The nutritional status of children below 5 years related to children's diet and mothers' workload in agriculture

A study among farmers in rural Rukwa, Tanzania

Master Thesis by
Sunniva Nordang

Department of Nutrition
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Front picture taken by the student, Msanzi village 2010.

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Abstract

Background: The nutritional status of the preschool children in Tanzania is poor, and only minor improvements have taken place since the late 1980s. The causes of child undernutrition are multifaceted and interlinked. Inadequate diet and frequent disease are the most significant causes of child undernutrition, which among many, depends on the mother's resources to provide care. Undernutrition is a major risk factor of child mortality and morbidity.

Aim: The aims of this study were to provide data on the nutritional status of children below 5 years of age, and to investigate factors associated with undernutrition such as children's diet and women's workload in the agricultural field, in a selected village in rural Tanzania. Further, the study aims to identify possible changes in children's nutritional status (underweight), and influencing factors (child feeding practices and women's education), which have taken place in the village since the late 1980s.

Methods: A cross-sectional study was undertaken in a village in rural Rukwa, Tanzania, from September to December 2010. A total of 152 children, the main child caretaker and the head of the household to which the child belonged, were included in the study. The study participants were randomly selected by single stage proportion to size sampling procedure. Data was collected by a 24-hour dietary recall, without amounts, of the children's diet, and a structured questionnaire which contained information on breastfeeding and complementary feeding of the children, main caretakers' workload in the field and their compensatory mechanisms for child care (such as what the mothers did with their children when they worked in the agricultural field), households' socio economic status, agricultural activities in the field and household food security. Anthropometrical measurements were taken of the children. A Minimum Dietary Diversity Score was developed for children (mostly breastfed) between 6 and 23 months. Diet Diversity Scores (DDS) (number of food groups consumed) and Food Variety Scores (FVS) (number of food items consumed) were developed for non-breastfed children. Women's workload was calculated based on number of days (period and frequency) the women had been working in the field the last agricultural season. Binary logistic- and linear regression analyses were performed.

Results: The prevalence of stunting, underweight and wasting among the children were 63.8%, 33.6% and 2.7% respectively. Nearly all children were breastfed for 1 year (99%) and 60% were breastfed at the age of 2. However, only 1 child had been exclusively breastfed for

6 months, and 72% of the children were given prelacteals (mostly sugar-water) the first day after birth. *Uji* (maize gruel) was introduced to the children at the median age of 2 (25, 75th percentile; 1-3) months, and 46.5 % of the children 6 to 23 months of age received less than four food groups the previous day. Mean DDS (SD) was 4.7 (1.1) and mean FVS (SD) was 6.7 (2.0). Neither DDS nor FVS were related to the children's nutritional status (stunting and underweight). The mean (SD) feeding frequency was 3.1 times/day (0.8). Children fed 1-2 feedings a day were significantly more likely to be severely stunted, compared to children fed ≥4 feedings a day (O.R: 4.05, C.I: 1.04, 15.71). More than half (57.9%) of the children were reported sick in the reference period (2 weeks), and diarrhoea was the most common disease, affecting 25%. Women worked in the field for median 48 days (25-75th percentile; 30.0-77.5), the last agricultural season. Most mothers (60.6%) brought their children to the field, where 86.7% of the children were fed. The children who did not come with their mothers to the field were in most part (63.1%) taken care of by an older sibling below 15 years. Women who worked the most (≥67 days) in the field the last agricultural season, were significantly more likely to have underweight children (O.R: 2.5, C.I: 1.06, 5.91) compared to women who worked less (≤38 days), in unadjusted analyses, but not when adjusted for age, disease and asset score. Age was found to significantly explain variation in height-for-age z-score. Age and dry season cultivation were found to significantly explain variation in weight-for-age z-score. Finally, the study findings revealed that fewer women were uneducated in the present study compared to the former study (1987/88), and that the rate of underweight children had not changed (26.4% in 1987/88 and 25% in 2010).

Conclusion: The results from the study reveal that the rate of stunting and underweight can be classified as very high for a population, according to WHO's classification of undernutrition. The practice of exclusive breastfeeding for 6 months is nearly non-existing. The quality of complementary foods are inadequate, and the diet monotonous. In addition the level of disease was high. Women's workload was related to underweight, but only in the unadjusted analyses. Exclusive breastfeeding should be promoted, and efforts should be made to improve the quality of the complementary foods and the older children's diet. More research should focus on women's workload in agriculture, their compensatory mechanisms and the role of the alternate caregivers. Research should be undertaken at different times of the year to detect seasonal variations in children's nutritional status, disease pattern, feeding practices and women's workload.

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First of all I want to express my gratitude to my main supervisor Margareta Wandel for introducing me to this project. Thank you for guidance, feedback and for taking time to critically review my work. I also want to thank Joyce Kinabo, my co-supervisor, for guidance during the period of fieldwork in Tanzania, and Gerd Holmboe-Ottesen for your advice and very useful comments.

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"*Asante kalesa*" Mambosasa and the people in Msanzi.

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Thank you Silja, Anker and Ida for proofreading my thesis, for valuable comments and for encouragement.

And finally, thanks to my family, Jens and friends, for love, support and for believing in me.

Sunniva

"Rukwa Ruka"

Literally it means "make Rukwa fly" in Kifipa (the local language in Rukwa region).

(This proverb was used as a slogan by Jerve and Ntemi in a study from Rukwa (2009)).

Abbreviations and Swahili terms

CDC – Centre for Disease Control and Prevention (US)

DHS – Demographic and Health Survey

Dagaa – Dried Sardine

DDS - Diet Diversity Score

FAO – Food and Agriculture Organization of the United Nations

FVS – Food Variety Score

GDP – Gross Domestic Product

HAZ – Height/(length)-for-age z-score

HIV/AIDS – Human Immunodeficiency Virus/Acquired Immuno Deficiency Syndrome

HDI – Human Development Index

MKUKUTA I and II - Tanzania's strategy one and two for economic growth and poverty reduction

MDGs – Millennium Development Goals

NCHS – National Centre for Health Statistics (US)

PAOH – Pan American Health Organization (International public health agency)

Shamba – Main field for cultivation

Severe stunting – Height/(length)-for-age z-score <-3

Severe underweight - Weight-for-age <-3

Stunting – Height/(length)-for-age z-score <-2

TDHS – Tanzania Demographic and Health Survey

Uji – Thin porridge, given to children in Msanzi.

Ugali – Stiff maize pudding, staple food in Msanzi.

Underweight –Weight-for-age <-2

UN – United Nations

UNICEF - United Nations Children's Fund

WAZ – Weight-for-age z-score

WHZ – Weight-for-height/(length) z-score

Wasting – Weight-for-height/(length) z-score <-2

WHO – World Health Organization

Definition of terms

Continued breastfeeding, on demand – Means to breastfeed the children until the child is 1 and 2 years of age, when he/she wants to be fed.

Complementary food/feeding - Nutrient-containing foods or liquids given to the child other then breast milk, in the period between 6 and 23 months.

Dietary diversity – Describes variation in the diet, and includes Diet Diversity Score, Food Variety Scores and an indicator of Minimum Dietary Diversity.

Diet Diversity Scores – Number of food groups consumed the last 24 hours.

Dry season cultivation – Cultivation on wet-land area during dry-season. Dry season cultivation is performed in addition to the main cultivation on the shamba (main cultivation takes place during the rainy season).

Exclusive breastfeeding - Exclusive breastfeeding is defined as giving the child nothing else then breast milk, except from medical supplements as drops, syrups with vitamins, minerals and medicine.

Food Variety Scores – Number of food items consumed in the last 24 hours.

Household - A household is defined as a group of people who occupy a particular housing unit as their usual residence, or who live there at the time of the interview and have no usual residence elsewhere.

Minimum Dietary Diversity – The proportion of young children (6-23 months) who receive foods from ≥4 food groups the last 24 hours.

Mixed feeding – The child is both breastfed and fed other foods/liquids.

Prelacteals –feedings, other then breast milk, given to the children the first day after birth.

Replacement feeding - Giving the child breast milk substitutes.

Z-score (SD-score) - Describes how far a measurement is from the reference median (average).

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1 Introduction

Globally, progress is being made in reducing the prevalence of undernourished people (both in general and among children); however the numbers continues to be intolerably high (1;2). In Sub-Saharan Africa the prevalence of underweight (low weight for age) and stunted[1] (low height for age) children has declined only modestly since the 1990s, and due to population growth, the numbers of stunted children have increased in the same period (2). Nearly all the Sub-Saharan African countries, including Tanzania, are far from achieving the Millennium Development Goal (MDG) 1[2] of halving the prevalence of underweight children under-five years of age from 1990 to 2015 (3;4). The nutritional status of children in Tanzania is poor (5).

The present study investigates children's nutritional status and possible associated factors in a Tanzanian village. The study is also partially a follow-up, of a former study conducted in two villages in Tanzania from 1987 to 1988, which resulted in the thesis " Nutrition Household Food Security and Agricultural Change, With Special Focus on Gender Issues" (6). The former study was conducted in two villages where the village chosen for follow-up was the most developed of the two in the 1980s, but with the highest prevalence of underweight (7). The study focused on women's and men's contribution in food production, households' food security and children's nutritional status, as well as the division of labour in food production, decision making processes in the household and on children's dietary habits (7-11;11).

The present study was conducted by two master students, a student from the master program in International Community Health at the Department of Community Medicine, University of Oslo and the author of this thesis. The tasks were divided between us; my fellow student focused on gender division of labour, decision making power and the impact on food security, while I explored the children's nutritional status and factors such as the children's diet, women's workload in the field and other background variables assumed to have an impact on the children's nutritional status. The results from the present study were compared with the former, in cases where comparisons were feasible. The present study used a somewhat different methodology compared to the former study, since international standards and recommendations have changed since the 1987/88, e.g. for assessment of nutritional status.

[1] Stunting is described in section 2.1.1 Anthropometric indicators of nutritional status.
[2] MDG 1 is to halve the proportion of people who suffer from hunger, between 1990 and 2015, and one indicator to monitor progress is the prevalence of underweight children under-5 years of age.

Even though the causes of undernutrition are widely documented, the prevalence and factors influencing nutritional status differ from one area to another. Additionally, food consumption studies from Tanzania, and studies from Sub-Saharan Africa (and elsewhere) which have looked into women's workload in the agricultural field and the impact on children's nutritional status are scarce. Farming is the main source of livelihood and economy in Tanzania. Increasing agricultural production is one (development) strategy to reduce poverty and undernutrition rates, and to increase economic growth. However, in order to improve the nutritional situation, agricultural development programs need to target women (12). Women are found to invest more in child nutrition, health and education, compared to men, and thus development programs must also firmly take into account women's time constraints. It is therefore a need to increase knowledge about women's contribution in food production/agricultural activities in order to understand the context in which women work and in order to be able to create the best possible programs and interventions (12).

Tanzania ratified the Convention of the Right of the Child in 1991 (13). The convention states e.g. that a child have the right to nutritious food, to good quality health care, a healthy environment and an adequate standard of living, and that Tanzania (as a State Party) is responsible to combat diseases and undernutrition (14). When this is not fulfilled, the child's human right is violated. Tanzania has ratified the Convention and is thus obliged to respect, protect and fulfil the rights of the children.

Finally, in the Rukwa region where the present study was undertaken, surplus of food is produced annually. At the same time the region has one of the highest levels of undernutrition in the country (15). This makes the study area an interesting field of investigation.

2 Background

2.1 Child growth and undernutrition

Children's growth potential the first 5 years of life is similar for all children (16). In developing countries child growth tends to falter early, and the periods when the child is most vulnerable to growth faltering are during the periods of intrauterine development and/or the transition from breast milk to family foods. Inadequate diets and frequent infections are found to be the main causes of growth faltering. Growth faltering the 2-3 first years of life has a detrimental impact on the physical- and mental development of the child, as it leads to irreversible damage. Compensatory- or catch up growth might take place in this period, under optimal conditions, and reverse growth faltering. However, children (in developing countries) who remain in the same environment they were born into are most likely to not catch-up growth and to remain growth faltered throughout life (17-20). Child growth is used as an indicator of a child's nutritional status, and growth faltering an indicator of undernutrition, namely low height-for-age, which will be discussed in section 2.1.2.

Undernutrition and malnutrition are often used interchangeably in the literature. The term undernutrition is used in this thesis, as malnutrition includes both undernutrition and overweight/obesity or over consumption of specific nutrients. Undernutrition is defined by United Nations Children's Fund (UNICEF) (2009) as "the outcome of insufficient food intake, inadequate care and infectious diseases. It includes being underweight for one's age, too short for ones age (stunted), dangerously thin for one's height (wasted) and deficient in vitamins and minerals (micronutrient deficiencies)" (2).

2.1.1 Anthropometrical indicators of nutritional status

A common method to assess a child's nutritional status is by the use of age and anthropometrical measurements of length/height and weight. By the use of growth charts, the anthropometrical indices height-for-age, weight-for-age and weight-for-height can be achieved (21). Low height-for-age implies long term undernutrition and poor health causing linear growth failure where the outcome is expressed as being stunted (shortness). The prevalence of stunting is usually highest in the second or third year of life (22). A high level of stunting in a society might reflect poor socio-economic conditions, health and nutrition.

Low weight-for-height/length is in most cases a consequence of recent and severe weight loss, and where the outcome is expressed as being wasted (thinness). The prevalence of wasting is usually highest during the period of complementary feeding, from 1 to 2 years (22). Low weight-for-age, on the other hand, can occur either as a consequence of stunting, wasting or both, and the outcome is expressed as being underweight (lightness), and is/was the most commonly used indicator of undernutrition (21;23). For instance, the prevalence of underweight children under-five years of age is one of the indicators used to monitor progress of the MDG 1 (to eradicate extreme poverty and hunger) (3).

The United States National Centre for Health Statistics/World Health Organization '(NCHS)/WHO reference population' and the new 'Child Growth Standards' are examples of commonly used growth charts. The Child Growth Standards were launched in 2006 and is now recommended for use (16). They replaced the NCHS/WHO reference population which had been recommended since the late 1970s (24). The NCHS/WHO reference population reflected North-American children's growth, and could therefore only be used as a reference population, and not a standard; which describes how children should grow, as the Child Growth Standards do. In addition, the NCHS/WHO reference population had some major technical and biological drawbacks, e.g. that it did not reflect accurately early childhood growth, where the 0-23 months reference population was based on formula fed infants (25). The new growth charts are based on breastfed, healthy children from various countries[3] throughout the world. And, as stated in section 2.1, child growth is nearly the same the first 5 years of age, under optimal environmental conditions, and despite of socioeconomic status, ethnicity and type of feeding, according to WHO (16;25).

2.1.2 The consequences of undernutrition

The consequences of undernutrition include both short and long term consequences, as illustrated in figure 3.

[3] Countries included in developing the Child Growth Standards were from Brazil, Ghana, India, Norway, Oman and the USA (16).

Children who are undernourished are more likely to die compared to nourished children, and undernutrition is the underlying cause of 35% of child deaths and 11% of the total global disease burden (Disability-Adjusted Life-Years)[4] worldwide (18).

Maternal and child undernutrition are associated with poorer human capacity (physical and mental) later in life, for instance shorter height, reduced cognitive abilities and school performance. This may in turn have an impact on the productivity (e.g. agricultural labour) and earning capacity as adults (27). The socio-economic development of a country and potential to reduce poverty is also hampered by high rates of undernutrition (28). Poor socio-socioeconomic status, may also detrimentally affect mental development (27). It is suggested that undernutrition spans over generations, where a stunted adult is more likely to give birth to smaller infants, who in turn are more likely to face impaired growth and development, and the vicious circle continues (28).

In most countries with high rates of undernutrition there is a lack of well-functioning interventions, except for e.g. vitamin A supplementation and salt iodisation (28;29).

2.2 The causes of child undernutrition

2.2.1 The UNICEF conceptual framework

The causes of undernutrition are complicated and interlinked. UNICEF launched in the 1990s the UNICEF conceptual framework as a tool to understand the causes of child malnutrition (undernutrition). The framework includes various causes of undernutrition, both biological and social of nature, and describes how the different levels of causality, immediate, underlying and basic, interact and how factors at one level affect others (30;31). The framework illustrated in figure 3 is a modification by Black et al. of the original UNICEF conceptual framework, and illustrates also the consequences of child undernutrition (18). A brief explanation of the framework presented in other readings (31-33) of the framework comprises; inadequate dietary intake and disease as the most immediate causes to

[4] Disability-Adjusted Life-Years (DALY's) "combines years of life lost due to premature death and years of life lived with disabilities into one indicator allowing assessment of the total loss of health from different causes". One DALY is thought of as one lost year of healthy life. The number of DALYs is used as an indicator of the disease burden, which measures the gap between an ideal situation where everyone lives into old age free from disability and disease with the current health status (26).

undernutrition. The immediate causes are affected by the underlying determinants; inadequate care and household food insecurity, in addition to inadequate quality and access to health services and poor environment. Poverty and basic causes, such as lack of human and natural resources in the society/region/country are affected by economic, political, cultural and societal structures in the society.

This study will mainly focus on the following causes of undernutrition, immediate causes (both inadequate dietary intake and disease) and underlying causes (mainly inadequate care and food insecurity), in addition to lack of social and human capital (inadequate resources to provide care as women's workload and time constraints) and income poverty (assets and employment).

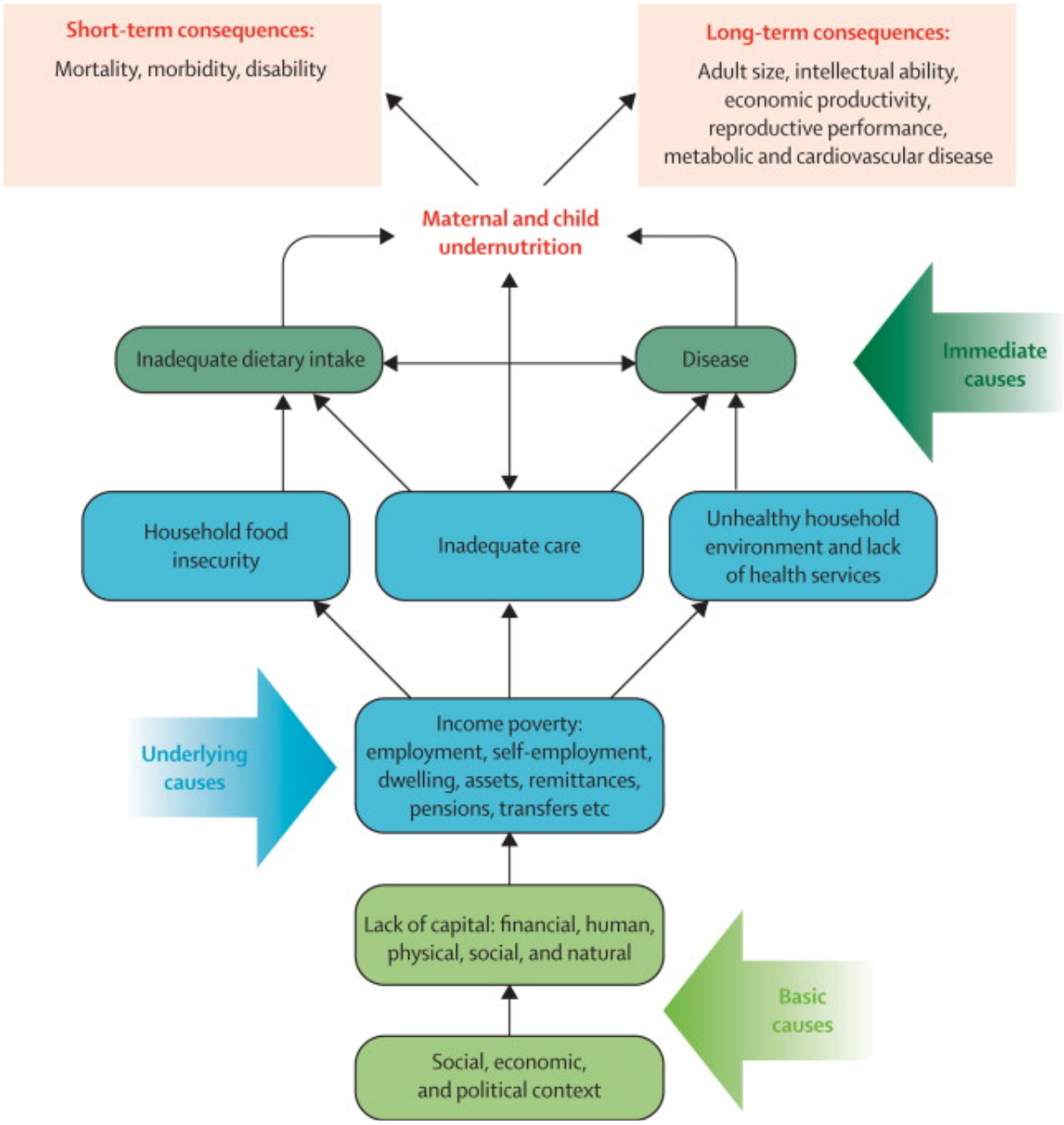

Figure 1: The UNICEF framework, modified by Black et al. (18) .

