	0.6	0.0	6.0	100.0	313
Mtwara	95.2	0.6	0.6	3.7	100.0	351
Ruvuma	95.9	0.0	0.0	4.1	100.0	370
Iringa	92.6	2.2	0.3	5.0	100.0	363
Mbeya	86.6	2.6	1.6	9.2	100.0	380
Singida	96.0	1.0	0.2	2.7	100.0	401
Tabora	93.5	2.4	0.8	3.2	100.0	493
Rukwa	91.1	2.7	0.6	5.7	100.0	338
Kigoma	86.6	4.6	2.1	6.7	100.0	389
Shinyanga	96.2	1.1	0.8	1.9	100.0	525
Kagera	93.4	1.6	0.8	4.2	100.0	377
Mwanza	96.9	0.4	0.4	2.3	100.0	482
Mara	96.1	0.2	0.0	3.7	100.0	433
Manyara	98.8	0.9	0.0	0.3	100.0	330
Unguja North	97.1	0.4	0.0	2.4	100.0	487
Unguja South	98.6	0.2	0.0	1.1	100.0	422
Town West	97.6	0.5	0.0	1.9	100.0	576
Pemba North	94.7	1.7	1.1	2.5	100.0	470
Pemba South	91.6	2.0	0.4	6.1	100.0	512
Total	94.3	1.6	0.5	3.6	100.0	10,522

Table 5.5 presents the unweighted and weighted numbers of women whose urine samples were tested for iodine. Almost 10,000 women provided urine samples. The percent distribution of women in each group is similar to that of women tested for vitamin A (Table 4.4).

Table 5.5 Background characteristics of women tested for urine

Percent distribution of de facto interviewed women age 15-49 in the whole sample for whom urine analysis was done, by background characteristics, Tanzania 2010

Background characteristic	Weighted percent	Weighted number	Unweighted number
Age			
15-19	21.6	2,127	2,181
20-29	35.1	3,465	3,389
30-39	26.7	2,631	2,578
40-49	16.6	1,638	1,773
Pregnancy status			
Pregnant	9.7	957	933
Breastfeeding	27.9	2,752	2,688
Neither	62.4	6,153	6,300
Residence			
Urban	27.9	2,754	2,506
Rural	72.1	7,108	7,415
Mainland/Zanzibar			
Mainland	96.7	9,539	7,556
Urban	26.6	2,621	1,808
Rural	70.2	6,919	5,748
Zanzibar	3.3	322	2,365
Unguja	2.1	211	1,451
Pemba	1.1	112	914
Region			
Dodoma	5.0	493	318
Arusha	3.9	383	347
Kilimanjaro	4.1	406	325
Tanga	4.9	485	321
Morogoro	4.8	474	330
Pwani	2.6	252	298
Dar es Salaam	8.1	801	414
Lindi	2.0	196	292
Mtwara	4.1	402	334
Ruvuma	3.5	350	355
Iringa	4.9	478	336
Mbeya	6.0	591	329
Singida	3.2	313	385
Tabora	4.4	433	461
Rukwa	2.5	248	308
Kigoma	4.3	428	337
Shinyanga	8.1	800	505
Kagera	5.8	575	352
Mwanza	8.5	837	467
Mara	3.8	375	416
Manyara	2.2	218	326
Unguja North	0.5	50	473
Unguja South	0.3	30	416
Town West	1.3	130	562
Pemba North	0.5	54	445
Pemba South	0.6	57	469
Education			
No education	19.1	1,888	1,862
Primary incomplete	14.8	1,456	1,501
Primary complete	50.1	4,938	4,252
Secondary+	16.0	1,579	2,306
Wealth quintile			
Lowest	16.7	1,651	1,577
Second	19.3	1,903	1,849
Middle	19.9	1,962	1,880
Fourth	20.8	2,054	2,252
Highest	23.2	2,291	2,363
Total	100.0	9,862	9,921

According to Table 5.6, 36 percent of women have urinary iodine concentrations below 100 µg/L, 13 percent have a concentration between 100 and 150 µg/L, 22 percent have the optimal level of iodine concentration (150 to 300 µg/L), and 30 percent have an excess of iodine concentration (higher than 300 µg/L). The overall median urinary iodine concentration (UIC) is 160 µg/L. The concentration declines with increasing age, from 180 µg/L among women age 15-19 to 147 µg/L among women age 40-49.

Median UIC among non-pregnant and non-breastfeeding women is 194 µg/L, which represents adequate iodine intake for a general population. UIC among pregnant women is 136 µg/L, which is lower than the WHO recommended range of 150-249 µg/L for pregnant women. The median UIC among breastfeeding mothers is 113 µg/L, which is toward the lower limit of the recommended iodine level of 100 µg/L for breastfeeding women (WHO, 2007).

The most remarkable variation, however, is by urban-rural residence. The median UIC for women who live in urban areas is more than twice as high as that of women in rural areas (375 compared with 118 µg/L). Whereas the median UIC in Zanzibar is only slightly higher than that in Mainland (180 versus 159 µg/L), iodine concentration across regions in Mainland vary widely, ranging from below 100 µg/L in Lindi, Mtwara, Ruvuma, Shinyanga, and Kagera to 360 µg/L in Morogoro. Out of 26 regions in Tanzania, 13 have median UICs below the WHO cut off level of 150 µg/L (WHO, 2007). Regions with median UIC below 100 µg/L include Lindi, Mtwara, Ruvuma, Rukwa, Shinyanga, and Kagera.

Table 5.6 Urinary iodine concentration in women

Median iodine concentration and percent distribution of women age 15-49 by urinary iodine concentration (UIC), by background characteristics, Tanzania 2010

		Distribution of women by urinary iodine concentration					
Background characteristic	Median iodine concentration	<100 µg/L	100 to <150 µg/L	150 to 300 µg/L (optimal)	>300 µg/L (excess)	Total	Number of women
Age							
15-19	180.4	30.7	12.5	22.8	34.0	100.0	2,127
20-29	161.5	36.3	11.9	22.0	29.8	100.0	3,465
30-39	148.2	36.6	13.7	20.3	29.4	100.0	2,631
40-49	146.9	38.5	11.9	21.7	27.9	100.0	1,638
Pregnancy status							
Pregnant	136.0	38.8	16.0	23.6	21.6	100.0	957
Breastfeeding	113.3	45.2	14.7	19.9	20.2	100.0	2,752
Neither	193.6	30.7	11.0	22.2	36.1	100.0	6,153
Residence							
Urban	374.5	12.2	8.1	21.8	57.8	100.0	2,754
Rural	117.6	44.6	14.2	21.6	19.6	100.0	7,108
Mainland/Zanzibar							
Mainland	158.7	35.9	12.4	21.3	30.4	100.0	9,539
Urban	386.1	11.9	7.9	21.3	58.9	100.0	2,621
Rural	115.9	45.0	14.1	21.3	19.6	100.0	6,919
Zanzibar	180.2	24.7	16.1	32.6	26.7	100.0	322
Unguja	209.9	18.1	14.5	36.0	31.4	100.0	211
Pemba	134.1	37.0	19.0	26.1	17.9	100.0	112
Region							
Dodoma	106.2	48.9	12.1	23.1	15.9	100.0	493
Arusha	289.6	14.2	10.1	28.4	47.3	100.0	383
Kilimanjaro	214.9	19.8	13.8	33.6	32.8	100.0	406
Tanga	277.1	14.2	14.3	25.4	46.2	100.0	485
Morogoro	359.9	16.1	10.2	16.4	57.3	100.0	474
Pwani	307.9	15.6	11.9	19.6	53.0	100.0	252
Dar es Salaam	153.2)	1.5	0.4	8.1	90.0	100.0	801
Lindi	92.6	53.2	11.8	17.7	17.3	100.0	196
Mtwara	57.7	71.8	12.5	8.9	6.8	100.0	402
Ruvuma	45.4	78.0	8.9	9.2	3.9	100.0	350
Iringa	173.8	37.5	8.8	22.9	30.7	100.0	478
Mbeya	241.1	24.3	11.5	21.5	42.7	100.0	591
Singida	121.7	43.5	13.5	18.9	24.1	100.0	313
Tabora	108.3	47.4	16.7	20.9	15.0	100.0	433
Rukwa	71.4	59.9	12.8	16.7	10.7	100.0	248
Kigoma	129.5	40.6	15.9	30.8	12.7	100.0	428
Shinyanga	94.0	52.2	16.4	20.9	10.5	100.0	800
Kagera	77.7	57.3	11.5	21.3	9.9	100.0	575
Mwanza	135.6	36.3	17.9	26.7	19.2	100.0	837
Mara	203.2	21.4	15.4	35.8	27.4	100.0	375
Manyara	147.2	31.9	19.8	22.8	25.4	100.0	218
Unguja North	161.0	26.4	20.1	36.9	16.6	100.0	50
Unguja South	228.1	13.5	13.4	38.3	34.9	100.0	30
Town West	226.7	16.0	12.6	35.1	36.3	100.0	130
Pemba North	100.3	50.5	18.9	19.3	11.3	100.0	54
Pemba South	166.1	24.3	19.1	32.4	24.2	100.0	57

Continued...

Table 5.6—*Continued*

Background characteristic	Median iodine concentration	Distribution of women by urinary iodine concentration					Number of women
		<100 µg/L	100 to <150 µg/L	150 to 300 µg/L (optimal)	>300 µg/L (excess)	Total	
Education							
No education	106.5	47.7	14.2	19.5	18.6	100.0	1,888
Primary incomplete	125.0	42.7	13.2	21.3	22.8	100.0	1,456
Primary complete	165.8	34.4	12.7	21.9	30.9	100.0	4,938
Secondary+	295.3	18.0	9.2	23.9	48.9	100.0	1,579
Wealth quintile							
Lowest	97.0	51.3	15.8	18.7	14.2	100.0	1,651
Second	102.7	49.4	14.7	20.0	15.9	100.0	1,903
Middle	116.6	43.4	15.4	21.4	19.8	100.0	1,962
Fourth	183.9	31.3	11.8	24.6	32.2	100.0	2,054
Highest	404.6	9.7	6.5	22.8	60.9	100.0	2,291
Total	160.0	35.5	12.5	21.7	30.3	100.0	9,862

HOUSEHOLD CONSUMPTION OF MAIZE FLOUR AND OIL

6

In Tanzania, the fortification of staple foods as a strategy to address micronutrient deficiencies is yet to be implemented on a wide scale. Food fortification is an innovative approach to delivery of micronutrients such as vitamin A and iron to at-risk population groups on a sustainable basis. Food fortification programmes in Tanzania are initially aimed to fortify staple foods, such as maize flour, wheat flour, and edible oil, by targeting the industries that produce these foods on a large-scale basis. Subsequent programmes are aimed at piloting fortification of rural producers, such as at hammer mills and medium-scale industries.

Establishing the consumption pattern of staple foods is one of the key activities that guides how much of the micronutrient should be added to the foods to meet the recommended dietary allowances post-production. Thus, to collect the required information on food consumption patterns of staple foods in Tanzania, the TDHS included questions on the consumption patterns of maize flour, wheat flour, and edible oils.

6.1 MAIZE FLOUR

Table 6.1 shows that 85 percent of households in Tanzania used maize flour to prepare ugali in the seven days preceding the survey. The use of maize flour is more common in Mainland than in Zanzibar (86 compared with 51 percent). Urban households are more likely than rural households to cook maize flour. There is considerable regional variation in the use of maize flour. Wealthier households are more likely to have consumed ugali in the previous week than poorer households (92 and 77 percent, respectively).