2.2.2 Dietary Intake

Adequate feeding is crucial for proper nutrition and health, but also for sustainable socio-economic development and poverty reduction (34).

Breastfeeding

The international recommendations on optimal breastfeeding practices include ‘exclusive breastfeeding’ the 6 first months of age and ‘continued breastfeeding’, ‘on demand’, until the child is 2 years or more (35;36). Exclusive breastfeeding means that all the food/liquid the child receives is from the mother’s milk (2). Suboptimal breastfeeding practices are found to increase the chances of morbidity and mortality among children below 5 years of age (18).

Breast milk covers all the nutritional needs of a healthy child the 6 first months of age. In addition, after these 6 months, breast milk continues to contribute with energy and important nutrients (36). For instance, a study from Kenya by Onyango et al. (37), among children around 2 years, found breast milk to be a major source of vitamin A and fat, though the role of breast milk depended on the quality of the complementary food.

One of the main positive effects of exclusive breastfeeding, and especially in unhygienic and unsafe environments, is the protection against infections, especially gastrointestinal infections as diarrhoea, and respiratory infections (38). A study from Peru for instance found that children who were exclusively breastfed had a lower prevalence of both diarrhoea and respiratory infections (39). The protective effects of breast milk are found to last for the first 2 to 3 years of life, though it decreases with increasing age and consumption of complementary foods (40). Breast milk is also important when the child is sick, as it might reduce the episode of illness, contribute with nutrients and prevent dehydration (36).

Exclusive breastfeeding is also recommended for HIV-1-positive mothers in resource poor settings, as it is found to have a protective effect on mother-to-child-transmission of HIV (MTCT) compared to ‘mixed feeding’. Additionally, exclusive breastfeeding protects against infections as diarrhoea, and contributes with essential nutrients for growth and development. ‘Replacement feeding’ is only recommended in settings where the food served to the child is safe, feasible, sustainable, acceptable and affordable (41;42).

Exclusive breastfeeding contributes to birth spacing as well (42).

Breastfeeding is nearly universal in Sub-Saharan Africa, continued breastfeeding for 1 and 2 years is common, but the practice of exclusive breastfeeding is rare. Data from the most recent Demographic and Health Survey (DHS) in the various countries show that 90% and 51% were breastfeed at the age of 1 and 2 years respectively and that 31% were exclusively

breastfed (among children 0-5 months) (43). Exclusive breastfeeding has increased since the 1990s (44).

A common practice in Sub-Saharan countries (41;45-47) is to give the children 'pre-lacteal feedings' such as sugar water and herbal water as early as the first days post-partum. Prelacteals have no beneficial effect to the child. On the contrary, children are more likely to have diarrhoea and to die of diarrhea (48).

Complementary feeding

'Complementary feeding' is the period when other foods or liquids are given to the child along with breast milk (usually from 6 to 23 months). 'Complementary foods' are nutrient-containing foods or liquids given to the child other than breast milk (40). According to the Pan American Health Organization/World Health Organization (PAHO/WHO) guidelines on complementary feeding, complementary foods should be introduced after 6 months, as breast milk alone can not provide all the nutrients essential for growth and development. The complementary foods given to the child should be adequate and age appropriate, safe and hygienically stored and prepared, and the child properly and responsively fed (36;49). The child should receive a diet of relative high energy content in addition to proteins and micronutrients and especially vitamin A and C, iron, calcium, zinc and folate, considering the limited capacity of the bowel (49).

Plant/starch based porridges are commonly used as complementary foods in developing countries (50). Traditional un-processed preparations of plant based porridges are found to have high viscosity and low content of energy and nutrients (as vitamin A, iron, calcium and zinc), and is commonly referred to as 'bulky foods' (51;52). Additionally, several components in plant based foods, as dietary fiber, phytic acid and polyphenol, are found to have a negative impact on the absorption of several minerals (50). Germination[5] of grains, e.g. maize, before preparing the porridge, is one food-processing and preparation method found to reduce viscosity (don't need to add more water when preparing the gruel) and increase nutrient absorption from the gruels (54). Unless food processing takes place, traditional unfortified complementary foods as this is not likely to contribute with adequate amounts of nutrients such as calcium, iron and zinc, but also in some cases vitamin A and riboflavin (40). For

[5] Germination is "a plant process, resulting in the activation of plant hydrolytic enzymes, and is the conversion of polymers (starches and proteins) to smaller molecules. The excess encymes can be utilized" (53).

instance a study from rural Malawi found the dietary intakes from complementary foods (thin maize porridge) to be lacking in energy, iron, zinc and calcium (55). The amount the child has to consume unless fortified or food processed is above the bowel capacity of the child (52).

Early introduction of complementary foods (in some cases at the age of 1 month) is common in many developing countries (50;56). Complementary foods introduced this early are found to displace breast milk and its important contribution of nutrients (36). Additionally, if breast milk is consumed within the same time period as plant based gruels, the components (phytic acid, dietary fiber, polyphenol) in the gruels are found to compromise the bioavailability of iron and zinc from the breast milk (50).

A too late introduction of complementary foods, on the other hand, will lead to nutritional deficiencies, as the breast milk can not contribute with enough nutrients after 6 months. So both a too early and a too late introduction of complementary foods might have a detrimental impact on children's growth and development (36).

Dietary diversity

Monotony of the diet has been explained "as the hallmark of poverty and poor nutrition" (56), and an increased dietary diversity[6] is associated with increased intake of energy and micronutrients in developing countries (57), with diet variety/balance and thus the quality of the diet (58). Dietary diversity scores as a proxy for adequacy of the diet are used in several studies (59-63). Dietary Diversity is found to be an adequate measurement of micronutrient adequacy in developing countries for young children (64) and a fairly good measurement of micronutrient adequacy for older non-breastfed children (57;65;66). However, not all studies have shown this association, as described by Steyn et al. (66). Nevertheless, in the young age group (6 to 23 months) a standardized method of dietary diversity scores (food groups, cut-off point and reference period) have been developed to classify the children as either adequately or inadequately fed. This method is internationally agreed upon and recommended by the UNICEF and WHO (67). Currently, there is no standardized method recommended for children above 2 years of age in regard to the use of dietary diversity scores, however it is under evaluation (58).

[6] I have used 'dietary diversity' to describe variety in peoples diet, as suggested by Onyango (56). The use of dietary diversity scores in this thesis are further described in methodology chapter, section 5.6.3.

2.2.3 Disease

Disease and undernutrition are strongly interrelated and make a vicious circle. An undernourished child is more susceptible to diseases, infectious diseases in particular, because of the child's reduced immunity and nutrient stores, and the incidents tend to be more frequent, severe and longer. A sick child can face loss of appetite and malabsorbtion, and on the other hand an increased need of nutrients, thus a child suffering from both undernutrition and disease is extremely vulnerable to weight loss and growth faltering (31). This is the case for e.g. diarrhoea (68) and malaria (69), common African illnesses which exacerbate low nutritional status. The use of prelacteals, as discussed in the previous section, is an example of a practice which is likely to cause e.g. diarrhoea. Furthermore, the conditions under which the food is prepared, served and stored under are often unsafe in many Sub-Saharan African countries, and expose the children to frequent infections (70).

2.2.4 Care and the extended model of care

The concept 'care' has been defined as "the provision in the household and the community of time, attention and support to meet the physical, mental and social needs of the growing child and other household members" (71). Further, it has been described as the "practice of the caregivers that affect nutrient intake, health and the cognitive and psycho-social development of the child" (72). Care is provided to the child by the main caretaker, who is the mother in most cases (72).

As illustrated in the extended model of care (see figure 2), a child's potential for development, growth and survival, relies on the mother's care-giving behaviour and resources. The caregivers' resources (capacity and ability) includes the mother's education, knowledge and beliefs, physical- and nutritional status, mental health and self-confidence, control of resources and autonomy (e.g. decision making power), workload and time constraints and the support she get from family members, community, e.g. alternate caregivers. This has impact on her capacity and ability to e.g. breastfeed and feed the child properly (72). According to Engle et al. a caregiver who has the resources available is more likely to give effective care and maintain good child nutrition (73). The child's own characteristics also affect the type of care it receives, but this will not be discussed in the present thesis.

For instance, education is an example of capacity which the main caregiver has and needs to provide proper care to the child, and workload, on the other hand, is a facilitating conditions within the family or community (72). Women's education is important, and educated women usually have a greater knowledge of nutrition (40). According to Smith et al., education of women was the main contributing factor in reducing child malnutrition rates (undernutrition) between 1970 and 1995 in developing countries, with 43% (33).

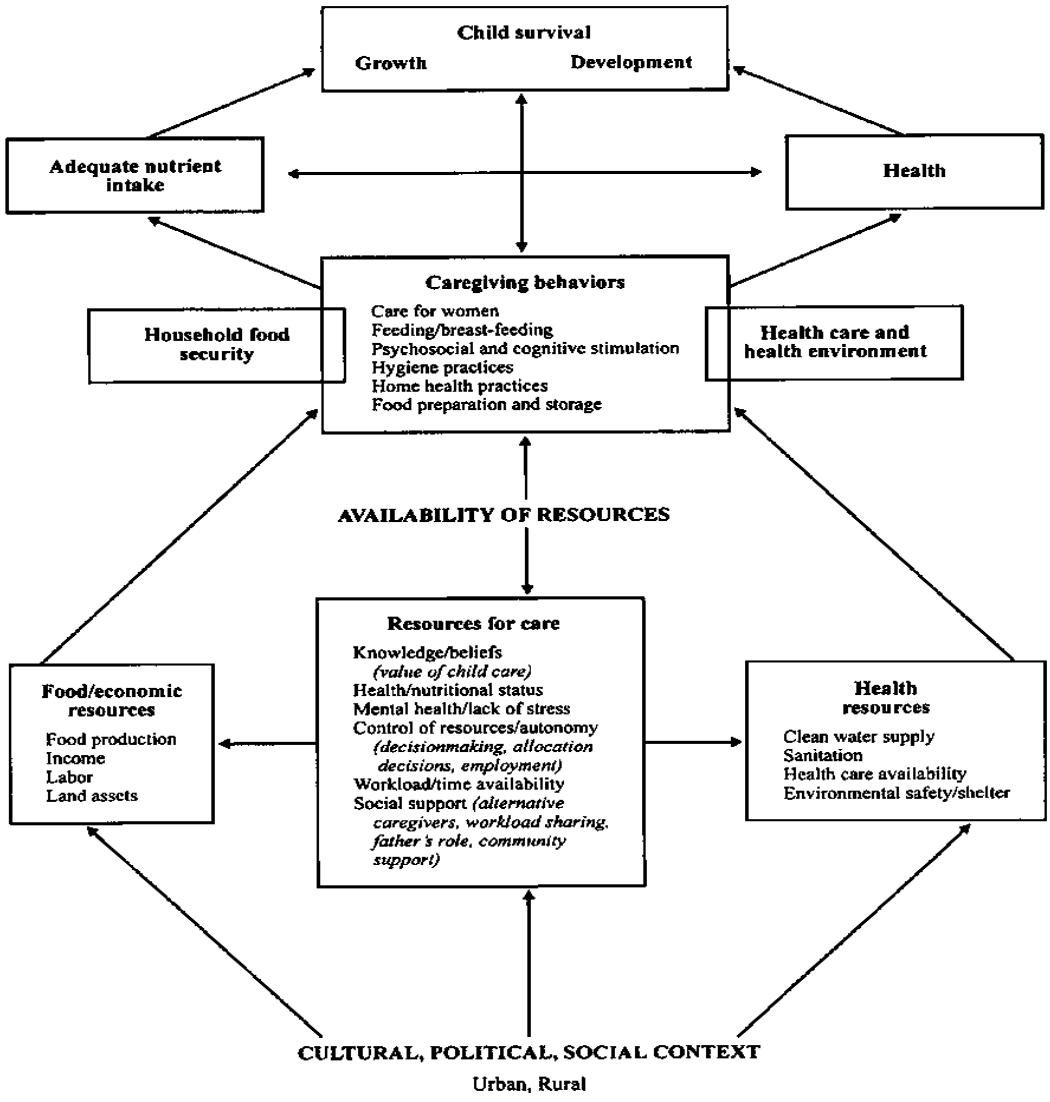

Figure 2: The extended model of care, adapted from Engle et al. 1996 (73).

Women's work and child care

The majority of women in developing countries, still work in the informal sector, most engaged in agricultural activities (74). Women participate more than men in both agricultural activities and in the household sphere (12;74). Rural women, in Sub-Saharan Africa and

elsewhere, have a heavy work burden, with responsibilities of farm work, household chores and other income generating activities to add on family incomes. A work day might add up to as much as 16 hours of the day. Typical women's work in the field is planting, weeding, harvesting in addition to post-harvest activities. Domestic tasks comprise e.g. fetching firewood and water, food preparation and child care (12;75;76). Women's time constraints are seen as one major determinant of limitations providing care (40). McGuire and Popkin have described poor women's work a 'zero sum game', where new activities have to either replace other activities or be conducted more effectively (76).

Women are found to invest more in child nutrition, health and education, compared to their male counterparts (12).

In Sub-Saharan Africa child care is often provided simultaneously as other activities, e.g. breastfeeding. Or it might be distributed to alternate caregivers; in many cases an older female sibling whose resources to perform proper care can be limited (72;76-78). However, if alternate caregivers are advised about e.g. child feeding, the children are suggested to be less susceptible to inadequate care (75;79).

There are many studies concerning women's work and its impact on children's nutritional status, but a causal conclusion has yet to been drawn. An article by Leslie (80) reviewed some of the first studies concerning women's workload, and found positive-, negative- and no effects on children's nutritional status. In addition she found that many of these studies had some major drawbacks such as methodology, categorisation of women's work, lack of definitions of women's work, and did not diverse children and type of work. A review article by Engle et al. (72) suggested women's workload and its impact on the children's nutritional status to be positive when income was fairly high and given to the mothers and/or when the mother had an adequate alternate caregiver and/or when the child was above one year of age. He further found the impact of women's work on nutritional status to be negative when the mothers had low wage and little control over income, long and inflexible workdays, young infants and no adequate alternate caregivers.

Studies of women's work in agriculture and the implications on children's nutritional status are scarce, and especially studies from the Sub-Saharan Africa. However, from the studies available, somewhat similar results as shown by Engle et al. have been revealed, in addition to a lack of association with child nutritional status (78;79;81-83).

Additionally, as pointed out in a paper by Holmboe-Ottesen et al. (84), women's workload in the field are found to peak during harvesting and weeding in wet season. In this period of high workload, which coincides with low food availability and increased infections, was also the period of the year when the children's nutritional status was poorest. Moreover, they suggested that other factors, such as low socio-economic status might be the cause of children's poor nutritional status, and not necessarily the women's workload. The paper furthers exemplifies practices found to successfully buffer the time-constraints the women were facing, e.g. that pregnant women were less involved in food production (which needs cooperation of the sexes), and older women in the household to be alternate caregiver (84). Heavy workload in the field is also found to limit time for breastfeeding (76).

Nevertheless, with this basis and the former study from Tanzania, women's workload in the field is suggested to affect children's nutritional status positively through increased food production (increased food availability, or increased household income and food expenditures), and negatively through less time available for caring practices (8). The outcome is also affected by type of work, amount of work, amount produced in the field, the age of the child and if the mothers bring the child along to work or not, the distance to the place of work and the quality of the alternate caregiver.

2.2.5 Other underlying/basic causes

Food security is defined by Food and Agriculture Organization (FAO) as a state in which " all people at all times have both physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (85). Food insecurity can occur whenever food supplies are limited or uncertain. In households relying on subsistence farming, food insecurity is found to be highest in the pre-harvest period (86). To cope with these temporarily food shortages various strategies are undertaken, e.g. borrow food, work for food or paid labour. According to Smith et al. improved food availability accounted for 26% of the reduction in child malnutrition (undernutrition) rates between 1975 and 1995 (33).

In the same article, health environment improvements and improvements in women's status relative to men accounted for 19% and 12% respectively, for the reduction in child malnutrition (33).

Of equal importance to food insecurity and inadequate care, as illustrated in figure 1, is poor environment; in terms of insecure water sources, poor sanitation facilities and poor household hygiene, and insufficient health services; as lack of health stations and poor quality of services provided as immunisation. For instance a study from rural Sudan found improved growth of children to be independently associated with improved water- and sanitation services (87). According to the most recent WHO immunization report, 20% of the children in the world do not receive the necessary vaccines, and these children are typically found in poor remote rural areas, and Africa is one of the regions hardest to reach (88).

Poverty can be both an outcome of and a contributor to undernutrition (27). Poor households are not likely to have the resources necessary to be food secure, to provide care and to attend health stations for health services, which obviously affects the children in the households. According to UNICEF (89), children are hardest hit by poverty, as it deprives them from basic needs such as nutrition, health, information, education, sanitation, water and shelter, which is essential for physical growth and mental development. Children who grow up in poverty are in turn most likely to live in poverty as adults (89). Thus, UNICEF (2005) (89) have proposed a definition of children in poverty as “children living in poverty experience deprivation of the material, spiritual and emotional resources needed to survive, develop and thrive, leaving them unable to enjoy their rights, achieve their full potential or participate as full and equal members of society”. On the other hand, undernutrition leads to poverty as undernutrition has a detrimental impact on the human’s potential in terms of mental and physical capacity, as described in section 2.1.1.