A majority of households that consumed maize flour in the previous week had the maize ground at a mill (69 percent), and three in ten households bought the flour. Urban households are much more likely than rural households to purchase flour (58 and 18 percent, respectively); four out of five rural households grind maize at the maize mill. In Zanzibar, where consumption of maize is far lower than on the Mainland, almost all households that used maize in the previous week bought the flour (98 percent). Regionally, the proportion of households that purchase maize flour varies from 3 percent in Tabora and Manyara to 95 percent of households in Dar es Salaam and 97 percent or more of households in all five regions in Zanzibar. As might be expected, the proportion of households that purchase maize flour increases steadily with wealth.

Table 6.1 Type of maize flour

Percentage of households that prepared ugali with maize flour in the past seven days, and among these households, percent distribution by type of maize flour, according to background characteristics, Tanzania 2010

Characteristic	Percentage of households that prepared ugali in the past 7 days	Number of households	Type of maize flour: Ground own maize at home	Ground at maize mill	Bought flour	Other	Missing	Total	Number of households
Residence									
Urban	90.5	2,507	0.5	40.7	58.3	0.3	0.3	100.0	2,268
Rural	83.2	7,116	0.5	80.5	18.1	0.8	0.1	100.0	5,918
Mainland/Zanzibar									
Mainland	86.0	9,377	0.5	70.5	28.2	0.7	0.1	100.0	8,062
Urban	91.8	2,417	0.5	41.6	57.4	0.3	0.3	100.0	2,220
Rural	83.9	6,959	0.5	81.5	17.1	0.8	0.1	100.0	5,842
Zanzibar	50.5	246	0.5	0.7	98.3	0.4	0.0	100.0	124
Unguja	63.8	157	0.5	0.7	98.3	0.4	0.0	100.0	101
Pemba	26.8	89	0.5	0.4	98.5	0.6	0.0	100.0	24
Region									
Dodoma	73.1	580	0.3	94.8	4.4	0.5	0.0	100.0	424
Arusha	95.1	411	0.0	64.0	35.7	0.3	0.0	100.0	391
Kilimanjaro	98.4	460	0.0	86.1	13.9	0.0	0.0	100.0	453
Tanga	96.1	551	1.1	46.2	52.0	0.0	0.7	100.0	530
Morogoro	98.7	499	0.9	50.1	47.5	1.1	0.4	100.0	492
Pwani	94.7	269	0.3	21.1	77.5	1.1	0.0	100.0	255
Dar es Salaam	88.8	730	0.5	4.5	94.6	0.3	0.2	100.0	649
Lindi	80.8	219	1.7	25.5	67.6	5.2	0.0	100.0	177
Mtwara	87.5	425	1.5	59.1	36.6	2.1	0.7	100.0	372
Ruvuma	83.2	361	0.4	92.3	7.0	0.0	0.4	100.0	300
Iringa	93.2	498	0.0	94.5	3.7	1.8	0.0	100.0	464
Mbeya	96.9	591	1.2	93.2	5.3	0.2	0.0	100.0	573
Singida	55.4	302	0.7	91.5	6.8	1.0	0.0	100.0	167
Tabora	89.8	365	0.0	97.5	2.5	0.0	0.0	100.0	328
Rukwa	93.7	278	0.1	96.8	3.0	0.0	0.0	100.0	261
Kigoma	64.3	417	0.6	43.6	55.8	0.0	0.0	100.0	268
Shinyanga	95.2	607	0.0	92.6	7.2	0.2	0.0	100.0	578
Kagera	83.2	556	0.3	76.1	21.5	2.1	0.0	100.0	463
Mwanza	67.2	699	0.7	84.0	15.2	0.0	0.0	100.0	470
Mara	68.8	326	0.0	94.8	5.2	0.0	0.0	100.0	224
Manyara	96.7	233	0.6	96.3	2.7	0.2	0.2	100.0	225
Unguja North	72.6	41	0.5	2.5	96.7	0.3	0.0	100.0	29
Unguja South	59.4	27	0.9	0.0	98.7	0.3	0.0	100.0	16
Town West	61.3	89	0.5	0.0	99.0	0.5	0.0	100.0	55
Pemba North	29.9	45	0.9	0.7	98.4	0.0	0.0	100.0	14
Pemba South	23.5	44	0.0	0.0	98.6	1.4	0.0	100.0	10
Wealth quintile									
Lowest	76.7	1,931	0.7	80.9	17.9	0.5	0.0	100.0	1,480
Second	81.6	1,917	0.6	79.5	18.2	1.4	0.1	100.0	1,565
Middle	85.3	1,946	0.6	80.7	18.1	0.6	0.1	100.0	1,661
Fourth	90.3	1,911	0.2	64.8	34.4	0.5	0.1	100.0	1,725
Highest	91.6	1,918	0.5	44.7	54.2	0.3	0.3	100.0	1,756
Total	85.1	9,623	0.5	69.4	29.3	0.7	0.1	100.0	8,186

As shown in Table 6.2, among households that purchased flour, 88 percent went to a shop and 7 percent bought it in a market; an additional 4 percent purchased flour at a hammermill. In all categories of background characteristics, the vast majority of households that purchase maize flour do so at a shop; in Tabora, Kigoma, and Kagera, a somewhat larger than average proportion of households—about one-third—purchase maize flour at a market.

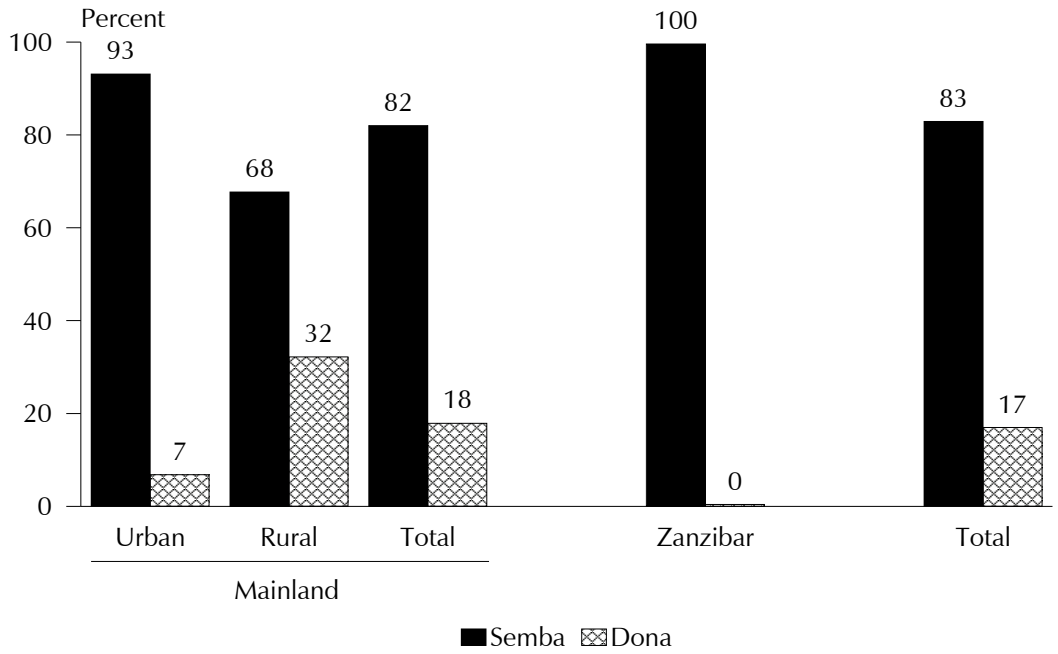
Table 6.2 Source of maize flour

Among households that purchased maize flour in the previous seven days, percent distribution by source of maize flour, according to background characteristics, Tanzania 2010

Characteristic	Source of maize flour					Total	Number of households
	Shop	Market	Hammermill	Other	Missing		
Residence							
Urban	89.3	5.3	5.1	0.2	0.1	100.0	1,328
Rural	87.0	9.5	2.3	0.7	0.4	100.0	1,079
Mainland/Zanzibar							
Mainland	87.7	7.6	4.1	0.4	0.2	100.0	2,285
Urban	88.9	5.5	5.3	0.2	0.1	100.0	1,279
Rural	86.1	10.2	2.5	0.7	0.4	100.0	1,005
Zanzibar	99.3	0.6	0.0	0.0	0.1	100.0	122
Unguja	99.2	0.8	0.0	0.0	0.0	100.0	99
Pemba	99.5	0.0	0.0	0.0	0.5	100.0	23
Region							
Dodoma	100.0	0.0	0.0	0.0	0.0	100.0	19
Arusha	85.3	1.3	13.4	0.0	0.0	100.0	139
Kilimanjaro	89.3	10.7	0.0	0.0	0.0	100.0	63
Tanga	94.6	3.3	1.3	0.0	0.8	100.0	279
Morogoro	86.6	4.2	8.6	0.6	0.0	100.0	236
Pwani	100.0	0.0	0.0	0.0	0.0	100.0	198
Dar es Salaam	95.6	0.1	3.9	0.2	0.1	100.0	615
Lindi	91.4	6.2	1.8	0.6	0.0	100.0	120
Mtwara	92.0	8.0	0.0	0.0	0.0	100.0	139
Ruvuma	79.7	6.3	4.5	4.2	5.4	100.0	22
Iringa	91.5	0.0	8.5	0.0	0.0	100.0	17
Mbeya	64.4	21.6	10.1	3.9	0.0	100.0	30
Singida	74.3	25.7	0.0	0.0	0.0	100.0	11
Tabora	63.4	36.6	0.0	0.0	0.0	100.0	8
Rukwa	86.1	9.8	0.0	0.0	4.2	100.0	8
Kigoma	62.4	36.6	0.0	1.0	0.0	100.0	150
Shinyanga	56.6	27.4	16.0	0.0	0.0	100.0	41
Kagera	61.5	35.4	1.7	1.3	0.0	100.0	99
Mwanza	71.9	13.1	12.8	2.1	0.0	100.0	72
Mara	83.7	2.8	7.2	0.0	6.4	100.0	12
Manyara	100.0	0.0	0.0	0.0	0.0	100.0	6
Unguja North	99.2	0.8	0.0	0.0	0.0	100.0	28
Unguja South	99.6	0.4	0.0	0.0	0.0	100.0	16
Town West	99.1	0.9	0.0	0.0	0.0	100.0	54
Pemba North	100.0	0.0	0.0	0.0	0.0	100.0	13
Pemba South	98.9	0.0	0.0	0.0	1.1	100.0	10
Wealth quintile							
Lowest	87.5	7.8	3.3	1.3	0.1	100.0	265
Second	88.3	10.0	0.4	0.5	0.8	100.0	288
Middle	83.4	13.2	2.5	0.3	0.6	100.0	302
Fourth	89.6	6.6	3.6	0.2	0.0	100.0	595
Highest	89.3	4.7	5.7	0.3	0.1	100.0	957
Total	88.3	7.2	3.9	0.4	0.2	100.0	2,407

When asked about the brand name of the flour, 83 percent of the households said that they used Semba and 17 percent used Dona (Figure 6.1). Dona is more popular in rural areas in the Mainland than in urban areas (32 percent compared with 7 percent). In Zanzibar, Semba is used exclusively.

Figure 6.1 **Brand of Maize Flour**



Tanzania 2010

6.2 COOKING OIL

Eight in ten households in Tanzania used oil for cooking in the seven days before the survey (Table 6.3). Urban households and households in Mainland are more likely to use oil than rural households or those in Zanzibar. Use of cooking oil increases steeply as household wealth increases, from 61 percent of households in the lowest wealth quintile to 95 percent of those in the highest quintile.