3 Country profile Tanzania

The United Republic of Tanzania is a peaceful costal country situated in Eastern-Africa with a total area of 947’300 sq kilometres (figure 3), and boarders Kenya, Rwanda, Burundi, the Democratic Republic of Congo, Zambia, Malawi and Mozambique. The total population is of nearly 43 billion (July 2011 est.), and is overwhelmingly young, with about 45% of the population below 15 years (90). The population density is low in Tanzania (40 pr square meter) (90).

Tanzania is divided into 26 administrative regions and 130 administrative districts (91).

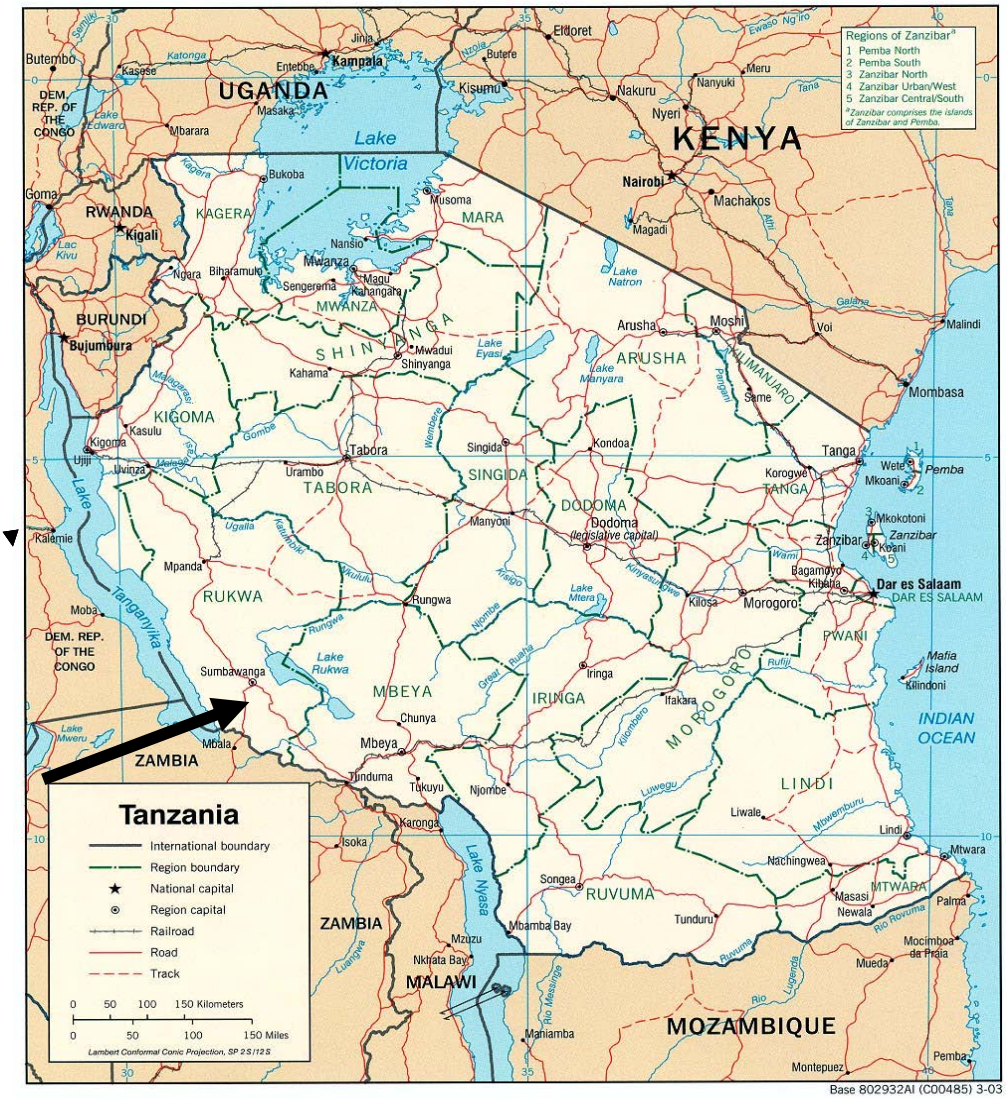

Figure 3: Map of Tanzania.

Source: http://geography.about.com/

The majority (75%) of the people reside in the rural areas, where agriculture is the main source (80%) of employment and livelihood. The majority is subsistence farmers, producing a variety of crops, according to the regional agro-ecological conditions. Women contribute the most in the agricultural labour force (15). Irrigation is not common in Tanzania, so the agricultural schedule depends on the rain. Major constraints in the agricultural sector are falling labour- and land productivity due to poor technology and irregular weather conditions (91).

Agriculture is also a major contributor to the Tanzanian economy; 25% of the Gross Domestic Product (GDP) in 2009, but not much is exported (92). The estimated GDP in Tanzania for 2010 was 22 billion US$, and places Tanzania as one of the poorest countries in the world (90). The GDP has grown in recent years (growth rate of 6% in 2009), mainly due to non-agricultural activities, especially tourism and gold (92). However, the growth in GDP has not been reflected in a decline of poverty rates (food- and basic poverty line[7]). In 2007 18.4% of the rural population fell below the food poverty line and 37.6% below the basic needs poverty line, only a small reduction since the early 1990s. These percentages represented rural areas, where the majority of the poor reside (93).

At the national level a strategy is undertaken to decrease poverty by economic growth, the National Strategies for Growth and Reduction of Poverty, MKUKUTA (1 and 2) in Kiswahili (94). However, social programs for the poor are close to non-existing, and is mainly provided by religious groups or non-governmental organisations (15). To overcome high poverty rates and to further increase economic growth, agricultural growth is one focus area in both MKUKUTA 1 and 2. One vision is to raise agricultural productivity among small-scale farmers through an initiative called “Kilimo Kwanza” (“Agriculture first”). To increase productivity, the strategy tries to facilitate access to technical inputs, capital and financing and connections to markets. Further, MKUKUTA 2, plans a gradual shift from small to medium to large scale farming (93;94).

Tanzania is ranked as number 148 out of 165 countries on UN’s Human Development Index (HDI)[8], indicating low human development. Primary education is for free, and nearly all children were enrolled in school in 2009, although there were some regional variations.

[7] The food- and basic needs poverty lines for 2007, in rural areas, had a cut-off at 9’574 and 13’114 TZ Shillings (93).
[8] HDI is a measure of countries’ health, education and living standards, measured through Gross National Income, expected years of schooling, mean years of schooling and life expectancy at birth (95).

However, the pupil to teacher ratio in governmental schools is high, ranging from 25:1 to 80:1. Secondary school and upwards is not for free, and the secondary school enrolment in 2009 was just below 30%. A quarter of the population do not have any education, with minor changes the last years. Of the educated, approximately half have primary level or lower. Lack of education is found to be most present in rural areas and among women. Life expectancy has increased and is assumed to be between 55 and 60 years (15;93).

Historically, in 1986, the International Monetary Fund and the World Bank implemented the Structural Adjustment Program, which consisted of privatisation and liberalisation of the market. This took place after years of social and political crisis and economic deprivation in the country. Tanzania still relies on the International Monetary Fund, the World Bank and bilateral funds (96).

Tanzania usually produces an overall food surplus. However, there are large disparities within the country. Food insecurity is most severe during rainy season (preharvest) and in periods of irregular weather conditions, and areas with one harvest is more vulnerable to food shortages compared to those performing irrigation (15).

3.1 The health and nutrition situation in Tanzania

3.1.1 Nutritional issues

Undernutrition is an extensive problem in Tanzania, especially among the children below 5 years of age. According to preliminary findings from the TDHS 2010, 42.3%, 15.7% and 4.6% of the children below 5 years of age were stunted, underweight and wasted respectively. Only a small reduction in undernutrition rates has taken place since the previous DHS was conducted in 2004/05, but since 1992 (when the first DHS was conducted) the prevalence have declined, 47% of the children were stunted in 1990/91, compared to 35% in 2010 (by applying the NHCS/WHO/CDC growth charts) (5). Stunting and underweight are found to increase with age, where as the prevalence of stunting peaks at the end of the second year and underweight after 6 months (5).

The distribution of stunting shows disparities due to residency (regional, urban-rural), gender and educational level of mother, where rural areas are more affected than urban, boys

somewhat more stunted than girls and children of educated mothers (secondary or more) less stunted than the others according to the most recent TDHS (5).

Overweight among children has been increasing since the first DHS was undertaken, mainly in the urban areas, and was 5% in 2010 (5).

Breastfeeding is an universal practice in Tanzania, and the most recent TDHS (5) found that nearly all (94%) were breastfed at the age of 1 year and more than half was breastfed well into their second year. According to the TDHS 2004/05, 35% of the children were given prelacteals the first week after birth. About 22% of the children 2-3 months and 93.4% of the children at 9 to 11 months were fed complementary food, according to the same study. Early introduction (52;97) and poor quality (53;98) of complementary foods are also suggested in other studies from Tanzania. Exclusive breastfeeding, on the other hand, is not customary. Only 50% of the children aged 0-5 months were exclusively breastfed, as a consequence of early introduction of liquids or foods, according to the last DHS 2010 (5). Other studies in Tanzania (77;99) have revealed similar findings of low rate of exclusive breastfeeding. However, the rate of exclusive breastfed children have increased since the first DHS was undertaken in 1992, 23% were exclusively breastfed at the age of 2 to 3 months in TDHS 1992, and 51.1% in TDHS 2010 (5;100).

3.1.2 Health issues

A country's health condition is associated with infant- and child mortality rates. The under-5 mortality rate has decreased from 137 deaths per 1000 live births in early 1990s to 81 per 1000 live births in the TDHS 2010 in Tanzania. The MDGs target of a under-five mortality rate on 48 per 1000 live births by 2015 is on track (5;101).

The most common diseases among children below 5 years of age include malaria, diarrhoea, acute respiratory infections and fever (5), which also are the top five causes of deaths in Tanzania. Poor sanitation and caring behaviours, poor handling and accessibility of safe water sources, low access to and quality of health centres and low levels of schooling are found to impact on these high numbers together with a poor nutritional status. Rural areas are more affected than urban (15).

The numbers of fully vaccinated children have increased since late 1980s and covered 75% of the children in the most recent DHS (5). Vitamin A supplementation is provided biannually together with de-worming tablets, since 2001 and 2004 (15).

The prevalence of HIV/AIDS was 5.1% among the adult population (15-49 years) in 2009, according to Joint United Nations Programme on HIV/AIDS (USAIDS) estimates, a decrease from 7% in 2003 (102). Children are mainly affected trough mother to child transmission.

Children below 5 years of age receive health care services for free, through Primary Health Care. The health care services are generally poor, especially the governmental health centres and in the rural areas. However, the coverage is increasing countrywide; approximately 80% of the population had access to health stations in 2001 (15). Programmes to control undernutrition and micronutrient deficiencies in children are present, but the coverage is generally low, except from national coverage of vitamin A supplementation (as mentioned above), iodized salt and distribution of iron, folic acid and anti-helmits (15). However, there is little information about nutrition in rural areas (103).

3.2 The study area

Msanzi village is situated in the Rukwa Region, Sumbawanga Rural District, which lies in the south western part of Tanzania. The area is shown by an arrow in figure 3. Sumbawanga[9] town is the region's capital city, a rough two days ride from Dar es Salaam, and a two hours ride from Msanzi. Msanzi village has 5'156 inhabitants (105). Rukwa region is one of the least populated regions in the country (96).

Msanzi is situated at the Ufipa plateau, a mountainous plateau ranging from 1200-2000 meters above sea level, covering most parts of the region. The majority of the people at the Ufipa plateau belong to the Fipa tribe, where most relies on subsistence farming. The main crops cultivated are maize, beans and finger millet, as they were in the late 1990s. Since then sunflower, rice and potatoes have also been introduced and cultivated. The agricultural production has increased since the late 1970s. This has been explained by increased production, improved market access and trade, population growth and introduction of the new

[9] Sumbawanga, in Kifipa (the local language) Sumba means throw and wanga means witchcraft, so litteraly it means throw whitch craft (104).

cash crops (96). However, there is still a limited access to the markets because of lack of transport and large distances, resulting in not so much profit for the local farmers (97).

The climate at the Ufipa plateau is uni-modal, with rainy season from October/November to around May, followed by dry season. The rainfall varies from 800–1200 mm, and the temperature is around 25C°, with a minimum temperature of 5-10 C° in June/July. The agricultural schedule follows the rain, where planting begins with the first rain, and main harvest is in July. Oxen or hoe are used for planting, and maize begins to ripen in March (97). Irrigation takes place in Msanzi, and provides an extra cultivation cycle during the dry season (53). Food insecurity is found to be most severe in the months before harvest, as many households run out of food. This time of the year describes Hadley (97) as a period with lower food availability, reductions in energy intake, increased workloads, increased infectious diseases, deterioration of nutritional status and child mortality.

Rukwa is also characterised as a remote and back-ward region, where the government has failed to provide the region with enough developing support. However, rural development is again on the agenda (96), which can be reflected e.g. in an improvement of the region's infrastructure, as some tarmac roads are being built to connect the region with neighbouring regions and the port at Lake Tanganyika. One of the roads passes through Msanzi. Telecommunication has also expanded, with good connections in the rural areas of the region, including Msanzi. Electricity is only present in Sumbawanga town; this is also where the regions library, post, bank, hotels, markets, high-school, several Non Governmental Organizations are located. Running water is not common in the villages.

The poverty levels are found to be high in Rukwa, but extreme poverty due to food deficit is low (96). In addition, Rukwa region is considered one of Tanzania's five "food baskets" producing a food surplus annually (15).

However, the rates of stunting, underweight and wasting in Rukwa are among the highest in the country, 50.4%, 13.5% and 3.8% respectively according to the most recent DHS (5). The health and nutrition situation is poorer in Rukwa compared to the rest of the country; though it has improved since the 1990s. Rukwa area is also affected by malaria, especially during and after the rainy season (97).

Health care is provided in the villages at governmental health centres/'village health' by a medical officer/health worker, and the regional hospital in Sumbawanga provides basic treatment. The coverage of health facilities is generally lower compared to other regions (106). However, the health system has improved, with more health stations, increased rates of vaccination, supplementation and deworming. The baby friendly hospital initiative does not exist in Rukwa (personal communication, medical officer). Rukwa is also widely known for the belief and use of witch craft.

Maize is the main staple in Rukwa. Maize flour is used to make *uji* (maize gruel given as complementary food) and the staple food *ugali* (stiff maize pudding). Available at the local market in Msanzi are mainly tomatoes, onions, and a variety of green leaves (7). Avocados, carrots etc. are not common, but are cultivated and sold in e.g. Sumbawanga town. In Msanzi, bananas are available throughout the year, mangoes from November to January, guava in June and July.

In general in Tanzania, vegetables are usually consumed on an everyday basis, but in small quantities, and thus the contributions of nutrients are limited. Intakes of fruits are generally low, considered not as important by many adults. Animal products such as meat, milk and eggs are rarely consumed. In rural areas it is common to eat from shared pots, and the cultural norm in the particular place decides which person who will eat first. Number of meals differ with the seasons, after harvest (dry season) two meals and during planting (rainy season) one meal is not uncommon (15). Firewood or charcoal are used for cooking (15).

3.3 Summary of the former study in Msanzi 1987/88

The majority of the participants in the former study from Msanzi village (1987/88) were subsistence farmers, and most women were uneducated (<1 year of education) (62%) (7).

The former study used underweight as an indicator of undernutrition, and found the prevalence of underweight (as percent below 75% of the NCHS/WHO reference median) among the studied children to be 26.4% (7). The prevalence presented was an average of measurements taken in three seasons (post-harvest, main harvest and pre-harvest). During pre-harvest season the prevalence of underweight children was highest, and was most pronounced among children with low socio-economic status (10). A similar pattern was

observed for feeding frequency, with the lowest feeding frequency during pre-harvest season (10).

About 40% of the children were breastfed until the second year, and *uji* maize or millet was introduced as complementary food between 4 and 6 months. At around 1 year the children were given *ugali* and relish, mostly bean stew and/or cooked green leaves, and sometimes with cooking oil, tomatoes, onions and/or groundnuts. Breakfast was normally given to the children, and non-breastfed children were fed in average 3 feedings a day. Fruits in season, maize on the cob, fresh maize stems and sugar cane were given as snack (6;8).

The former study investigated the relationship between household food insecurity (measured as months without food in stock) and nutritional status among preschool children. The nutritional status of children was found to be significantly better in the households which were without maize stock for a shorter period of time compared to those with food shortage for a longer period (107). Additionally, it was found that underweight was a problem in the households with a surplus of food as well (8).

In seasons of high workload in the field women were found to spend less time in child care (9), cooking and feeding (8). A negative, but not significant relationship was found between women's workload (measured by 24-hour recall) and the children's nutritional status, where the women who worked a large part of the day in the field had more underweight children compared to women who worked less (8). To compensate for time constraints, about half of the mothers brought their children to the field, where only half of them were fed, mainly *uji*. The children who were fed in the field were fed more often than the children who were not fed in the field, but they did not have a better nutritional status. However, the quality of food (measured by 24-hour dietary recall) taken together with feeding frequencies were found to be significantly and positively associated with children's nutritional status (8).

4 Aims and research questions

The aims of the present study are to provide data on the nutritional status of children below 5 years of age, and to investigate factors assumed to cause undernutrition. The study further aims to explore possible changes since the former study was conducted in the same village in 1987/88.

The following questions were investigated:

1. What is the nutritional status, measured as the prevalence of stunting, underweight and wasting, of the children below 5 years of age? Is there a difference between age/gender and nutritional status?

2. For how long do the mothers breastfeed/exclusively breastfeed their children?

3. What are the practices of feeding children below 5 years of age?

   At what age was the first liquid/food introduced and what was introduced to the children?

   How is the quality of children's diet, measured with Minimum Dietary Diversity, Food Variety Scores (FVS) and Diet Diversity Scores (DDS)?

   How often are children fed?

   Is there a relationship between children's nutritional status and DDS, FVS and food frequency respectively?

4. Does women's workload in the field affect their abilities to provide care for their children, measured as the relationship between women's workload and children's nutritional status?

5. Is there any association between children's nutritional status and selected factors, such as biological- and demographic variables and indicators of socio-economic status, food security and women's workload?

6. What changes in children's nutritional status (underweight), and possible influencing factors (duration of breastfeeding, child feeding, women's level of education) have taken place since the former study was conducted in Msanzi in 1987/88?

5 Methodology

5.1 Study design

The study was conducted in Msanzi village in Sumbawanga district, rural Rukwa region. The study was undertaken from September to December 2010, in the pre-planting/planting season, but only a minor part was collected in the planting season (about 30 households).The location was chosen since this was one of the sites where the former study from 1987/88 was undertaken.

The present study was cross-sectional in nature and used quantitative methodology, which included a structured questionnaire, 24-hour dietary recall, without amount, and anthropometrical measurements.

5.2 Study population and sampling

5.2.1 Study population

The study population was households with at least one child below 5 years of age, and within these households the study participants were one child below 5 years of age (target child), the main caretaker of the child and the household head.

Inclusion criteria:

Households with at least one child below 5 years of age.

Caretakers and household heads willing to participate.

Permanent residents of Msanzi since October 2009.

The households which moved to Msanzi after October 2009 were excluded because they were assumed not to be representative of the Msanzi population. Disabled children were excluded as they do not have the same growth and development patterns as non-disabled children, which would have brought bias to the sample.