Overall, the two most popular types of oil are red palm (37 percent) and sunflower oil (31 percent). Eleven percent of households use cottonseed oil, and 7 percent use cow fat or ghee. Types of cooking oil vary considerably by background characteristics.

Table 6.3 Type of cooking oil

Percentage of households that used oil to cook in the past seven days, and among these households, percent distribution by type of oil, according to background characteristics, Tanzania 2010

Background characteristic	Percent of households that used oil to cook in the past 7 days	Number of households	Type of oil									Total	Number of households
			Simsim/ sesame	Ground nut	Sun-flower	Coconut	Red Palm	Cotton-seed	Cow fat/ Ghee	Other	Missing		
Residence													
Urban	90.8	2,507	2.1	2.1	31.6	1.4	45.1	6.0	2.0	9.7	0.1	100.0	2,276
Rural	76.1	7,116	1.8	2.7	30.7	2.0	33.7	13.4	9.4	6.3	0.1	100.0	5,416
Mainland/Zanzibar													
Mainland	80.5	9,377	1.9	2.5	31.3	1.8	37.0	11.4	7.2	6.7	0.1	100.0	7,546
Urban	91.3	2,417	2.2	2.2	32.0	1.5	45.6	6.2	2.0	8.3	0.1	100.0	2,206
Rural	76.7	6,959	1.8	2.7	31.0	2.0	33.4	13.6	9.4	6.0	0.1	100.0	5,340
Zanzibar	59.1	246	0.0	0.2	12.5	2.0	43.1	0.1	4.3	37.7	0.0	100.0	146
Unguja	65.2	157	0.0	0.3	15.3	2.6	34.6	0.2	1.5	45.5	0.0	100.0	103
Pemba	48.4	89	0.0	0.0	6.0	0.5	63.5	0.0	10.9	19.1	0.0	100.0	43
Region													
Dodoma	67.4	580	0.0	0.0	69.7	0.0	16.6	0.0	8.5	5.2	0.0	100.0	391
Arusha	94.0	411	0.6	4.1	33.6	0.5	15.4	0.6	33.0	12.4	0.0	100.0	386
Kilimanjaro	98.6	460	3.1	4.9	57.0	0.0	21.8	0.2	3.6	9.5	0.0	100.0	453
Tanga	89.7	551	0.0	0.0	3.3	0.7	77.0	0.0	13.0	6.0	0.0	100.0	494
Morogoro	84.9	499	0.4	1.4	25.5	3.8	45.5	7.1	7.4	8.9	0.0	100.0	423
Pwani	84.7	269	0.0	2.2	9.6	15.8	37.7	16.6	1.1	16.9	0.3	100.0	228
Dar es Salaam	89.7	730	0.3	0.7	21.4	1.9	66.2	0.6	0.2	8.4	0.4	100.0	655
Lindi	51.3	219	18.6	1.3	9.7	24.4	25.2	4.5	1.3	14.5	0.4	100.0	112
Mtwara	57.2	425	11.9	7.0	15.8	7.9	28.9	0.4	7.1	21.0	0.0	100.0	243
Ruvuma	78.1	361	0.0	2.7	19.7	3.1	41.3	0.0	11.8	21.4	0.0	100.0	282
Iringa	86.4	498	0.0	1.2	77.3	0.0	18.9	0.0	1.7	0.9	0.0	100.0	430
Mbeya	86.5	591	0.3	2.1	61.4	0.0	28.3	0.0	2.3	5.6	0.0	100.0	512
Singida	82.5	302	0.0	0.2	90.8	0.9	3.4	0.0	4.0	0.7	0.0	100.0	249
Tabora	85.1	365	1.3	2.3	21.3	0.0	49.7	13.5	10.6	1.1	0.2	100.0	311
Rukwa	71.4	278	0.0	3.9	43.5	0.0	50.8	0.4	0.5	0.9	0.0	100.0	199
Kigoma	83.4	417	0.3	0.0	2.2	0.3	96.6	0.0	0.3	0.0	0.3	100.0	348
Shinyanga	82.5	607	0.0	0.2	13.6	0.3	64.0	5.5	14.4	2.0	0.0	100.0	501
Kagera	71.5	556	0.5	0.4	3.3	0.8	6.4	76.3	1.8	10.2	0.4	100.0	398
Mwanza	74.7	699	4.0	14.1	4.4	0.7	12.9	53.5	9.1	1.3	0.0	100.0	522
Mara	62.3	326	21.8	1.8	3.3	0.0	2.5	62.0	6.7	1.8	0.0	100.0	203
Manyara	88.7	233	0.0	0.6	82.0	0.0	7.7	0.0	6.9	2.2	0.4	100.0	206
Unguja North	38.4	41	0.0	0.0	4.1	7.4	73.8	0.7	8.4	5.6	0.0	100.0	16
Unguja South	63.3	27	0.0	0.0	29.2	4.5	15.9	0.4	1.5	48.4	0.0	100.0	17
Town West	77.9	89	0.0	0.4	14.3	1.0	30.5	0.0	0.0	53.7	0.0	100.0	70
Pemba North	38.9	45	0.0	0.0	3.9	0.6	66.4	0.0	18.8	10.3	0.0	100.0	18
Pemba South	58.2	44	0.0	0.0	7.4	0.4	61.4	0.0	5.5	25.2	0.0	100.0	25
Wealth quintile													
Lowest	60.6	1,931	2.2	3.5	25.3	3.2	35.7	11.9	12.0	5.9	0.2	100.0	1,170
Second	71.3	1,917	1.6	3.1	27.5	2.1	33.5	14.9	11.8	5.3	0.2	100.0	1,368
Middle	83.0	1,946	1.9	2.8	31.0	1.7	33.9	15.4	8.0	5.4	0.0	100.0	1,614
Fourth	90.4	1,911	2.0	1.7	34.1	1.1	36.5	11.6	4.9	8.1	0.0	100.0	1,728
Highest	94.5	1,918	1.7	1.9	34.3	1.5	44.2	3.7	2.1	10.6	0.1	100.0	1,812
Total	79.9	9,623	1.9	2.5	31.0	1.8	37.1	11.2	7.2	7.3	0.1	100.0	7,692

As shown in Table 6.4, nine in ten households purchase their cooking oil, and only 9 percent process the oil at home. Households in rural areas are more likely to process their own cooking oil than urban households (12 percent and 3 percent). Over one-fifth of households in Dodoma, Lindi, and Tabora process their own cooking oil.