5.2.2 Estimation of sample size

The sample size was determined by using a formula (indicated below), where the prevalence of underweight children below 5 years of age in rural Rukwa was used, which was 24.5% according to TDHS 2004/05 (106).

The formula used: $n = \frac{t^2 \times p(1-p)}{m^2}$

n=required sample size, t=confidence level at 95% (standard value 1.96),
p=estimated prevalence undernutrition in the project area (24.5%), m= margin of error (7%)

From this formula, a total number of 145 children were obtained; thereafter an additional 5% was included to account for attrition (the non-response rate) rendering minimum 152 children. The number of 152 children is a sample size representative to the target population at a 7% precision point and with a confidence of 95%.

Thus 152 households were included in the study. The main caretakers of the target children and the household heads were recruited from these households.

5.2.3 Sampling procedure

The households included were selected based on single stage proportion to size sampling procedure. Msanzi village is divided into three sub divisions and further into six sub villages. No comprehensive list of all the households in Msanzi village existed, but in each of the sub villages a comprehensive list of households was present and obtained from the different sub-village leaders. According to the Ward/Village Executive Officer and the sub village leaders, the sub villages had approximately the same numbers of households, except for two sub villages, one which was a little larger and one which was smaller than the others. Thus, the sample size in the different sub villages included: 25 households in the four sub villages of equal size, 31 households in the largest and 21 households in the smallest sub village. The households were randomly selected from the different sub villages by the following procedure: first a sampling interval was developed by dividing the total number of households in the sub village by the number required; household number one was randomly selected and thereafter the sampling interval was applied. If the selection criteria were not fulfilled in any of the selected households, the sampling procedure continued until the acquired number was obtained.

For random selection of children in the cases where a selected household had two eligible children, a coin toss was used, and in cases of three children we wrote the children's names on a piece of paper from where one piece where drawn. If the study participants were not at home when they were supposed to be interviewed they were re-visited, at least once more.

5.3 Ethical considerations and research clearance

Ethical clearance was obtained from the National Institute of Medical Research in Tanzania (NIMR) and from the Regional Committee for Medical Research Ethics in Norway prior to study start.

Information about the study was provided by my fellow student, in easy words and in Kiswahili, to all the study participants at the day of the interview. The information concerned; the purpose and aim of the study; it was explained that participation was voluntary and that there would be no negative consequences if they decided not to participate; their right to at any point of time withdraw from the study; the non traceability of respondents and the confidentiality of the information gathered. Informed consent was obtained from all the study participants. A written consent or thumb print was obtained from all the main caretakers and household heads who participated. The informed consent form which was used is attached in appendix 1.

After ethical clearance was approved, research permit for foreign researchers was applied for and obtained from the Commission for Science and Technology (COSTECH) in Tanzania. Thereafter an immigration officer provided research visa.

5.4 Preparation for data collection

5.4.1 Information to the government officers

The study was introduced to Rukwa Regional Administrative Office, Rukwa Regional Health Office and to Sumbawanga Rural District Health Office by a letter and formal meeting. This was followed by meeting with government officials in Msanzi.

5.4.2 Field assistant and sub village leaders

As my fellow student speaks Swahili fluently, there was no need for an interpreter. A field assistant, recommended to us by the government officer in Msanzi, was employed the whole period of data collection. The field assistant introduced us to the various sub village leaders prior to data collection in their sub village. The sub-village leaders were employed by us during our stay in their sub village (approximately two weeks). The sub village leaders informed their residents about our presence, provided us with the village inhabitants list, arranged appointments for our visits and accompanied us, together with the field assistant, to the different households at the day of interview.

Logistical matters in the field

During our period of field work we stayed in a nearby village of Msanzi called Matai. Transportation was limited between Msanzi and Matai; therefore the data collection started around 8-9 in the morning and lasted until the afternoon (from 1pm to 5pm). Incentives were not provided to the households which participated.

5.5 Data collecting procedures and tools

5.5.1 Data collecting procedures

Data collection was based on face-to-face interviews with a structured questionnaire, 24-hour dietary recall, without amount, of the target child and anthropometrical measurements of the target child. The interviews were performed by my fellow student, and the anthropometrical measurements were carried out by both of us, together with the field assistant. The interviews for the household head and wife/main caretaker were done separately and privately.

5.5.2 The structured questionnaire

A draft questionnaire was developed by us (the students) together with the local and external supervisors before we went to the field. The questionnaire was based on the questionnaire used in the former study conducted in 1987/88 (not published), the TDHS 2004/05(106), the Multiple Indicator Cluster Surveys (108) and a study from Malawi (47). The questionnaire was reviewed after pilot-testing and translated into Swahili by my fellow student. The

questionnaire had both open- and close ended response categories. The close-ended response categories had in most cases an option called “other”, which was used for the responses which did not fit our pre-coded categories, and where the participants’ responses were written down (see questionnaire, appendix 2).

One questionnaire was prepared to contain information for both of the two master students. The questionnaire is found in appendix 2. The parts of the questionnaire relevant for this thesis concerned information about the following:

Child characteristics: Date of birth (age), gender.

Households’ demographic characteristics: Household head’s relation to the target child, number of wives, size of the household, number of children below 16 and 5 years, main caregiver of the child.

Socio-demographic characteristics: Educational level, occupation and other income generating activities of the household head and main caretaker/wife.

Economic status: materials of the roof, number of cows, possession of assets, size of main field (*shamba*).

Prevention and control of disease: Main source of drinking water, child sick the last two weeks, vaccination status, vitamin A supplementation, deworming.

Feeding practice of the child: if the child was breastfed and/or fed with food at the time of the interview, ever breastfed, length of breastfeeding, the first type of liquid/food introduced to the child after birth, age of the child when introduced to first liquid/food after birth.

Child care while working: What the main caretaker did with her child when she went to the field, if the child was fed if she brought the child with her, what the main caretaker fed the child in the field, if the child was not brought to the field, who was the child left with, if the child was fed by the person the child was left with.

Agricultural characteristics: size of land cultivated last season, type of crops cultivated last season, main source of food in the household, dry-season cultivation, the length of the agricultural periods in the different type of crops.

Agricultural workload: the main caretaker/wife's length of different agricultural activities and frequency of all agricultural activities which are land clearing, ploughing/hoeing, planting, weeding and harvesting.

Food security: numbers of months without food in stock.

All the questions were asked to the main caretaker of the child, except the questions related to the household head's occupation/education/other income generating activities and the household head's workload in the field, whom were asked to the household head. Thus, the main caretaker was regarded the main respondent in the present study.

5.5.3 The 24-hour dietary recall

The dietary assessment was performed by the use of the 24-hour dietary recall method. The main caretaker of the target child was asked about what the child had consumed of foods and drinks, without estimations of amount, the day and night before the interview took place. The dietary recall sheet prepared for this study was based on the former study (data not shown) and a sheet by Gibson (modified from Weiner and Lourie (1969)) (22). The dietary recall sheet is attached to the questionnaire in appendix 2.

5.5.4 Pre-testing

The questionnaire and 24-hour dietary recall sheet were pre-tested in 15 households. The aim was to see if the questions were understandable, that they were in a logical order and that we got the information we needed. The questionnaire was then revised and adjusted based on the responses during the pretesting. Some questions were changed completely and some were reformulated to make them more understandable. Changes concerned the following questions: The question about wall material was excluded, as we observed that all houses were made up of the same material, and some assets were added to the questions concerning material possession such as; sofa/chairs and table. The part considering women's and men's workload was completely changed, as it was found not to catch the actual workload, whereby recalls on last agricultural period and frequency were used instead. Two questions concerning the children who received sugar water as the first liquid were added; for how long the sugar water was given; and when the child was introduced to water after sugar water was discontinued.

5.5.5 Anthropometrical measurements

Weight and length/height were measured and recorded for all the target children, in addition to age. The tools needed for anthropometrical measurements were provided by Sokoine University, before we (the students) went to the field. We were also trained in conducting anthropometrical measurements at Sokoine University, and the field assistant was given training by us.

The weight of the children was measured by using an electronic scale, a standardized digital UNICEF uniscale. The scale was placed on a flat surface and was recorded to the nearest 0.1 kg. Children were measured without shoes and with light clothing. Children who were too small or children who refused to stand on the scale alone, were measured together with the mother. The mother stepped on the scale, the scale was tarred, the child was then given to the mother and the weight recorded. Two weight measurements were taken; if the measurements varied a third measurement was taken. Recorded was wither the two similar measurements or the mean of the three. The scale was regularly checked for accuracy by the use of a 1.0 kg bottle of water.

The length/height was measured using a hard wood three piece length board. The measuring board had a fixed board at zero and a piece which was moveable. Length or height was measured in children below and above about 85cm (approximately 2 years) respectively. The smallest children were measured lying straight, with the head touching the fixed board, the face up, the knees pressed down and the heels towards the moveable piece. The children above approximately 2 years who could stand by themselves were measured in a standing position; face straight (chin support) and back/knees/heals touching the board. The length/height was recorded to the closest millimetre. Anthropometric Indicators Measurement Guide, 2003 edition, was used as guidance (109).

The age of the children were obtained from the caregivers and then verified with the clinic cards. When no clinic card was available (this was the case in three households) the mothers recalls were used, after a long discussion, as they were found trustworthy.

Training of performing anthropometrical measurements was conducted at Sokoine University and in the village.

5.6 Variables used in the analyses

Both binary logistic- and linear regression analyses were performed in this study. The analyses were inspired by the UNICEF framework (figure 1) for determinants of undernutrition. Thus, the variables used in the study were arranged according to the framework. Additionally, some variables were used to characterise the study population only.

5.6.1 Logistic regression analyses

Height-for-age z-score, weight-for-age z-score and feeding frequency were used as dependent variables in the binary logistic regression analyses. Diet Diversity Score (DDS), Food Variety Score (FVS), feeding frequency and the women's workload in the field were used as independent variables, in addition to the confounding factors age, disease and the asset score/women's workload. Section 5.7 provides more information about the logistic regression analyses.

5.6.2 Linear regression analyses

In linear regression analyses weight-for-age z-score and height-for-age z-score were used as dependent variables. The independent variables tested for in crude analyses are presented below. Included in the final model were variables with a p-value <0.15. The independent variables that did not meet this criterion are presented in Appendix 4. Section 5.7 provides more information about the linear regression analyses.

Independent variables

Age of child, sex of child, disease in the reference period (last 2 weeks), women's workload in the field, months without food in stock, dry season cultivation, assets score, type of roofing, possession of cattle, size of *shamba*, mother's/father's education/other income generating activities, father's occupation, household head, number of wives, size of household, children below 16 and 5 in the household, frequency of fathers'/mothers' beer drinking.

5.6.3 Operational definitions of some of the variables used in the analyses

Nutritional status

Length/height-for-age, weight-for-age and length-for-length/height [10] were used as indicators of nutritional status (21), and was computed by comparing the child's measurements to a standard; the WHO Child Growth Standards (16) and a reference population; the NCHS/WHO reference population (24). The latter was applied to be able to perform comparisons with the former study from Msanzi (7). That study used only weight-for-age compared to the NCHS/WHO reference population as a measure of nutritional status, which was internationally recommended at that time (24).

When the Child Growth Standards were applied, z-scores (or SD-scores) were calculated for each child. Z-scores describe how far a measurement is from the median (average)[11] (110). A z-score below -2, describes that the child is undernourished and applies to all the anthropometrical indices, as recommended by WHO (21). Moreover, throughout the thesis, stunting, underweight and wasting are used to refer to height-for-age z score (HAZ), weight-for-age z-score (WAZ) and weight-for-height z-score (WHZ) below -2.

Weight-for-age was used as index when the NCHS/WHO reference population was applied. Percent of the median relative to the NCHS/WHO reference median was used, and a cut-off was set at 75% of the median where as children below the cut-off were classified as underweight, as in the former study (8). 100% weight-for-age represents the median of the NCHS/WHO reference population.

Based on the WHO Child Growth Standards (2006), the categorizations of HAZ, WAZ and WHZ were as follows:
Obese/overweight: WHZ >+ 2 z-scores.

Normally nourished: HAZ, WAZ and WHZ, + 2 to -2 z-scores.

Undernourished: HAZ, WAZ and WHZ <- 2 z-scores.

[10] Hereby length is excluded from the name of the indices, length/height-for-age and weight-for-length/height.
[11] Z-scores are calculated differently for normally distributed and non-normally distributed populations; normally distributed (height-for-age) z-scores are calculated from the following formula: z-score = (observed value – median value of the reference population) / z-score of the reference population. Non-normally distributed weight-for-age and weight-for-height) z-score = ((observed value ÷M)^{L}-1)/L*S. M, L and S are values for the reference median (110).

Moderately undernourished: HAZ, WAZ and WHZ, <- 2 to -3 z-scores.

Severely undernourished: HAZ, WAZ and WHZ <- 3 z-scores.

Based on the NCHS/WHO (1983), the categorization of weight-for-age was as follows: Underweight: < 75% of the reference median.

Exclusive breastfeeding

This information was given by the main caretaker's recall of age of introduction of liquid/complementary foods, from where length of exclusive breastfeeding was calculated.

Indicators of diet quality

To indicate the quality of the diet, an indicator of Minimum Dietary Diversity was used for children between 6 and 23 months (most of whom were breastfed), and a Food Variety Score (FVS) and a Diet Diversity Score (DDS) for non-breastfed children. These indicators were all based on data from the 24-hour recall. Minimum Dietary Diversity is an indicator of the diet quality of children between 6 and 23 months of age where consumption of foods from at least 4 food groups is associated with better quality diets for both breastfed and non-breastfed children. This method has been validated based on several studies (61;64), and used by the UNICEF (67). The FVS and DDS have been found to be fairly good indicators of nutritional adequacy of the diet of non-breastfed children (57;65;66), but no validated score (list of food groups/items, cut-offs, age group, reference period) have yet been made which are internationally agreed upon, but research work is ongoing (58). A reference period of 24 hours is commonly used, e.g. in a study by Steyn et al. (66) and suggested for use for non-breastfed children 2 to 6 years of age (111), and young children from 6 to 23 months (61). The children were removed from the analyses due to sickness, if this had affected normal feeding.

Minimum Dietary Diversity Indicator, children aged 6-23 months

Minimum Dietary Diversity has been defined by WHO as "the proportion of children 6-23 months of age who received foods from 4 or more food groups the previous day" (67),whether breastfed or not, and is calculated based on a standardized list of 7 food groups, which are, 1: Grains, roots and tubers, 2: Legumes and nuts, 3: Dairy products, 4: Flesh foods,

5: Eggs, 6: Vitamin A rich fruits and vegetables and 7: Other fruits and vegetables. This method was applied, and each food group got a score of 1, if consumed, and of 0 if not consumed, and the highest score a child could obtain was therefore 7. The children were grouped into two groups, children who had consumed ≥ 4 or < 4 food groups.

Food Variety Score (FVS), children not breastfed

The Food Variety Score was defined as the number of food items eaten over a period of 24 hours, as defined by Hatløy et al. (65). The score in the present study was developed based on 23 food items from a total of 26 food items, reflecting all the different food items eaten by the children in Msanzi. Sugar items and beverages were excluded. Each food item consumed in the 24-hour period got a score of 1, and food items not consumed got a score of 0. A sum score was computed for each child based on frequency distribution and was further divided into three groups to indicate low, average and high food variety.

Diet Diversity Score (DDS), children not breastfed

The Diet Diversity Score was defined as the number of food groups consumed by the child over a period of 24 hours, which is a similar definition to what is used in other studies (65;66). The score was based on 9 food groups, 1. Grains, 2. Legumes and nuts, 3. Diary products, 4. Eggs, 5.Flesh foods (meat and fish), 6. Vitamin A rich vegetables and fruits, 7. Other vegetables, 8. Other fruits, 9. Oils and fats. This grouping was chosen based on similar studies of non-breastfed children (57;65), other studies (66) and recommendations from FAO (111). A food group got a score of 1 if consumed, and of 0 if not consumed. The highest score a child could obtain was therefore 9. A score was computed for each child, and based on the frequency distribution the children were further divided into three groups, indicating low, average and high diet diversity. Sweets, sugar and beverages as tea, juices and soda were not included in other studies, e.g. a study by Kennedy et al. (57), and were not included in this study either.

Feeding frequency

The number of feedings (which included meals and snacks in between) the child received the previous day according to the 24-hour recall, was used as a proxy for energy intake. It is found to strongly correlate with energy intake from complementary foods among breastfed children in all age groups; correlations for non breastfed children were generally lower (112).

The numbers of feedings were categorised into three groups, to indicate low, average and high feeding frequency.

Disease

Disease was measured by the cases of disease at the present or the previous two weeks, according to the main caretaker's recall. Included in the regression analyses were children with diarrhoea, fever and/or vomiting, as they were assumed to contribute to undernutrition.

Food stock

The number of months without the main food crop (maize) in stock was used as the indicator of food security. The main caretaker was asked whether the household was out of stock before the last harvest and the number of months they have stayed without maize in stock. This method has been used by the former study (10) and another study from Rukwa Region (97). This method was used to capture accessibility to food the whole year around, despite seasonal variation. The households were considered to be food secure if they had maize in stock throughout the year from one harvest to the next harvest.

Women's workload in the field

The women's workload was estimated based on the period and frequencies of days they went to the main field (*shamba*) in various agricultural activities and in cultivation of various crops the last agricultural season (October/November 2010 to July 2011). The agricultural activities included land clearing, ploughing/hoeing, planting, weeding and harvesting, and the crops cultivated were maize, beans, finger millet, groundnuts, wheat and sunflower. The period women were working was calculated by the length, in weeks/months, of the various agricultural activities for each crop. The frequency, that is the number of times she went to the field, was classified into everyday, several times a day, twice a week, once a week, occasionally and never for each period. The number of days the women went to the field was then calculated by multiplying frequency with the length of the period(s). The number of days the women went to the field was used as a proxy for women's workload.

Everyday a week was given a value of 6 days, since they usually did not work in the field on Sundays; Several times a week was given a value of 4 days, which is a mean between 3 to 5 days a week. Three categories were developed according to frequency distribution.

Indicators of economic status

Four different indicators of economic status were constructed, based on the data from the questionnaire.

Possession of cows

The indicator was developed based on if the households were or were not in possession of cattle. A score of 1 was given to households which had cattle and a score of 0 was given to households which did not have cattle. Other studies, e.g. a study from Rukwa used possession of cows as an indicator or wealth (97). Possession of cow is a sign of wealth in Rukwa.

Size of main field (shamba)

The indicator was developed according to size of the *shamba*, which were divided into three groups based on frequency distribution. The cut-off's were set at ≤ 0.80 Ha, >0.80–<1.61 and ≥ 1.61, according to frequency distribution. Size of *shamba* has been used in other studies as an economic indicator.

Type of roofing

Type of roofing was either iron sheets or thatched straw, and households with iron sheets were assumed to be wealthier than the households with thatched roof.

Possession of assets (asset score)

The different assets were given an economic value based on an approximate monetary value (what the assets cost in the market, in Tanzanian Shillings (TZS)) which we came to know by our presence in Msanzi during the fieldwork.

The values given to the assets were as follows:

Economic Value	Asset
5'000 TZS	Wrist watch
10'000 TZS	Radio
30'000 TZS	Mobile phone
40'000 TZS	Chair/Table
100'000TZS	Sofa/Table
	Cupboard
120'000TZS	Plough
	Bicycle
	Sewing machine
200'000 TZS	TV
1'000'000 TZS	Milling machine
	Motorcycle

1 TZS = 0.004 NOK (1.10.2010)

Each household received a score according to the number of assets and their monetary value. The majority of the households had none or one asset, but in households which were in possession of more than one asset the monetary value of the assets were added. Thereafter two cut off points were set, according to frequency distribution, ≤40’000 TZS, >40’000 to <160’000TZS and ≥160’000TZS. The groups indicated poor, middle, and high economic status respectively, in Msanzi.

5.7 Data handling and analysis

The majority of the questionnaires were checked for any incorrect, illogical or missing data while in the field. In case of such irregularities, we went back to the respondent to seek clarity. Most of the data was entered into Statistical Package for Social Science (SPSS) version 16 in the field and was checked and cleaned by going through each and every questionnaire by both of us. Missing values were also detected by running frequencies on each variable.

WHO Anthro 2005 v 3.1.0 was used to convert the anthropometrical data into z-scores. Excel was used to obtain the children’s percentage value of the NCHS/WHO reference median and to calculate the women’s workload and socio-economic status before transferred into SPSS for analyses. Calculations of the women’s workload were performed by my fellow student.

For a description of the study population, frequency distribution with mean and standard deviation was used if normally distributed and median and min-max and/or 25-75th percentile was used if not normally distributed. Cross tabulation and Pearson chi-square test were used to test for differences in proportions and significant difference between groups. Mann Whitney U Test was used to assess if there were any differences in age between the genders. Kruskal Wallis Test was used to assess if there were any differences between the children's nutritional status according to age groups.

Binary logistic regression analyses were conducted to examine the relationship between the dependent variables: severe stunting, stunting, underweight and feeding frequency, and the independent variables: FVS, DDS, feeding frequency score and women's workload. The analyses were first conducted in separate analyses, between the dependent and independent variables. Included in the final model were potential confounders and the selected independent- and dependent variables. The confounders included in the adjusted analyses were based on factors discussed in the literature (theory). Confounders included in analyses considering FVS, DDS and feeding frequency were disease, age and women's workload, and confounders included in the analyses considering women's workload were disease, age and the asset score. Assumptions of sample size, multicollinarity and outliers were met, as described in the literature (113;114). As a majority of the children were stunted (HAZ <-2), severe stunting (HAZ <-3) was also used as one of the dependent variables. Severe stunting and underweight (HAZ <-2) are illustrated in the tables in the section considering the results.

Linear regression analyses were applied to explore which variables (according to the UNICEF framework) contributed to the variation in height-for-age and weight-for-age respectively. All independent variables were tested, one at a time, with the dependent variables (HAZ and WAZ), and only the most significant variables were included in the final model ($p<0.15$). In the final model multicollinearity, outliers, normality, linearity, homoscedasticity and independence of the residuals were tested for, as described in the literature (113;114). Dummy variables were developed for categorical variables that had more than two categories and for continuous variables that were not linearily correlated with the dependent variable. The number of independent variables in the analyses was in accordance to the sample size requirements, by the use of the following formula: $n>50+8\times m$ (n=sample size, m=independent variables) (113).

Statistical significance was set at $p <0.05$.

6 Results

6.1 Characteristics

In 140 of the households both the household heads and the main caretakers were interviewed, and in the remaining 12, only the mothers were interviewed as they were both household head and main caretaker of the child.

6.1.1 Demographic characteristic of the households

In most of the households (90.1%) the father (or stepfather) was the household head[12] and approximately 10% of the households were polygamous (table 1). Less than 10% were female headed households. The mothers were the main caretakers[13] of the children in all cases except one, where the grandmother was the main caretaker as the mother was under age and no father was present. The sizes of the households ranged from 2 to 11 people with a median value of 6 (5-8). The number of children below 5 years in the study ranged from 1 to 3, where slightly more than half the households had more than 2 children below 5 years of age (table 1). In addition, most people in Msanzi were religious, mainly Catholics.

[12] Household head hereafter called father.
[13] Main caretaker hereafter called mother.

Table 1: Demographic characteristics of the households, n=152.

	%	N
Household head		
Father	90.1	137
Mother	7.9	12
Stepfather	1.3	2
Grandfather	0.7	1
Main caretaker of the child		
Mother	99.3	150
Grandmother	0.7	1
Fathers, number of wives (n=140)		
1 wife	88.6	124
2 wives	10.7	15
3 wives	0.7	1
Size of household		
<5 people	38.8	59
6 - 7 people	31.6	48
>8 people	29.6	45
Children <5		
1 child	43.4	66
2 children	54.0	82
3 children	2.6	4
Children <16[a]		
≤3	44.1	64
4	24.1	35
≥5	31.7	46

[a] Missing values, n=145

6.1.2 Demographic and socio-economic characteristics of the mothers and fathers

The educational level was low, and the mothers of the children were less likely to have completed primary school compared to the fathers (table 2). Less than or equal to 2.7% of the mothers and 7.2% of the fathers had secondary school or above.

Nearly all mothers practised farming (96.7%), but fewer reported farming as their main occupation (92.8%) (table 2). In addition, the majority of the mothers (71.1%) were also involved in other small scale income generating activities, mainly beer brewing. The majority of the fathers also reported farming as main occupation (78.6%), whilst the remaining were devoted to various types of business (as cattle business, selling buying crops, having

shops/bars etc) and craft. There were not many paid professionals in our sample, only 1 mother and 4 fathers.

Table 2: Socio-economic characteristics of the mothers and fathers in the households.

	Mothers[a]		**Fathers**[b]	
	%	N	%	N
Education				
No education	36.8	56	12.9	18
Primary school, not finished	14.5	22	20.9	29
Primary school	46.1	70	59.0	82
Secondary school	2.0	3	5.0	7
Higher education	0.7	1	2.2	3
Main occupation				
Farmer	92.8	141	78.6	110
Petty trade	2.6	4	1.4	2
Paid professional	0.7	1	2.9	4
Business	1.9	3	10.7	15
Craftsman	1.3	2	5.7	8
Other	0.7	1	0.7	1
Other income generating activities[c]				
Beer brewing	44.7	68	0	0
Petty trade	25.7	39	8.6	12
Business	7.3	11	9..2	13
Farming	3.9	6	16.4	23
Craftsman			2.9	4
None	28.9	44	62.9	88
Paid Labour [d]				
Yes	51.7	77	33.6	46
No	48.3	72	66.4	91

[a] n=152, [b] n=140, one missing value father education, [c] The mothers could have >1 other income generating activity, [d] Missing values, Mother, n=149, Father, n=137.

The majority of the households were poor and in possession of few assets[14], actually 18.4 % (n=28) had none of the assets asked for in the questionnaire. As illustrated in table 3, the households were categorised into 3 groups according to their asset score, to reflect low, middle and high economic status. Those with the lowest economic status, had either none or a maximum of 2 assets, and those with middle economic status had from 1 to 3 assets. The households in group 3, with high economic status, had from 2 to 7 assets and the items TV,

[14] The assets asked for where: wrists watch, radio, mobile, chair-table, sofa-table, cupboard, plough, bicycle, sewing machine, TV, milling machine and motorbike.

cupboard, sewing machine, milling machine, and/or motorbike were only observed in this group.

Table 3: Characteristic of the households' economic status, n=152.

	%	n
Asset score[a]		
Low	35.5	54
Middle	33.6	51
High	30.9	47
Number of cows		
0	60.5	92
≥1	39.5	60
Type of roof		
Thatch	55.9	85
Iron sheets	44.1	67

[a] The asset score was developed based on the possession of assets in the household and the economic value of the household's assets. More details in methodology, section 5.6.3.

There were slightly more households with thatched roofs than iron sheet roofs. Thatch was gathered for free in the bush (table 3).

About 40% of the households were in possession of cattle, ranging form 1 to 30 cattle, with a median value of 3. The price for a cow is high, relative to most assets in the asset score.

The possession of cattle, type of roofing and size of cultivated land (cultivated land illustrated in table 4) were separately analysed according to the asset score in cross tabulation (chi-square) to assess for internal association between the variables. A significant association between the asset score and the three different indicators were observed ($p \leq 0.001$)[15].

Thatched roofs were more common among the households with low and middle asset score. However, 40% (n=19) of the households with high asset score also had roofs made out of thatch. The use of iron sheets was more common in the middle and high asset score, however 24% (n=13) of the households in the low asset score group had iron sheet roofs as well. Among the households with a low assets score fewer were in the possession of a cow, 16.7% (n=9), compared to 47.1% (n=24) and 57.4% (n=27) in the households with a middle and high asset score respectively. Among the households with a low asset score more households had the smallest size of cultivated land (≤0.80 Ha) (62%) compared to the households with a middle (28%) and high asset score (23.2%).

[15] By the use of chi-square.

Nearly all households used piped water, through a village tap (98.7%, n=150). The remaining two households were fetching water from the river. Most of the water sources were located in the centre of the three sub villages.

6.1.3 Agricultural characteristics

Most of the households (91.4%) relied on food from harvest as their main source of food, and were thus classified as subsistence farmers (table 4). Nearly all (97.4%) the households cultivated some type of crops last season.

The food staple and most commonly cultivated crop was maize, followed by beans, groundnuts, sunflower and finger millet (table 4). Wheat was a minor crop, cultivated by about 5% of the households. Most of the households (≈75%) cultivated 1 or 2 crops last season. A small part, about 10%, cultivated 4 or 5 crops (data not shown). Maize was generally characterized as both subsistence crop and cash crop. Beans, millet and groundnuts were subsistence crops only, and sunflower and wheat were solely cash crops (data not shown).

In addition to crops, green leaves, tomatoes, onions, potatoes- both sweet and Irish and sugar canes were cultivated in the gardens (data not shown). Green leafy vegetables could also be gathered in the bush.

All the households performed cultivation on the main field (*shamba*). The median size of the *shamba* was 1.9 (0.8-2.3) Ha, ranging from 0.2–16.0 Ha. Additionally, approximately three fourth of the households also did dry season cultivation. Dry season cultivation was performed during the dry season at wetland areas, and was in addition to the main cultivation which took place during rainy season. Maize and beans were planted at the wet land areas.

Table 4: Description of agricultural activities.

Agricultural indicators	%	N
Main source of food in the households (n=152)		
Direct from harvest[a]	91.4	139
Purchasing	8.6	13
Nb of households cultivating last season (n=152)	97.4	148
Nb of households who did dry season cultivation last season (n=148)	71.6	106
Size of shamba cultivated last season (Ha) (n=144)[b]		
≤080	36.8	53
>0.80-<1.61	32.6	47
≥1.61	30.6	44
Crops grown in the households last season (n=148)		
Maize	98.0	147
Beans	43.3	66
Groundnuts	22.4	34
Sunflower	19.1	29
Finger millet	11.8	18
Wheat	5.9	9
No cultivation	2.6	4

[a] Described as subsistence farmers, [b] Also an indicator of economic status, n=144, because of missing values.

Shamba (Kiswahili) – main field, Dry season cultivation – an wet-land area where it is possible to plant an extra round of maize and beans.

6.1.4 Alcohol consumption and food security

As illustrated in table 5, more than 50% of the fathers reported to drink beer everyday or several times a week, compared to less than 10% of the mothers.

More than half the households that relied on subsistence farming (n=139) were classified as food insecure with one month or more without food in stock (table 5). The median length of months without food in stock was 1 month and ranged from 0 to 12 months.

Table 5: Description of the mothers' and fathers' beer drinking and the household food security.

	%	n
Beer drinking, mother (n=145)[a]		
Everyday	2.1	3
Several times a week	7.6	11
Once a week	15.1	22
Never	75.2	109
Beer drinking, father (n=133)[a]		
Everyday	20.3	27
Several times a week	33.8	45
Once a week	5.3	7
Never	40.6	54
Months without food in stock (n=136)[b]		
0	41.2	56
≥1	58.8	80

[a] Missing values, [b] Based on the households which stated food from harvest as their main source of food, 3 missing values.

6.1.5 Child characteristics

A description of the children's age and the proportion of girls and boys in the sample are presented in table 6. There was slightly more boys than girls in the sample. No statistical difference between the genders according to age was found.

Table 6: Characteristics of the children, n=152.

Child characteristics			
	Boys	Girls	Total
Percentage (n)	54.6 (83)	45.4 (69)	100 (152)
Age, median	30.3	31.2	30.8
Age, 25-75th perc.	16.7-39.9	18.7-45.6	17.1-43.7
Min-Max	1.2-57.4	3.1-59.9	1.2-59.9

[a] No significant differences between gender and age (continuous) (Mann-Whitney U Test).

6.2 The children's nutritional status

As illustrated in figure 4, the prevalence of stunting[16] was high, 63.8% (n=97) of the children were stunted (height-for-age z-score (HAZ) <-2), including 32.8% (n=50) who were severely

[16] Stunting and to be stunted are used interchangeably in this thesis, although stunting is the 'process' and used for children under 2-3 years of age, and stunted the 'outcome', used for children over 2-3 years of age. Similar for wasting and to be wasted, and "losing weight" and underweight (21;32).

stunted (HAZ <-3). 6% (n=9) of the children had a HAZ below -4 and 1.3% (n=2) a HAZ below -5. Mean HAZ for the children was -2.46 (1.11).

Underweight (weight-for-age z-score (WAZ) <-2) was also common among the children, with a prevalence of 33.6% (n=51), including 7.3% (n=11) of the children who were severely underweight (WAZ <-3) (figure 4). One of the children had a WAZ <-4. The mean WAZ was -1.53 (1.0).

When using the NCHS/WHO (1983) reference population, the prevalence of underweight children (below 75% of the reference population's median) were 25% (n=38), and mean weight-for-age (as percent of the reference population's median) was 83.5 (12.1) (table 7).

The prevalence of wasting (WHZ <-2) was low compared to the other two indicators, rendering 2.7% (n=3) of the children, as illustrated in figure 4. One child was severely wasted (WHZ <-3). The mean WHZ was -0.16 (1.04).

Overweight/obesity was not common, 2% (n=3) had a WHZ >+2, indicating weight-for-height above normal (data not shown).

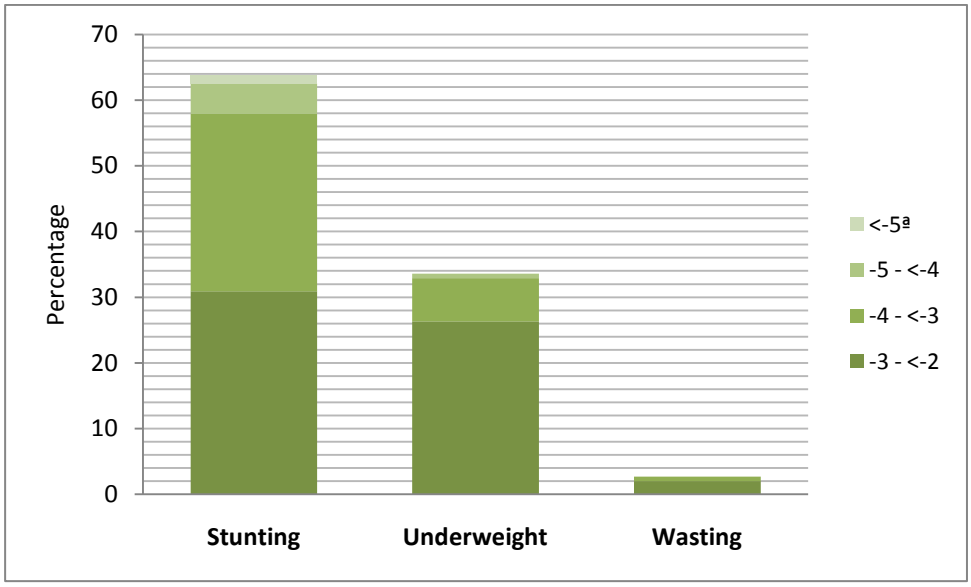

Figure 4: The percentage distribution of stunting, underweight and wasting (z-score cut off below -5 and from; -5 to <-4, -4 to <-3, -3 to <-2) among the children (<60 months) n=152[b].

[a] z-scores, [b] Based on WHO Child Growth Standards (2006) (16).

Stunting - Height-for-age z-score (HAZ) <-2, Underweight – Weight-for-age z-score (WAZ) <-2, Wasting – Weight-for-height z-score (WHZ) <-2.

Table 7: The percentage distribution of underweight among the children (<60 months), n=152[a].

	n	Mean (±SD) %	C.I %	Median (25-75th perc.) %	Underweight % (n)
Weight-for-age	152	83.5 (12.10)	81.6, 85.5	81.9 (74.9, 90.4)	25.0 (38)

[a] NCHS/WHO (1983) reference population (24).

Weight-for-age - as % of the reference median, SD – Standard Deviation, C.I – Confidence Interval, Underweight - as % below 75% of the reference population's median.

Undernutrition, age and gender

The prevalence of stunting and median HAZ in various age groups are presented in table 8. Stunting and severe stunting were lowest among the children aged 6-<12 months. After 12 months the prevalence of stunting increased and remained high until the 36-<48 months age group, after which it started to decline. The prevalence of stunting among the children aged 0-<6 months was also high. A statistical significant difference was found between the age groups according to stunting (p=0.000) and it was a significant difference between the children in the age group 0-<12 months compared to the children in the age groups 12-<24 (p=0.001), 24-3<6 (p=0.000) and 36-<48 (p=0.000). Mean HAZ showed a similar pattern to

Underweight rates according to age were found to increase until the second year, from where it remained high (table 8). A statistical significant difference was evident between the groups (p=0.008). The children aged 0-11 months had the lowest rates of underweight, with no cases.

Wasting was not present up to 12 months. Wasting in the other groups were around 3%. Severe wasting was only present in the 12-<24 months age group, with 3% (table 8).

Table 8: The nutritional status according to age, among children <60 months, n=152.

		Height-for-age z-score[b]		
	n	<-2 (%)	<-3 (%)	Median (25-75th p.)
Age				
0 - <6[a]	14	35.7	14.3	-1.49 (-2.70, -0.65)
6 - <12a	12	16.7	8.3	-1.55 (-1.92, -1.08)
12 - <24	32	75.0	31.3	-2.78 (-3.14, -2.03)
24 - <36	38	73.5	42.1	-2.82 (-3.43, -1.92)
36 - <48	33	75.8	45.5	-2.77 (-3.46, -2.22)
48 - <60	23	56.5	26.1	-2.19 (-3.07, -1.61)
				Mean z-score(±SD)
Total	152	63.8	32.9	-2.46 (1.11)
		Weight-for-age z-score[b]		
	n	<-2 (%)	<-3 (%)	Median (25-75th p.)
Age				
0 - <6[a]	14	14.3	0	-0.53 (-1.36, -0.29)
6 - <12[a]	12	16.7	0	-0.87 (-1.80, -0.53)
12 - <24	32	40.6	6.3	-1.82 (-2.38, -1.26)
24 - <36	38	39.5	10.5	-1.62 (-2.33, -0.83)
36 - <48	33	30.3	6.1	-1.66 (-2.27, -1.02)
48 - <60	23	39.1	13.0	-1.67 (-2.27, -0.94)
				Mean z-score(±SD)
Total	152	33.6	7.2	-1.53 (1.0)
		Weight-for-height z-score[c]		
	n	<-2 (%)	<-3 (%)	Median (25-75th p.)
Age				
0 - <6	14	0	0	0.93 (0.54, 1.39)
6 - <12	12	0	0	-0.31 (-0.91, 0.17)
12 - <24	32	3.1	3.1	-0.83 (-1.11, -0.09)
24 - <36	38	2.6	0	-1.16 (-0.89, 0.67)
36 - <48	33	3.0	0	-0.25 (-0.57, 0.52)
48 - <60	23	4.3	0	-0.29 (-0.92, 0.18)
				Mean z-score(±SD)
Total	152	2.6	0.7	-0.16 (1.04)

[a] The two age groups 0-<6 and 6-<12 were merged before Kruskal-Wallis Tests were performed.