Table 6.4 Source of cooking oil

Among households that used oil to cook in the past seven days, percent distribution by source of oil, according to background characteristics, Tanzania 2010

Characteristic	Source of oil: Processed self at home	Local mill	Bought	Other	Missing	Total	Number of households
Residence							
Urban	2.7	1.3	94.9	1.1	0.0	100.0	2,276
Rural	12.0	1.3	85.3	1.1	0.2	100.0	5,416
Mainland/Zanzibar							
Mainland	9.4	1.3	88.0	1.1	0.1	100.0	7,546
Urban	2.7	1.3	94.8	1.1	0.0	100.0	2,206
Rural	12.2	1.4	85.2	1.1	0.2	100.0	5,340
Zanzibar	1.2	0.0	97.6	1.3	0.0	100.0	146
Unguja	1.4	0.0	97.5	1.0	0.0	100.0	103
Pemba	0.5	0.0	97.8	1.7	0.0	100.0	43
Region							
Dodoma	22.5	0.7	74.9	1.9	0.0	100.0	391
Arusha	7.7	0.6	89.8	1.3	0.7	100.0	386
Kilimanjaro	6.1	1.6	92.4	0.0	0.0	100.0	453
Tanga	0.0	0.6	97.8	1.7	0.0	100.0	494
Morogoro	8.7	0.0	86.0	5.3	0.0	100.0	423
Pwani	7.9	0.0	85.4	6.7	0.0	100.0	228
Dar es Salaam	0.5	2.0	97.0	0.5	0.0	100.0	655
Lindi	23.1	0.5	75.8	0.6	0.0	100.0	112
Mtwara	14.3	0.0	85.2	0.5	0.0	100.0	243
Ruvuma	7.7	0.3	91.3	0.6	0.0	100.0	282
Iringa	7.0	1.9	90.3	0.8	0.0	100.0	430
Mbeya	9.1	4.6	84.5	1.6	0.2	100.0	512
Singida	11.6	2.6	85.2	0.6	0.0	100.0	249
Tabora	21.4	0.9	77.4	0.3	0.0	100.0	311
Rukwa	9.0	4.4	85.8	0.8	0.0	100.0	199
Kigoma	12.0	0.0	87.4	0.6	0.0	100.0	348
Shinyanga	15.8	1.0	82.6	0.3	0.3	100.0	501
Kagera	0.5	0.0	98.7	0.0	0.8	100.0	398
Mwanza	13.7	0.8	85.3	0.2	0.0	100.0	522
Mara	4.4	0.9	94.6	0.0	0.0	100.0	203
Manyara	15.5	5.6	78.4	0.0	0.6	100.0	206
Unguja North	0.7	0.0	97.8	1.5	0.0	100.0	16
Unguja South	3.7	0.0	93.1	3.1	0.0	100.0	17
Town West	1.0	0.0	98.5	0.4	0.0	100.0	70
Pemba North	0.6	0.0	99.4	0.0	0.0	100.0	18
Pemba South	0.4	0.0	96.6	3.0	0.0	100.0	25
Wealth quintile							
Lowest	13.7	0.9	83.8	1.4	0.2	100.0	1,170
Second	14.2	1.8	82.8	1.0	0.2	100.0	1,368
Middle	11.9	1.1	85.7	1.3	0.0	100.0	1,614
Fourth	6.4	1.1	91.4	0.9	0.2	100.0	1,728
Highest	3.0	1.6	94.1	1.2	0.1	100.0	1,812
Total	9.3	1.3	88.2	1.1	0.1	100.0	7,692

Households were also asked the brand name of the cooking oil they used. More than one in three households in Tanzania use Korie, while 14 percent use Sunola, and 4 percent use Safi. One in four households reported no brand (25 percent), and 7 percent did not know the brand.

Table 6.5 Brand of cooking oil

Among households that purchased oil, percent distribution by brand of oil, according to background characteristics, Tanzania 2010