[b] Statistical difference between height-for-age z-score (continuous) and age groups (p=0.001), and statistical difference between weight-for-age z-score (continuous) and age groups (p=0.008), by the use of Kruskal-Wallis Test.

[c] Weight-for-height z-score was not tested for differences between age groups because of few wasted children.

The girls' and boys' prevalence of underweight and stunting (<-2 and <-3 z-scores respectively) were compared, and no significant differences between the genders were revealed in either of the two indicators (figure 5).

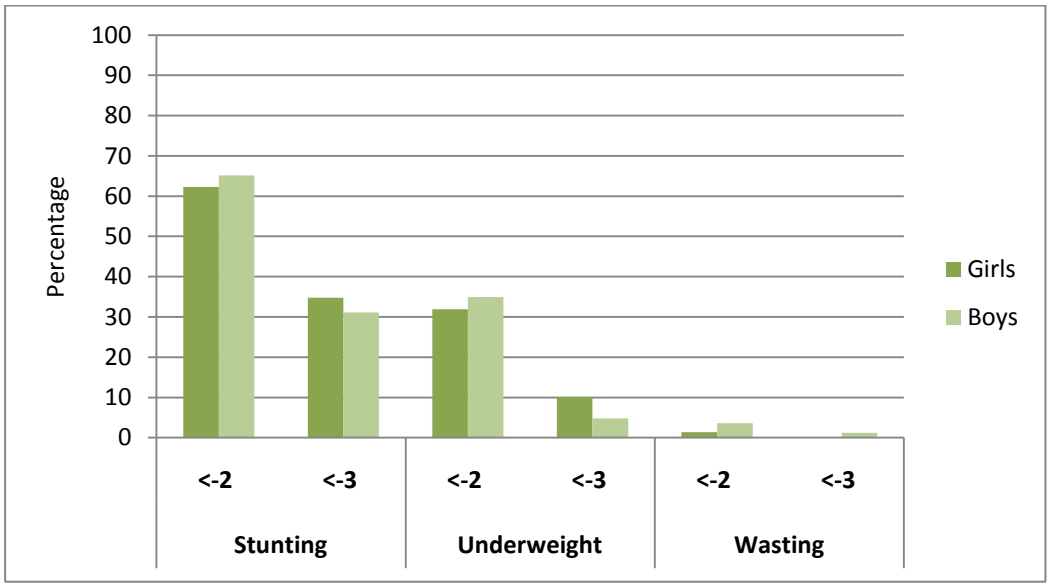

Figure 5: The prevalence of stunting, underweight and wasting (<-2 and <-3 z-scores) according to gender among children <60 months, n=152.

Pearson chi-square used to test for differences between HAZ and WAZ (<-2, <-3) and gender, p>0.05.

Stunting – Height-for-age z-score <-2, Underweight – Weight-for-age z-score <-2, Wasting – Weight-for-height z-score <-2, Severe stunting/wasting/underweight - <-3 z-scores.

6.3 Feeding the young children

6.3.1 Breastfeeding practices

All the children had been breastfed at one point of time. At the time of the interview, none of the children were exclusively breastfed, 36.8% (n=56) were partly breastfed, and 63.2% (n=96) were not breastfed.

The analyses of duration of breastfeeding were based on non-breastfed children (n=96), the analyses of exclusive breastfeeding were based on all the children respectively (n=152), and both based on mothers' recalls.

Duration of breastfeeding

The median length of breastfeeding was 24 months (20.0–25.5), ranging from a minimum of 9 months to a maximum of 36 months. Nearly all the mothers reported to have breastfed their children at the age of 12 months (98.9%, n=95), at the age of 2 years the number had decreased to about 60% (n=57) (figure 6).

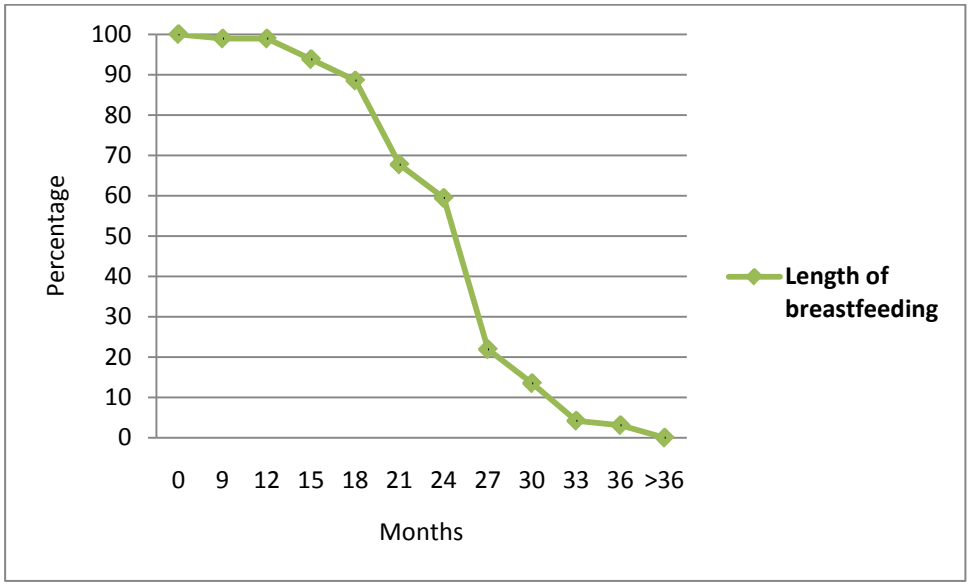

Figure 6: Cumulative percentage of breastfeeding duration, among non-breastfed children at the time of the interview aged 11.8-59.9 months, n=96 (based on mothers' recalls).

Exclusive breastfeeding rate

Only one mother reported to have exclusively breastfed her child for 6 months. The median duration of exlusive breastfeeding was 1day. The prevalence of exclusively breastfed children the first day after birth was about 28% (n=42), thereafter it decreased to 12.5% (n=19) at 2 months and 2.6% (n=4) at 4 months (figure 7).

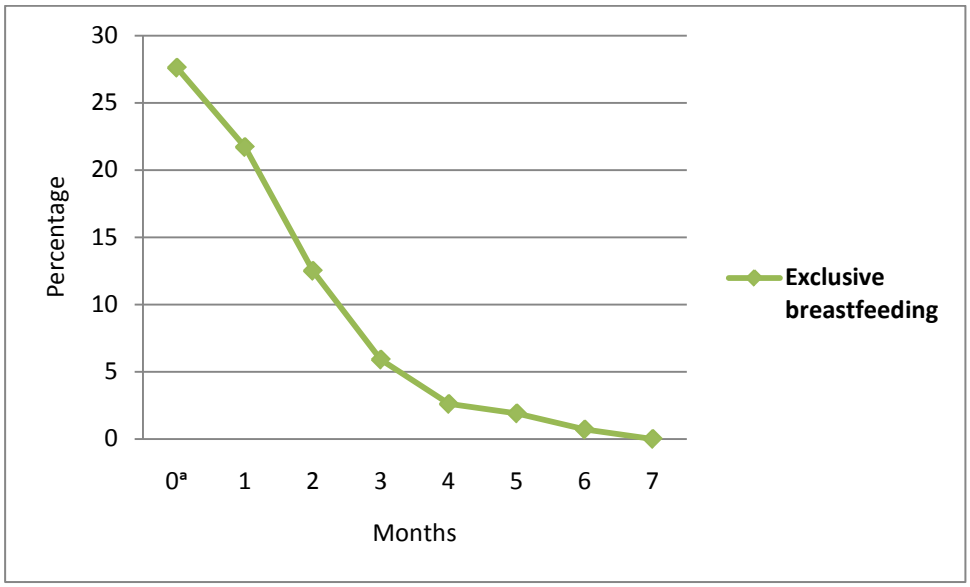

Figure 7: Cumulative percentage of length of exclusive breastfeeding, among children aged <60 months, n=152 (based on mothers' recalls).

[a] Day 1 after birth.

6.3.2 The first liquid and the first complementary foods given to the children

The first types of foods and liquids and time of introduction were assessed based on the mothers' recalls. At the time of the interview, all children except 3 had been introduced to other foods than breastmilk. A total of 11 children had been given food before liquid. The analyses of first liquid was based on all children (n=152) and of first food on 149 children.

The first liquid

The children were given either a solution of water and/or sugar and/or salt (hereafter called sugar water) (63%, n=96) or plain water (37%, n=56) (figure 8).

As illustrated in figure 9, nearly three-quarters (72%, n=110) of the children were given prelacteals (defined as liquids/foods given the first day after birth). At 3 months nearly all the children had been introduced to their first liquid (97.4%, n=148).

Among the children whom received prelacteals, most (87.2% (n=96)) were given sugar water. Sugar water was only introduced as a prelacteal feeding. The sugar water was given to the children for median 1 week, from a minimum of 2 days to a maximum of 1 year. The majority

of the children, 65.6% (n=63), continued with water after the sugar water was discontinued. Among the remaining children (n=33), nearly 70% (n=22) received water within the 3 first months.

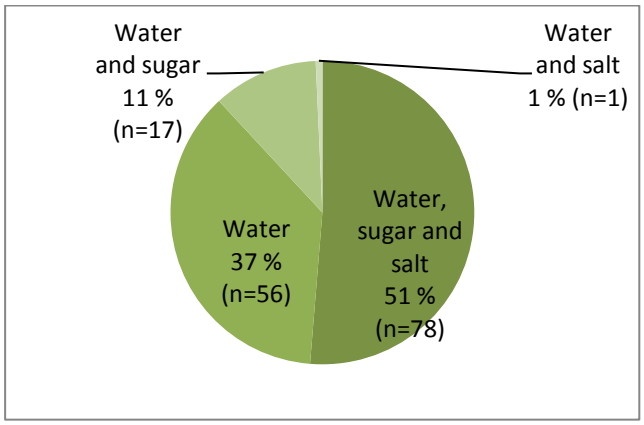

Figure 8: The percentage distribution of type of first liquid the children received, n=152.

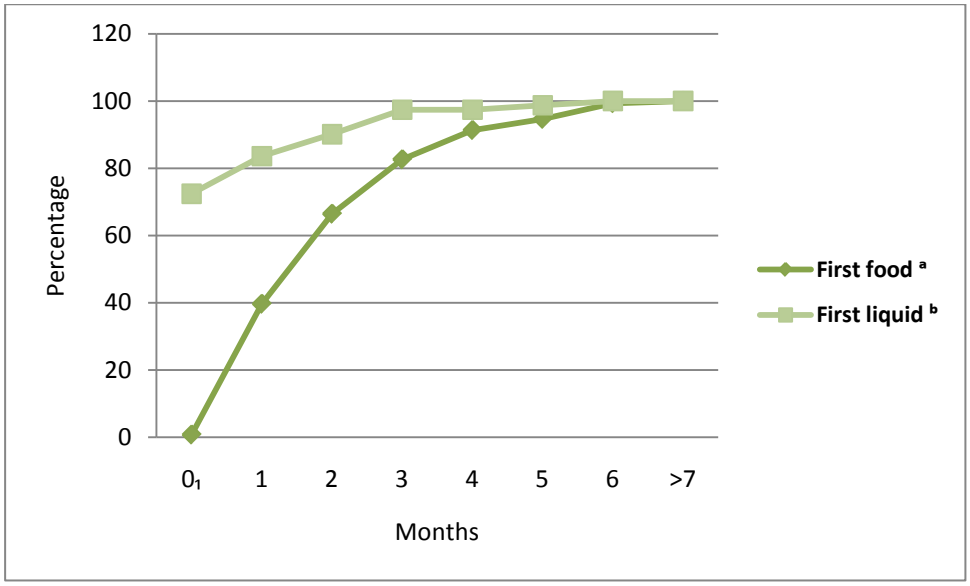

Figure 9: The cumulative percentage of time of introducing the first liquid and complementary foods to the child after birth (based on mothers' recalls).

[a] First food (uji-gruel), n=149, [b] First liquid (sugar water or plain water), n=152.

The first complementary feeding

Uji was the first type of food introduced to all the children. Most of the children were given millet *uji* (57%, n=85) or maize *uji* (38.9%, n=58). Six child received *uji* made out of a mix of

millet, maize and/or groundnuts. Complementary foods were introduced later than liquids, as illustrated by figure 9, and was introduced at median 2 months after birth. One child received *uji* already the first day after birth, followed by a rapid increase to 40% (n=59) at 1 month, and about 80% (n=123) had been introduced to *uji* at the age of 3 months. All children, except one, had been introduced to *uji* before 6 months of age.

6.3.3 Complementary foods given to children 6-23 months of age (Minimum Dietary Diversity)

The dietary diversity score of the children between 6 and 23 months of age were assessed based on the 24-hour dietary recall data. Forty-four children fell into this category (1 missing, rendering 43), of which 83.7% (n=36) were breastfed.

Among the children between 6 and 23 months of age, 46.5% (n=20) were fed less than 4 food groups a day and 53.5% (n=23) were fed more than 4 food groups a day. Flesh foods were consumed by 20.9% (n=9), both fish (55%, n=5) and meat (45%, n=4). No one consumed egg or milk.

6.4 Feeding the non-breastfed children

The non-breastfed children's diets and feeding frequencies were analysed based on the 24-hour dietary recall. As two of the children were sick at the time of the interview, and did not eat as they used to, they were excluded from the analyses, rendering 94 children. The children were from 11.8 to 59.9 months, with a median (25^{th}-75^{th} perc.) age of 38.7 (31.4-47.9), and 45.8% were girls and 54.2% boys.

6.4.1 Children's diet after breastfeeding

An overview of what the children, who were not breastfed at the time of the interview (n=94), had consumed the last 24 hours is presented in table 9. All the children had consumed grains, mainly maize as either *uji* or *ugali*. *Uji* was consumed by 18.1% (n=17) and *ugali* by 97.9% (n=92). Other food groups consumed by nearly all (>95%) the children were the "other vegetables and fruits group" (mainly tomato and onion) and from the group named "other" (mainly sugar cane and white sugar). Food groups eaten frequently (among > 60%) were, the nuts and beans group (more beans than groundnuts); the vitamin A rich fruits and vegetables

group (primarily green vegetables) and oil (sunflower oil). Fish (*dagaa* (dried fish) and fresh fish), consumed by close to 40% of the children was more commonly used than meat. Approximately 10% of the children had been drinking milk. Egg (1.1%) and fruits (5.3%) were very rarely consumed.

Breakfast was not prepared in all household. In the ones who did eat breakfast, porridge, with or without sugar, was most common. Tea with *andazi* (similar to doughnut) was also provided. Food items given to the children as snacks, according to the 24-hour recall, included; sugar canes, *mandazi*, ground nuts, bananas and in one household mango.

Children started to consume *ugali* after 6 months (5 out of 12 children (aged 6-<12 months) reported to have consumed *ugali* in the 24-hour recall). *Ugali*, the main staple, were usually consumed with a relish made out of green leaves (prepared with at least tomatoes, but onions and sometimes oil and/or groundnuts could also be added) and/or beanstew, and sometimes meat or fish.

Even though many of the households (70%, n=67) had chickens, few children were given eggs. Nearly 40% (n=36) of the households had cows. The mothers reported that this type of cows doesn't produce much milk, especially not if the cow was used for ploughing.

Table 9: Foods consumed by non-breastfed children aged 1.8-59.9 months, n=94, based on 24-hour dietary recall.

Food Groups		**Food items**	
Total 10	% (n)	Total 26	% (n)
1. Grains	100 (94)	Maize	100 (94)
		Millet	24.5 (23)
		Rice	19.1 (18)
		Wheat	2.1 (2)
2. Beans and nuts	81.9 (77)	Beans	68.1 (64)
		Groundnuts	38.3 (36)
3. Egg	1.1 (1)	Egg	1.1 (1)
4. Dairy products	10.6 (10)	Milk	10.6 (10)
5. Fish	38.3 (36)	Dagaa	25.2 (24)
		Fish	16.0 (15)
6. Meat	8.5 (8)	Beef	5.3 (5)
		Pork	2.1 (2)
		Chicken	1.1 (1)
7. Vit. A rich fruits and vegetables	67.0 (63)	Green leaves	63.8 (60)
		Sweet potatoes	9.6 (9)
		Mango	1.1 (1)
8. Other fruits and vegetables	97.9 (92)	Tomato	97.9 (92)
		Onion	75.5 (71)
		Irish potato	6.4 (6)
		Banana	3.1 (3)
		Orange	1.1 (1)
9. Oil	64.9 (61)	Sunfloweroil	64.9 (61)
10. Other	95.7 (90)	Sugarcane	90.4(85)
		Sugar/sweets	33.0 (31)
		Mandazi	29.8 (28)
		Tea	8.5 (8)
		Soda/artificial juice	2.1 (2)

Dagaa – Sardine, Mandazi - Doughnut

6.4.2 Dietary Diversity (DDS and FVS)

The mean (SD) of the Diet Diversity Score (DDS) was 4.7 (1.1) ranging from 1 to 7 food groups, however few children had consumed 1 and 7 food groups. The distribution is illustrated in table 10.

Dividing the children's DDS into three groups placed 40.4% (n=38) in the lowest group (≤4 food groups), 36.2% (n=34) in the average group (5 food groups), and 23.4% (n=22) in the highest group (≥6 food groups).

In figure 10, food groups consumed according to low, average and high DDS are illustrated. The basic foods, from the grain group and "the other vegetables than those rich in vitamin A" group, were consumed by almost all the children in all the DDS groups. Beans and nuts were consumed by only 70% in the low DDS group, which was less than the other groups. Vitamin A rich fruits and vegetables, fish, and oil were significantly more fed in the high DDS group compared to the low DDS group ($p<0.001$).

Table 10: Diet Diversity Scores (DDS) and Food Variety Scores (FVS) for non-breastfed children 11.8-59.9 months, based on 24-hour dietary recall.

FVS	**Child consumption** % (n)	**DDS**	**Child consumption** % (n)
1	1.1 (1)	1	1.1 (1)
3	4.3 (4)	3	9.6 (9)
4	6.4 (6)	4	29.8 (28)
5	17.0 (16)	5	36.2 (34)
6	18.1 (17)	6	20.2 (19)
7	20.2 (19)	7	3.2 (3)
8	14.9 (14)		
9	10.6 (10)		
10	4.2 (4)		
11	3.2 (3)		

FVS – Food Variety Score, based on number of food items (n=23), DDS – Diet Diversity Score, based on food groups (n=9).