Characteristic	Brand of oil							Total	Number of households
	No brand	Korie	Sunola	Safi	Other	Don't know	Missing		
Residence									
Urban	17.4	43.0	14.9	7.4	9.5	7.2	0.6	100.0	2,161
Rural	27.7	32.9	13.7	2.5	15.4	7.2	0.6	100.0	4,629
Mainland/Zanzibar									
Mainland	24.8	35.7	14.3	4.1	13.1	7.3	0.6	100.0	6,648
Urban	17.7	42.5	15.2	7.7	9.0	7.3	0.6	100.0	2,092
Rural	28.0	32.6	13.9	2.5	15.0	7.2	0.6	100.0	4,556
Zanzibar	8.6	52.1	4.4	0.0	31.2	3.6	0.1	100.0	142
Unguja	9.3	65.3	4.2	0.0	16.9	4.1	0.2	100.0	100
Pemba	6.9	20.6	4.8	0.0	65.2	2.6	0.0	100.0	42
Region									
Dodoma	36.3	26.1	0.0	0.5	1.0	36.2	0.0	100.0	293
Arusha	35.5	14.2	13.8	1.5	28.1	1.5	5.4	100.0	349
Kilimanjaro	0.0	24.3	53.4	0.2	22.0	0.0	0.0	100.0	419
Tanga	0.6	77.9	2.2	4.5	14.8	0.0	0.0	100.0	483
Morogoro	15.7	48.9	4.8	3.5	9.8	16.9	0.4	100.0	364
Pwani	12.9	53.9	2.3	10.4	4.1	16.5	0.0	100.0	195
Dar es Salaam	4.7	57.6	9.6	17.4	4.3	6.1	0.3	100.0	635
Lindi	9.4	33.4	10.7	16.9	27.8	1.9	0.0	100.0	85
Mtwara	11.8	39.0	10.1	21.1	17.5	0.5	0.0	100.0	207
Ruvuma	37.1	26.7	15.2	7.8	11.1	1.3	0.7	100.0	257
Iringa	27.2	13.9	56.3	0.3	1.7	0.6	0.0	100.0	388
Mbeya	18.6	29.3	37.7	2.3	6.5	3.0	2.6	100.0	433
Singida	43.8	3.0	2.7	0.4	3.4	46.8	0.0	100.0	212
Tabora	45.3	40.8	5.1	0.1	6.7	2.0	0.0	100.0	240
Rukwa	12.7	54.3	31.4	0.0	0.6	0.0	0.9	100.0	171
Kigoma	2.6	92.0	0.9	0.0	0.4	4.2	0.0	100.0	304
Shinyanga	30.0	54.8	6.0	2.7	4.1	2.5	0.0	100.0	415
Kagera	24.9	4.6	2.1	0.0	68.0	0.0	0.4	100.0	396
Mwanza	64.4	7.8	0.3	0.0	12.8	14.3	0.5	100.0	445
Mara	63.9	0.2	0.5	0.0	21.5	14.0	0.0	100.0	192
Manyara	77.1	5.0	15.9	0.0	0.9	0.0	1.1	100.0	163
Unguja North	15.9	61.4	1.4	0.0	19.8	1.5	0.0	100.0	15
Unguja South	12.6	74.1	3.2	0.0	9.5	0.6	0.0	100.0	16
Town West	7.1	64.1	5.1	0.0	18.0	5.5	0.3	100.0	69
Pemba North	10.3	20.5	4.6	0.0	64.6	0.0	0.0	100.0	17
Pemba South	4.5	20.6	4.9	0.0	65.6	4.4	0.0	100.0	25
Wealth quintile									
Lowest	32.3	36.3	5.9	2.2	10.8	12.0	0.5	100.0	983
Second	28.5	32.9	10.3	2.9	16.7	8.4	0.4	100.0	1,135
Middle	28.7	31.9	12.9	2.3	16.9	6.5	0.7	100.0	1,384
Fourth	23.3	35.3	17.0	3.8	12.6	7.0	0.9	100.0	1,583
Highest	14.9	42.2	19.7	7.5	10.9	4.3	0.5	100.0	1,706
Total	24.5	36.1	14.1	4.0	13.5	7.2	0.6	100.0	6,790

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PROTOCOL FOR THE MEASUREMENT OF RETINOL BINDING PROTEIN (RBP) FROM DRIED BLOOD SPOTS

Elution Protocol

1. Punch out two (2) 6mm (¼ inch) discs from the centre of each of the DBS samples to be assayed. Place the discs into the respectively labelled micro tube.

2. Add 300 µL of sample diluent (provided with the kit) to each micro tube. Incubate the samples overnight (18-20 hours) at 4-8°C in a refrigerator.

3. On the day of the assay, remove the samples from refrigerator, vortex for 15 seconds, and centrifuge at 5,000 rpm for 2 minutes.

Assay Procedure

Preparation of controls

1. Add 450 µL of sample diluent to the vials containing the ***RBP Positive Control*** and the ***RBP Negative Control***. Vortex the vials for 15 seconds, followed by centrifugation at 5,000 rpm for 2 minutes.

Preparation of RBP Calibrators

1. Prepare the calibrators according to the **Certificate of Analysis** that comes with each Lot of RBP kits. **Include a 15 µL and a 30 µL calibrator as follows:**

Calibrator value	Stock calibrator	Sample diluent
10 µL	6 µL	654 µL
15 µL	9 µL	651 µL
20 µL	12 µL	648 µL
30 µL	18 µL	642 µL
40 µL	24 µL	636 µL

2. Transfer 100 µL of calibrators, diluted controls, and samples (DBS eluates) in duplicate to the appropriate wells on the microwell plate.

STRICTLY FOLLOW THE ORDER OF THE PLATE MAP

3. Prepare the HRP-conjugate according to the **Certificate of Analysis. (Add 6 µL conjugate to 12 mL of sample diluent)**

4. Dispense 100 µL of HRP-conjugate into each microwell using a multi-channel pipettor.

5. Rotate the plate on a horizontal rotator for 1 min at 250 rpm.

6. Incubate for 15 minutes at room temperature. **Do not rotate the plates.**

7. At the end of the incubation, empty the wells and wash each well 5 times with 300 µL of diluted wash buffer per well. Remove excess fluid by inverting the plate and blotting on paper towels.

8. Add 200 µL of substrate to all wells using a multi-channel pipettor. Cover the microwells with a self-adhesive plate sealer and rotate for 1 minute at 250 rpm.

9. Incubate for 10 minutes at room temperature.

DO NOT EMPTY WELLS AFTER INCUBATION WITH SUBSTRATE

10. Terminate the reaction by adding 100 µL of ***Stop Solution*** to each well using a multi-channel pipettor.

11. Mix the contents of each microwell by rotating the microplate on a horizontal rotator for 1 minute at 250 rpm to remove air bubbles.

12. Read the colour developed in each microwell in a microplate reader set at 450 nm and 630 nm (background correction).

13. The wells must be read within 30 minutes of adding ***Stop Solution***

14. An acceptable agreement between duplicates is defined as a coefficient of variation (CV) ≤10% between the optical densities (OD) of duplicates as specified in the manufacturer's protocol and according to established assay acceptance criteria.