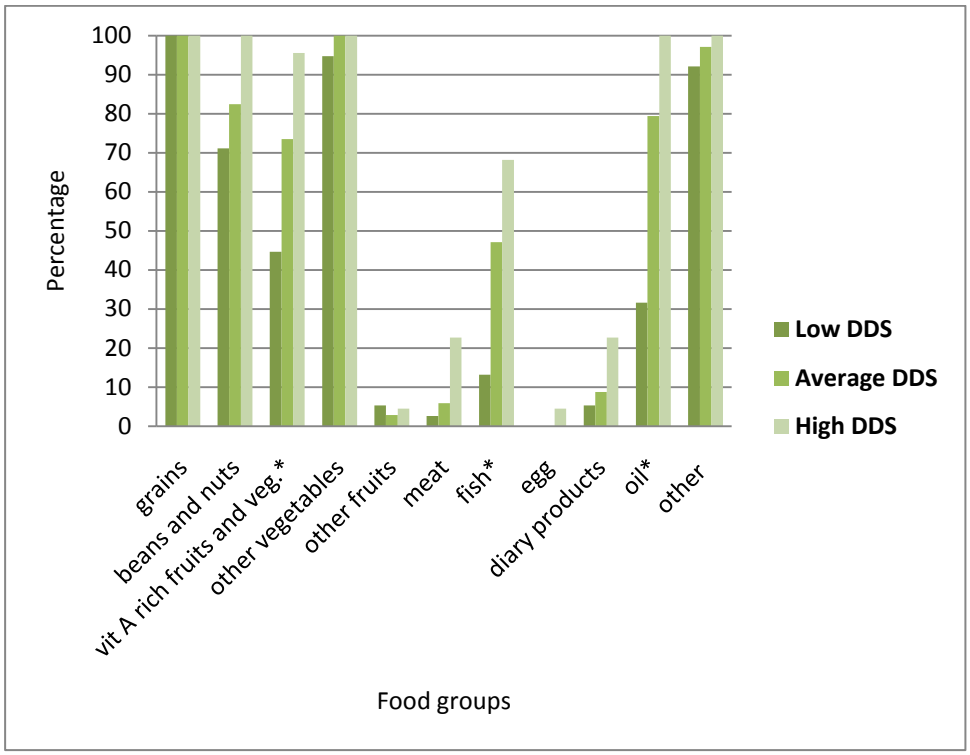

Figure 10: Percentage distribution of what food groups non-breastfed children 11.8-59.9 months of age (n=94), had consumed according to their Dietary Diversity Score (DDS), low (≤4 food groups), average (5 food groups) or high (≥6 food groups).

*Significant difference between low and high DDS ($p<0.001$) (chi-square).

The mean (SD) of the Food Variety Score was 6.7 (2.0), ranging from 1 to 11 food groups, however only a few children had consumed 1 and 11 food groups, as illustrated in table 10.

The children's FVS were also divided into three groups, which placed 28.7% (n=27) in the lowest group (≤5 food items), 38.3% (n=36) in the average group (6-7 food items) and 33% (n=31) in the highest group (≥8 food items).

6.4.3 Feeding frequency

Mean feeding frequency was 3.1 (0.8). As illustrated in table 11, most of the children were fed 3 times a day (52.1%, n=49), followed by 4-5 times a day (28.7%, n=27), and 1-2 times a day (19.2%, n=18). Very few children were fed 1 and 5 times a day, 1.1% (n=1) and 2.1% (n=2) respectively. Table 11 also shows distribution of meals, where more than half were fed 3 meals.

Table 11: Feeding frequency and number of meals, among non-breastfed children 11.8-59.9 months (n=94), based on 24-hour dietary recall.

Feeding frequency			**Meal frequency**		
	%	n		%	n
≤ 2	19.2	18	1	1.1	1
3	52.1	49	2	43.6	41
≥4	28.7	27	3	55.3	52

Feeding frequency - includes meals and snacks in between.

6.4.4 Diet Diversity Score, Food Variety Score, feeding frequency and nutritional status

The relationship between the independent variables (DDS, FVS and feeding frequency) and the dependent variables stunting (HAZ <-3 and <-2) and underweight were separately analysed by the use of binary logistic regression analyses, first in crude analyses therafter by adjusting for age, disease and mothers' workload, as illustrated in table 12. The results of HAZ <-2 are not presented in the table.

Neither DDS nor FVS could significantly predict stunting, severe stunting or underweight. The lack of significant relationship was also verified by adjusting for disease, age and mothers' workload. On the other hand, children with low feeding frequency (≤2feedings) were significantly more likely to be severely stunted compared to the children with high feeding frequency (≥4 feedings), in both the crude and adjusted analyses (table 12). This was however, not observed by the use of underweight (table 12) and stunting (data not shown in the table) as dependent variables.

Table 12: FVS, DDS and feeding frequency's related to severe stunting and underweight, in binary logistic regression analyses, among non-breastfed children 11.8–59.9 months, n=94.

		HAZ <-3[a]		
	n	%	Crude OR (95% C.I)	Adjusted OR (95% C.I)
FVS				
≤ 5	27	51.9	1.53 (0.53, 4.39)	1.26 (0.41, 3.92)
6	36	33.3	0.71 (0.25, 1.95)	0.65 (0.23, 1.95)
≥8	31	41.9	1	1
DDS				
≤ 4	38	42.1	0.72 (0.24, 2.16)	0.58 (0.17, 1.98)
5	34	35.5	0.54 (0.18, 1.68)	0.54 (0.16, 1.79)
≥6	22	50.0	1	1
F.F				
≤ 2	18	61.1	3.73 (1.06, 13.12)*	4.05 (1.04, 15.71)*
3	49	40.8	1.64 (0.60, 4.50)	1.92 (0.63, 5.87)
≥4	27	29.6	1	1
		WAZ <-2[b]		
	n	%	Crude OR (95% C.I)	Adjusted OR (95% C.I)
FVS				
≤ 5	27	44.4	1.52 (0.52, 4.47)	1.17 (0.36, 3.78)
6	36	36.1	1.07 (0.39, 2.99)	0.98 (0.32, 2.97)
≥8	31	35.5	1	1
DDS				
≤ 4	38	42.1	0.89 (0.30, 2.65)	0.56 (80.16, 1.94)
5	34	29.4	0.51 (0.16, 1.61)	0.48 (0.14, 1.67)
≥6	22	45.5	1	1
F.F				
≤ 2	18	50.0	2.25 (0.65, 7.81)	2.50 (0.64, 9.79)
3	49	38.8	1.35 (0.49, 3.73)	1.66 (0.54, 5.18)
≥4	27	29.6	1	1

[a] 1= < -3, 0=≥ -3, [b] 1= < -2, 0 ≥ -2.

Adjusted for disease (diarrhoea, fever, vomiting), age (continuous), mothers' workload (≤38, 39-66, ≥67).

FVS – Food Variety Score, DDS – Diet Diversity Score, F.F – Feeding Frequency, HAZ <-3 - Severe stunting, WAZ <-2 - Underweight, OR – Odds Ratio, C.I – Confidence Interval.

6.5 Child disease

6.5.1 Prevalence of disease

A total of 88 (57.9%) children had been sick 2 weeks prior to the interview, according to the mothers. The distribution is illustrated in figure 11 and shows diarrhoea to be the most common disease (25.0%, n=38) followed by fever (23.7%, n=36) and cough (19.7%, n=30).

Diarrhoea was more common in the younger age groups; 35.4% of the children below 36 months had diarrhoea compared to 7.1% among the children who where 36 months or above. This reached statistical significance, $p<0.001$.

A higher proportion of the children who were underweight had been sick 2 weeks prior to study compared to the children who were not underweight ($p=0.03$, Pearson chi-square). The relationship was also found among children who had been sick with diarrhoea, fever and/or vomiting (n=65) ($p<0.001$). No significant difference was found between diseases and stunting.

No difference between gender and total disease burden was found, however boys had more cases of diarrhoea than the girls ($p=0.048$).

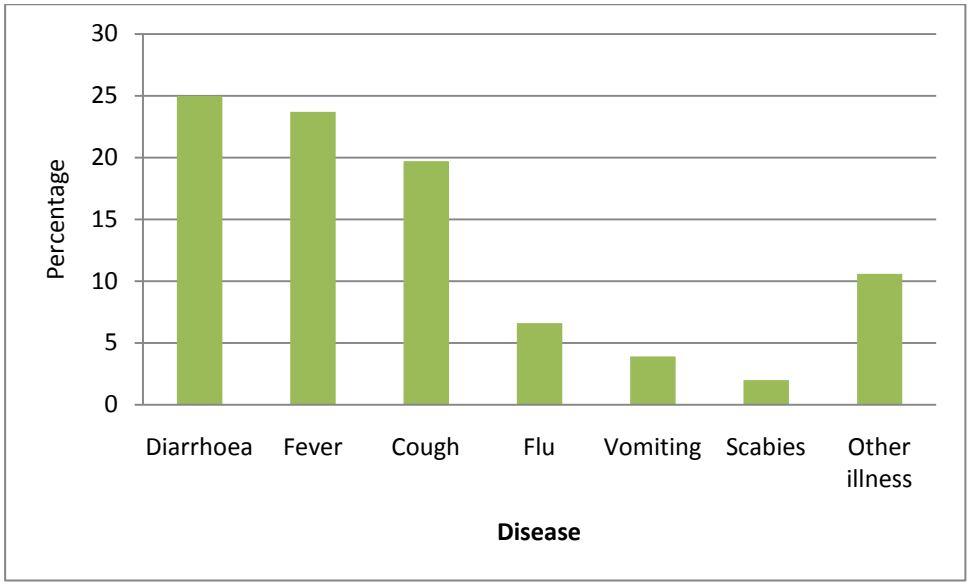

Figure 11: Cases of disease 2 weeks prior to the study among children <60 months (n=94).

6.5.2 Vaccination, vitamin A supplementation and deworming

More than 90% of the children had been fully vaccinated[17].

Nearly all mothers (95.5%, n=127) with children ≥6 months attended the national Vitamin A supplementation/deworming campaign in June 2010.

6.6 The mothers' workload and care

The mothers had large responsibilities in the domestic sphere and in the field. The domestic work comprised e.g. care for children, cooking, washing, fetching water and firewood for fuel. All the various tasks mentioned were solely women's work, except for fetching firewood, which also the men participated in (in < 20% of the households).

6.6.1 The mothers' workload in the field

The mothers' workload in the field was estimated based on the number of days the women had been working the last agricultural season on the *shamba*, in the various agricultural tasks[18] and crops[19], as explained in section 5.6.3.

A working week was usually 6 days, and the numbers of days the mothers went to the field varied from 2 days to 6 days (data not shown).

In the last agricultural period (October/November 2009 to July 2010) the mothers who reported farming as main occupation (92.8%) worked for median 48 days (30.0-77.5), from a minimum of 5 days to a maximum of 208 days in the different crops and agricultural activities performed at the *shamba*. One mother did not cultivate last season, so this calculation was based on 140 mothers. Thereafter, due to frequency distribution, the mothers' workload in the field the last season was categorized into three groups, ≤38 days, 39-66 days or ≥67.

The mothers were found to spend more time in the field during the period of weeding compared to the other agricultural activities; harvesting, land clearing and planting. Weeding was considered the physically hardest activity and a "women's work". All mothers

[17] According to WHO, a child is considered fully vaccinated if he/she has received, during the first year of life, 1 BCG vaccination, 3 doses of DPT (Diphtheria, pertussis, tetanus), 3 doses of polio, 1 dose of measles (106).
[18] Land clearing, ploughing/hoeing, planting, weeding, harvesting were assessed.
[19] Maize, millet, beans, groundnuts, sunflower, wheat were assessed.

participated in maize cultivation, followed by cultivation of beans, groundnuts, sunflower, millet and wheat. Further, the mothers spent most time in cultivation of maize, followed by millet, groundnuts, sunflower, beans and wheat. According to the residents of Msanzi, millet and groundnuts are considered women's crops. See appendix 3 for exact numbers of the above data.

Mothers' workload and feeding frequency

Cross tabulation (chi square) was used to test for association between women's workload and feeding frequency. No significant association was observed (data not shown).

Mothers' workload and children's nutritional status

As illustrated in table 13, the prevalence of stunting (both HAZ <-2 and <-3) and underweight are highest among the mothers who worked the most the last agricultural season. The relationship was also observed when mean z-scores were used.

Table 13: Mothers' workload in the field and association with height-for-age z-score and weight-for-age z-score, n=140[a].

Mothers' workload		**Height-for-age**	**z-score**		
days	n	<-2 (%)	<-3 (%)	mean z-score (SD)	95% C.I
≤38	47	55.3	25.0	-2.32 (1.05)	-2.60, -2.04
39-66	46	63.0	34.8	-2.40 (1.34)	-2.80, -2.02
≥67	47	72.3	42.6	-2.66 (0.99)	-2.94, -2.37
		Weight-for-age	**z-score**		
days	n	<-2 (%)	mean z-score (SD)	95% C.I	
≤38	47	27.1	-1.44 (0.85)	-1.69, -1.19	
39-66	46	26.1	-1.46 (1.17)	-1.81, -1.11	
≥67	47	48.9	-1.69 (1.03)	-1.99, -1.39	

[a] Included in the analyses are mothers who stated farming as main occupation.

SD –Standard Deviation, C.I, Confidence Interval

The relationship between the mothers' workload in the field and the dependent variables stunting (HAZ <-3 and <-2) and underweight were analysed by the use of binary logistic regression analyses, as illustrated in table 14. The analyses for HAZ <-2 is not presented in the table.

The analyses found that women who worked ≥67 days the last agricultural season were more likely to have underweight children, compared to women who worked ≤38 days in the same period in the crude analysis (table 14). This was not observed in the adjusted analysis, after adjusting for the age, disease and asset score. No significant relationship was observed between the mothers' workload and stunting (neither HAZ <-2 nor HAZ <-3).

Table 14: Mothers' workload in the field in relation to underweight and severe stunting, in binary logistic regression analyses, n=140[a].

Mothers' workload		**HAZ <-3[b]**	
days	n	Crude OR (95% C.I)	Adjusted OR (95% C.I)
≤38	47	1	1
39-66	46	1.56 (0.63, 3.80)	1.89 (0.73, 4.84)
≥67	47	2.16 (0.90, 5.18)	2.27 (0.90, 5.72)
		WAZ[c]	
days	n	Crude OR (95% C.I)	Adjusted OR (95% C.I)
≤38	47	1	1
39-66	46	0.92 (0.37, 2.31)	1.13 (0.42 - 3.03)
≥67	47	2.50 (1.06, 5.91)*	2.40 (0.94 - 6.01)

[a] Included in analyses are mothers who stated farming as main occupation, [b] 1= <-3, 0= ≥-3, [c] 1= <-2, 0= ≥-2.

Adjusted for: age (continuous), disease (diarrhoea, vomit, fever), assetscore.

OR – Odds Ratio, C.I – Confidence Interval

6.6.2 The mother's compensatory practices

The mother's caring practices during the work in the field were assessed based on various questions, such as what they did with their children when they went to the field and if the children were fed during that period. The results are presented in table 15.

More than half (60.6%) reported that they brought their children to the field, where nearly 90% of the children were fed, and *uji* was most commonly served. Among the children who usually stayed at home (n=54), about 85% were fed, in most parts by a sibling below 15 years (63.1%).

The children who came with their mothers to the field were younger than the children who stayed at home (table 15), 90% (n=9) of the children below 1 year and 82,4% (n=24) of the children below 2 years were brought by their mothers to the field.

Table 15: What the mothers usually did with their children when they went to the field, and age characteristics, n=137[a].

Child feeding and age indicators	%	N
Did the mother bring the child to the field? (n=137)		
Yes	60.6	83
No	39.4	54
Did the mother feed the child in the field? (n=83)		
Yes	86.7	72
No	13.3	11
What was the child fed in the field? (n=72)		
Uji	69.4	50
Ugali or rice	2.8	2
Ugali/rice and vegetables/beans	13.9	10
Other[b]	13.9	10
The children who did not come along with their mothers to the field, were they fed? (n=54)		
Yes	85.2	46
No	14.8	8
By whom were the children fed if they did not come along to the field? (n=46)		
A woman in the village[c]	21.7	10
Sibling > 15 years	15.2	7
Sibling < 15 years	63.1	29
Age of the children	**Median**	**25-75th perc.**
Children who came along with the mothers	22.2	12.0-39.2
Children who did not come along with mothers	37.2	31.9-46.1

[a] n=137, because of missing values, [b] Sugarcane, potato (sweet or irish), breastfed only, [c] Female adult relative or other woman in the village.

Uji – thin porridge made out of either maize or millet, Ugali – stiff rice pudding.

Among the children who were fed by their siblings below 15 years there were a somewhat equal distribution of undernourished and nourished children (data not showed).

Analyses were performed to explore if children who stayed at home and was fed compared to the children who came with their mothers and were fed, could predict stunting or underweight. After adjustment of age, no significant effect on neither stunting nor underweight was observed (data not shown, logistic regression).

6.7 Factors associated with children's nutritional status

Two linear regression models were created, one for HAZ and one for WAZ, to find out if/ which variables (such as biologic- and demographic variables and indicators of socio-economic status, food security and women's workload) could explain variation in HAZ and WAZ respectively. The construction of the linear regression models were based on the UNICEF framework (figure 1), and the determinants of child undernutrition found in the framework. Included in the final model (analyses) were independent variables that were associated with HAZ or WAZ with a p-value <0.15 in the crude analyses. The variables excluded from the final analyses are presented in appendix 4.

6.7.1 Factors associated with height-for-age z-score

In the crude analyses age, months without food in stock and mothers workload were found to significantly explain variation in HAZ (table 16). Together, age, months without food in stock and mothers' workload explained 8.7% of the variation in HAZ. Age was the only variable which could significantly explain variation in HAZ in the final model, where HAZ decreased inversely with age (B= -0.01, C.I: -0.03, 0.00). Months without food in stock was nearly significant (p=0.06), and children in households with ≥1 month without food in stock had a lower HAZ compared to children in households with no months without food in stock (B=-0.37, C.I: -0.76, 0.01).

Table 16: Factors associated with height-for-age in linear regression analyses, n=152.

	Crude			**Adjusted**		
Variable	B	95% C.I	P	B	95% C.I	p
Age (months)	-0.01	-0.03, -0.01	0.004	-0.01	-0.03, 0.00	0.04
≥1 month w.o food in stock[a]	-0.51	-0.89, -0.13	0.009	-0.37	-0.76, 0.01	0.06
W. workload (days)						
≤38	0.34	-0.10, 0.77	0.13	0.24	-0.21, 0.69	0.30
39-66	0.25	-0.19, 0.70	0.27	0.17	-0.29, 0.63	0.47
≥67 (ref)						

R^2=0.087.

[a] 0=No months without food in stock, 1= ≥1 month without food in stock.

B – Regression coefficient, C.I – Confidence Interval.

6.7.2 Factors associated with weight-for-age z-score

In the crude analyses age, disease (the last 2 weeks), children <16 in the household, father other income, dry season cultivation and months without food in stock were found to significantly explain variation in WAZ (table 17). The above mentioned variables explained 18.4% of the variation in HAZ. However, only age and dry season cultivation could significantly explain variation in WAZ in the final model. Disease was nearly significant (p=0.07). WAZ was found to decrease with age (-0.01, C.I: -0.02, 0.00). Children in households who performed dry season cultivation, in addition to cultivation on the main field, had a lower WAZ than children in households who did not perform dry season cultivation (B=-0.40, C.I: -0.76, -0.05). Sick children were found to have a lower WAZ than children who were not sick (B=0.32, C.I: -0.03, 0.67).