PROTOCOL FOR THE MEASUREMENT OF TRANSFERRIN RECEPTOR (sTfR) FROM DRIED BLOOD SPOTS

Elution Protocol

1. Punch out one (1) 6 mm (¼ inch) disc from the centre of each of the DBS samples to be assayed into the respective labelled micro tubes.

2. Add 500 µL of sample diluent (provided with the kit) to each micro tube. Incubate the samples overnight (18-20 hours) at 4-8°C in a refrigerator).

3. On the day of the assay, remove the samples from the refrigerator and rotate the tubes on a horizontal rotator at 350 rpm for 2 hours at room temperature.

Assay Procedure

Preparation of controls

1. Add 10 µL of the ***Normal*** and 10 µL of the ***High*** sTfR control to 1 mL of sample diluent in separate micro tubes to make a 1:100 dilution of the controls.

2. Transfer 100 µL of the pre-diluted standards, diluted controls, and sample eluates, in duplicate to the appropriate wells on the microwell plate.

STRICTLY FOLLOW THE ORDER OF THE PLATE MAP

3. Dispense 100 µL of HRP-conjugate into each microwell using a multi-channel pipettor.

4. Seal the plate with the self-adhesive strip (provided with the kit) and rotate the plate on a horizontal rotator for 10 minutes at 250 rpm.

5. Incubate the plates for 2 hours at room temperature without rotation.

6. At the end of the 2 hour incubation, empty the wells and wash the microwells 4 times with 300 µL of diluted wash buffer per microwell, while tapping the sides of the plate.

7. Add 200 µL of substrate to all microwells using a multi-channel pipettor. Cover the plate with a self-adhesive strip and rotate the plates on a horizontal rotator for 1 minute at 250 rpm.

8. Incubate the microplate for 1 hour at room temperature in the dark.

DO NOT EMPTY WELLS AFTER INCUBATION WITH SUBSTRATE

9. Terminate the reaction by adding 50 µL of Stop Solution to each microwell using a multi-channel pipettor.

10. Mix the contents of each microwell by rotating the microplate on a horizontal rotator for 1 minute at 250 rpm to remove air bubbles.

11. Read the colour developed in each microwell in a microplate reader set at 450 nm and 630 nm (background correction).

12. The wells must be read within 30 minutes of adding ***Stop Solution***

13. An acceptable agreement between duplicates is defined as a coefficient of variation (CV) ≤10% between the optical densities (OD) of duplicates as specified in the manufacturer's protocol and according to established assay acceptance criteria.

PROTOCOL FOR THE MEASUREMENT OF C-REACTIVE PROTEIN (CRP) FROM DRIED BLOOD SPOTS

Elution Protocol

Preparation of elution buffer

1. Prepare assay buffer as follows: Pour the entire contents (5 mL) of the **Assay Buffer Concentrate** into a clean 100 mL graduated cylinder. Bring to final volume of 100 mL with distilled water. Mix gently.

2. Punch one (1) 3.2 mm (⅛ inch) disc from the centre of each of the DBS samples to be assayed. Place the disc into the respectively labelled micro tube.

3. Add 500 µL of the diluted assay buffer to each micro tube.

4. Incubate the samples overnight (18-20 hours) at 4-8°C in a refrigerator.

5. On the day of the day of the assay, remove the samples from refrigeration and rotate on a horizontal rotator at 350 rpm for 1 hour at room temperature.

Assay Procedure

DO NOT REMOVE MICROWELL PLATE AND CALIBRATORS FROM FREEZER UNTIL EVERYTHING IS IN PLACE TO START PLATING

1. Remove the pooled human serum sample (control) from the freezer and allow it to thaw. When thawed, prepare a control by diluting the human serum control sample 1:500 with assay buffer as follows:

   I. 10 µL human serum sample (control) sample + 490 µL assay buffer

   II. 50 µL human serum sample (control) diluted sample + 450 µL assay buffer

   Vortex the tubes containing the newly made CRP dilution thoroughly before removing the volume of solution required to prepare the final control

2. Remove the microwell plate from the freezer.

3. Transfer 100 µL of diluted human serum sample (control) and sample eluates in duplicate to the appropriate wells on the microwell plate.

STRICTLY FOLLOW THE ORDER OF THE PLATE MAP

4. Remove the calibrator well strips from the freezer and insert them carefully into the appropriate positions on the plate.

5. Add 50 µL of distilled water to all microwells.

6. Seal the plate with the self-adhesive strip included in the kit and incubate the microplate for 2 hours at room temperature while rotating the microplate on a horizontal rotator at 250 rpm.

7. At the end of the incubation, empty the wells and wash each well 4 times with 300 µL of diluted wash buffer per well. Remove excess wash buffer by inverting the plates and blotting the fluid on paper towels.

8. Add 100 µL of substrate to all microwells using a multi-channel pipettor. Cover the microwells with a self-adhesive plate sealer and rotate the plate on a horizontal rotator for 1 minute at 250 rpm at room temperature.

DO NOT EMPTY WELLS AFTER ADDING SUBSTRATE

9. Incubate the microplate for 7-8 minutes at room temperature in the dark.

10. Read the plate at 630 nm to check that the optical density of the highest calibrator (wells A1 and A2) is about 0.60-0.65.

11. Terminate the reaction by adding 100 µL of ***Stop Solution*** to each well using a multi-channel pipettor.

12. Mix the contents of each microwell by rotating the microplate on a horizontal rotator for 1 minute at 250 rpm to remove air bubbles.

13. Read the colour developed in each microwell in a microplate reader set at 450 nm and 630 nm (background correction).

14. The wells must be read within 30 minutes of adding ***Stop Solution***

15. An acceptable agreement between duplicates is defined as a coefficient of variation (CV) ≤10% between the optical densities (OD) of duplicates as specified in the manufacturer's protocol and according to established assay acceptance criteria.

PERSONS INVOLVED IN THE MICRONUTRIENT COMPONENT

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