Table 17: Factors associated with weight-for-age in linear regression analyses, n=152.

	Crude			**Adjusted**		
Variable	B	C.I	P	B	C.I	p
Age (months)	-0.02	-0.03, -0.01	0.004	-0.01	-0.02, 0.00	0.02
No disease[a]	0.33	0.01, 0.65	0.046	0.32	-0.03, 0.67	0.07
Children < 16 in the h/h						
≤3 (ref)						
4	-0.17	-0.59, 0.24	0.41	-0.11	-0.53, 0.31	0.61
≥5	-0.36	-0.74, 0.02	0.07	-0.26	-0.64, 0.13	0.19
Father other income[a]	0.37	0.03, 0.71	0.03	0.22	-0.15, 0.58	0.24
Dry season cultivation[a]	-0.42	-0.76, -0.08	0.02	-0.40	-0.76, -0.05	0.03
≥1 month w.o food in stock[a]	-0.51	-0.84, -0.17	0.004	-0.31	-0.69, 0.07	0.11

R^2=0.184.

[a] 0=Disease, 1= No disease, 0=Father no other income, 1= Father other income, 0=No dry season cultivation, 1=Dry season cultivation, 0=No monhts without food in stock, 1= ≥1 month without food in stock.

B – Regression coefficient, C.I – Confidence Interval.

7 Discussion

7.1 Main findings, and main methodological strengths and limitations

The results revealed that a high proportion of the children were stunted (63.8%) and underweight (33.6%). The rate of exclusive breastfeeding was low, as a consequence of introduction of prelacteals, and early introduction of *uji*. Both the children who received complementary foods (6-23 months, mostly breastfed) and the non-breastfed children had a low dietary diversity. No relationship was observed between the dietary diversity scores (FVS and DDS) and children's nutritional status, but a relationship between feeding frequency and severe stunting was found. The mothers' workload in the field last agricultural season was not significantly related to the children's nutritional status in adjusted analyses, but a tendency of poorer nutritional status among the children of mothers with high workload was observed. More than half the mothers brought their children to the field and most fed their children *uji*. The children who did not come with their mothers were in most part taken care of by an older sibling below 15 years. Age was found to significantly explain variation in height-for-age z-score. Age and dry season cultivation were found to significantly explain variation in weight-for-age z-score.

The main strengths of this study is probably that my fellow student, who is a Tanzanian, and thus knows the language and culture, was the interviewer, and the pretesting of the tools (questionnaire and 24-hour dietary recall). The main limitations are recall bias, the sample size and that the dietary diversity scores used, FVS and DDS, have not been validated for the community.

7.2 Discussion of results

7.2.1 Characteristics

The present study found that most of the households practiced farming, which is similar to the former study (7). Nearly half the mothers (44.7%) were found to brew beer in the present study, which where fewer than in the former study from Msanzi where 83% of the mothers

reported to brew beer (7). Fewer women were uneducated (<1year in school) in the present study, compared to the former study from Msanzi; 36.8% had no education in the present study, and 62% had no education in the former study (7). This might imply that the educational system has improved, or that an increased focus on education of girls has taken place, and thus more girls have been enrolled into school.

7.2.2 The children's nutritional status

The prevalence of stunting (63.8%) and underweight (33.6%) identified in the present study is classified as very high for a population[20], by WHO (21). The prevalence found for wasting (2.7%), on the other hand, was characterised as low. The present study found a higher prevalence of stunted and underweight children compared to the regional level (the prevalence of stunting 50.4% and underweight 13.5%) and national level (the prevalence of stunting 42.3% and underweight 15.7%) according to the most recent findings from the TDHS (5). The prevalence is also found to be higher compared to the overall prevalence in Sub-Saharan Africa, where the prevalence of stunting was 42% and underweight was 22% according to most recent national surveys (115). The prevalence of severely stunted (32.8%) in the present study, were higher than at the regional level where about one fourth were severely stunted.

One explanation of the high prevalence of stunting found in the present study compared to the regional level might be that Msanzi is situated in a rural area. Rural areas have generally a higher prevalence of child undernutrition compared to more urbanised areas, although Rukwa is not that urbanised (5). Seasonal variations in food availability and disease might also impact on the rates of undernourished children. However, these factors are most likely to impact on weight-for-age and weight-for-length as these indicators are most sensitive to e.g. acute food shortages and infections. If food shortage persists and infections are frequent, height-for-age might also be affected. However, our data collection took place few months after harvest.

The prevalence of underweight (as below 75% of the median NCHS/WHO reference population (1983) (24)) in the present study was somewhat lower and the mean weight-for-

[20] A prevalence of stunting above 40%, and a prevalence of underweight above 30% are classified as a very high prevalence of stunting and underweight respectively in a population. A prevalence of wasting below 5% is low in a population (21).

age (as percent of the NCHS/WHO reference population (1983)(24)) was somewhat higher in the present study (25% and 83.5%) compared to the former study in Msanzi (26.4% and 81.8%) (7). These data are not in line with improvements (although small) taken place at the national level, where the TDHS 1992 found that 28.5% and 7.0% (100) had a WAZ <-2 and -3 respectively, compared to 21.0% and 3.8% respectively in TDHS 2010 (5).

The cut-off used in the present and former study, 75% of the median NCHS/WHO reference population indicates moderate undernutrition, and is somewhere between <-2 and <-3 z-scores, as 80% is approximately the same as <-2 z-scores (109).

As described in section 2.1.2, the nutritional status indicators reflect different processes of undernutrition (22). Using underweight as indicator is challenging because it fails to distinguish between tall and thin children (which reflects wasting) and small children with adequate weight (which reflects stunting). Thus, in a population with high rates of stunting and low rates of wasting, the use of underweight as an indicator will yield a too low rate of undernourished children. Additionally, proper interventions are difficult to develop, of the same reason. Both stunting and wasting should be measured when doing surveys. Among the children in the present study, wasting was close to absent and stunting and underweight rates where high, thus the children were most likely to be small children with adequate weight.

The age distribution of stunting in the present study found that stunting increased with age and peaked in the second year of the children (table 8). This pattern is similar to that at the national level (106) and a study based on child growth in the African region (20). The rate of underweight peaked during the first year (table 8), which was later than at the national level but similar to the African region. Stunting was also particularly pronounced the first six months of life (few participants in this age group, n=12). This age distribution of prevalence of stunting and underweight, might be a sign of insufficient intrauterine nourishment, the use of pre-lacteals and early complementary feeding, but also frequent episodes of infections. It might also illustrate the problematic transition period, from breast milk to adult food, as described in section 2.1 and 2.2. As we did not collect information about birth weight, it is not possible to conclude that the intrauterine nourishment had been poor.

No differences between the genders according to prevalence of stunting and underweight were observed (figure 5). This was in accordance to the TDHS 2004/05 (106), but the TDHS 2010 (5) found boys to be more stunted than girls. A meta-analysis conducted in Sub-Saharan

Africa found that boys where more likely to be stunted compared to their female counterparts (116). This was more pronounced in households with low socio-economic status. On the other hand, a study from Eastern Kenya found girls to be more undernourished compared to the boys, as a consequence of less food intake (117).

7.2.3 Breastfeeding practice

In the present study breastfeeding was found to be universal and nearly all children were breastfed at the age of 1 year and more than half were breastfed at 2 years (figure 6). These results confirm the findings from the latest TDHS (5), and are similar to the breastfeeding practice on the Sub-Saharan African continent (43).

The former study in Msanzi (7) found 40% of the children to be breastfed for 2 years, which implies that the length of breastfeeding has increase with 20%. At the national level a similar trend is observed between the TDHS 1992 (100) and TDHS 2004/05 (5), and might be explained by breastfeeding promotion.

The poor practice of exclusive breastfeeding found in this study (1 child exclusively breastfed for 6 months), did not meet the recommendations from WHO of exclusive breastfeeding for 6 months (35). The low exclusive breastfeeding rate in this study (figure 7) was lower than other studies from Tanzania (77;99) and at the national level, according to the most recent TDHS (5). The TDHS applied the 24-hour recall method to measure exclusive breastfeeding, which is discussed in section 7.2.2. The practice of giving prelacteals might explain some of the poor practice of exclusive breastfeeding observed in the present study, and is discussed in the next section.

According to the local health centre there are HIV-1-infected mothers in Msanzi, but the exact number is not known. Children who are not exclusively breastfed for the 6 first months of age are more susceptible to mother-to-child transmission of HIV and other infections (42).

Prelacteal feeding

The high prevalence of children receiving prelacteals (≈70%) found in this study was similar to the regional level where 71% received prelacteals, according to the TDHS 2004/2005 (106). Large regional variations existed within the country, according to the same report. Giving children prelacteals is generally a common practice among African mothers, and other

studies from different regions in Tanzania (77;99) and in the neighbouring country Uganda (41;45) have reported similar practices. However, only the study by Shirima et al. (99) from Morogoro region in Tanzania reported such a high proportion (≈70%) of mothers introducing prelacteals at the first days after birth, as found in the present study. The TDHS 2004/05 (106) found that mothers assisted by Traditional Birth Attendants, living in rural areas and with low socio-economic status were more likely to give prelacteal feeds, compared to mothers assisted by health professionals and with higher socio-economic status.

The reasons for giving the children prelacteals were not assessed in the present study, but according to discussions with some women in Msanzi, we got the impression that prelacteals were given because of traditions. When we asked them if it was because of "lack of milk"/"crying baby", they responded no. The staff at the local health centre told us that they recommended the mothers of Msanzi to exclusively breastfeed, but that this advice was not followed.

In a study from Uganda (41), where about 50% of the mothers gave their children prelacteals within the three first days postpartum, the reasons the mothers reported for giving prelacteals were that the baby was hungry, that the mothers had to wait until the milk started flowing, the mothers' pain and exhaustion after delivery, advice from health staff and cleaning the baby's throat. A study from Malawi (55) found the reasons for early introduction of water to be that the baby was always crying or "baby so hungry that feeding the child only breast milk would not be enough".

According to the staff at the local health centre in Msanzi, diarrhoea among children below 6 months of age was not uncommon. Diarrhoea is one main negative effect of giving children prelacteals, and might have a detrimental impact on children's growth (48). The present study did not assess weather the liquid and utensils used were safe and that the water was cooked before it was given to the child, which might increase the risk of infections even more.

The rate of educated mothers in Msanzi was low (≈50% had not finished primary school), and according to the staff at the health centre in Msanzi they had annually a course in nutrition, however it was usually few participants. A study from Morogoro district in Tanzania found the mothers knowledge of adequate breastfeeding practices to be positively associated with longer period of exclusive breastfeeding than those who do not have that knowledge (118).

7.2.4 Complementary foods

Complementary feeding started at median 2 months in Msanzi, which is much too early according to recommendations from WHO, as they recommends complementary foods to be introduced at 6 months of age (36). The negative impacts are similar to those of prelacteals as described above. In addition, early introduction of *uji* might displace breast milk and compromise the absorption of nutrients from the breast milk (36;50). Unprocessed *uji* is also found to be an inadequate complementary food after the first 6 months, as it provides insufficient amounts of micro- and macronutrients (55;98). For instance, the former study from Msanzi found the energy density of *uji* to be low, and the diet insufficient to cover the dietary needs of young children (8).

The present study did not assess weather the grains used for *uji* was processed, e.g. due to germinisation. However, it is used when the women make the local beer. The use of germinisation is found to reduce the viscosity, without adding more water, of thick cereal porridges, and to increase the energy and nutrient densities (54). An intervention study of increasing the use of kimea (which is flour of germinated millet) in *uji* by de Paoli in Msanzi (1990) (53) found the use of germinisation to be low, both before and after the intervention.

The age of introduction of complementary foods found in the present study (median 2 months) confirms Hadley's (97) findings from another study conducted in Rural Rukwa. He found that the children of the Pimbwe tribe were introduced to *uji* at two months, although different from the practice of the Sukuma tribe which introduced *uji* at four months. The TDHS 2004/05 found 32.5% of the children 2 to 3 months of age to receive complementary foods (106).

The former study in Msanzi found *uji* to be introduced from about 4 to 6 months, which is later than in the present study. This implies that no improvement have taken place the last 23 years.

A review article by Muhimbul et al. from Tanzania (52) suggested complementary feeding practices to depend on factors such as location, ethnic group and socio-economic status.

About half (53.5%) of the young children (6-23 months of age, mostly breastfed) had a Minimum Dietary Diversity of at least 4, indicating that the children received food from at least 4 food groups, which is a Minimum Dietary Diversity recommended by the WHO (67).

Children who receive ≥4 food groups are found to have a high likelihood of consuming, in addition to the staple food, one animal product and one fruit or vegetable the previous day (67). The percentage with a Dietary Diversity above 4 food groups found in this study was higher than at the national level (34%) and other countries in Eastern Africa (119). The sample size (n=44) in this age group did not allow a preferred disaggregation of data, due to age groups and breastfeeding status. In addition, feeding frequency was not assessed for children between 6 and 23 months, because feeding recommendations (49;67) vary with the age groups and if the child is breastfed or not, and thus the sample size was too small.

7.2.5 Children's diet after breastfeeding

In the present study the non-breastfed children were found to have a low dietary diversity (the mean DDS was 4.7 and the mean FVS was 6.7).

The low dietary diversity found in the present study is similar to a description of the Tanzanian children's diet in a paper by Kinabo et al. (15), and similar findings are observed in a study from Kenya among non-breastfed children 12-36 months (62) and in a review article by Onyango et al. representative to African communities (56). Low dietary diversity diets are associated with poorer quality of the diet (56;58).

This study found especially low intake of animal products and fruits, but also that all children consumed grains, nearly all tomatoes and onions (>95%), the majority beans and nuts (>80%) and green leaves (>60%) and around 40% fish (table 9). In addition, it shows that children with a high DDS consumed more of especially vitamin A rich fruits and vegetables, fish and oil (table 10).

High cost might explain the low intake of animal products in this village. Low intake of fruits can be explained by the fact that fruits are not commonly cultivated in the area (except bananas, guavas and to a smaller degree mangoes when the fruits are in seasons), and as explained by Kinabo et al. of Tanzania, many mothers do not find fruits important to give to the children (15). For instance, the households interviewed in the mango season in the present study (around 30 households) only one mother reported in the 24-hour recall to have given her child a mango.

The former study's description of the children's diet was similar to the findings from the present study (6).

In contrast to the findings from this study, most other studies from developing countries, which I have been able to find, have found a positive association between children's nutritional status and the dietary diversity scores, e.g. a study from Kenya (62), a study from rural Bangladesh (59) and a study by Sawadogo et al. from Burkina Faso (60). The food groups and age ranges used in the above studies are slightly different from the present study. A paper based on 11 DHS from developing countries, among children 6-23 months, found DDS to be significantly associated with HAZ in 9 of the studied countries (61). On the other hand, a study by Ntab in rural Senegal found no association between DDS and HAZ (63).

The lack of association found in the present study between nutritional status and DDS/FVS (table 12) might be explained by the fact that amount of food was not measured in the present study. For instance a child was given a score of 1 if she/he eats some spoonfuls or large portions several times a day. Additionally, mothers of undernourished children might have been recommended by e.g. health officers/elderly in the village to give their children more nutritious foods, and then undernourished children will have higher FVS/DDS scores. Another explanation to this contradictory finding might be the overall low variety of the diet, which might make it difficult to detect a difference between the children. In addition, if the sample size had been increased it might have yielded more significant results. Lastly, there might be other factors which impact more than the diversity of the diet.

The children were fed mean 3.1 feedings a day in the present study. This is similar to the mean feeding frequency found in February/March in the former study from Msanzi, characterised by a period of high workload of the women (8).

In the present study children fed 1-2 feedings were more likely to be severely stunted compared to children who were fed 4-5 feedings a day (table 12). Similar relationships have also been found in other studies e.g. in a study from Burkina Faso (60). More frequent feedings is associated with higher energy intake (112), and this finding suggests the importance of frequent feedings. The former study in Msanzi (8) found no association between feeding frequency and underweight. However, they found a positive relationship between numbers of feedings taken together with quality of foods, as measured through a 24-hour dietary recall.

7.2.6 Disease

In the present study, 57.9% of the children had been sick in the reference period. The prevalence of diarrhoea (25%) was much higher compared to the regional and national levels (106). Disease rates, e.g. colds, have been reported to be higher during wet season; when women's workload is high and coincides with food shortage, however only a small part of the data collection was done during the wet season (53;97), so it is not likely that this matter of fact can explain the high rate of diarrhoea. On the other hand, e.g. poor food handling and preparation, in addition to hygiene as discussed in 2.2.2 and 2.2.3 might explain the high rates.

7.2.7 The mothers' workload in the field and child feeding practices

The present study found no association between the mothers' workload and feeding frequency. The former study from Msanzi (8) found a significant negative association between mothers' workload and feeding frequency in the season of most agricultural work. In the present study, information of women's workload and feeding frequency were collected at different times, so association might be difficult to reveal and the analyses might be questioned.

The present study could observe a negative tendency between mothers' workload and the children's nutritional status (height-for-age and weight-for-age) (table 13). However, only the crude analysis found mothers who worked the most to be significantly more likely of having underweight children (table 14). In the linear regression analyses mothers' workload was included in the final model ($p<0.15$, table 16).

The mothers' workload and its impact on weight-for-age found in this study was similar to that of the former study in Msanzi (8), which found a negative, but not significant relationship between the mothers' workload (the hours mothers worked per day categorised into three group) and underweight. A study undertaken in Rural Chad (81) found no association between mothers' workload (the hours the mothers worked per day) and the children's nutritional status (height-for-age). On the other hand, Rabiee and Geissler in their study from Iran (78) found an association between the mothers' workload (hours the mothers spent away from home per day, categorised into three groups) in the field and proportion of wasted children below 2.5 years, but no association with stunting. However, only simple

methodological analyses were used. A study from Mali (79) found mothers' farm work to be negatively associated with height-for-age z-score among children 12-36 months of age.

The present study used a different method to calculate women's workload compared to the former study in Msanzi (as discussed in section 7.2.6) and the other studies mentioned above. The majority of the other studies applied the 24-hour recall method, and was collected at the same time as the children's nutritional status was taken. Additionally, the studies were undertaken at different times of the year. This study was conducted in pre-planting/planting season, a period characterised by low workload, compared to weeding and harvesting. The former study, and other studies, has found the workload to differ between the activities, with highest workload observed in harvesting and weeding. The method used to collect information of the mothers' workload and in which type of season it is done, can impact on the results as discussed in section 7.2.2.

Moreover, a qualitative study undertaken in Kenya concerning the women's perception about reasons for undernutrition among their children, they stated lack of time to feed the child as one problem, as a consequence of several tasks in the household and in the field (82). Mwangome et al. reported similar findings among mothers in rural Gambia (83).

As described by Kulwa et al., (77) even though women have heavy work burdens and time constraints, the mother's find strategies to modify their work pattern and compensate for loss of time available for feeding and care. This may explain the lack of significant association between women's workload and children's nutritional status. In this study we found a practice of bringing the children to the field and feed them there, or leave the children with alternate caregivers to buffer the effect of time constraints. Another explanation of the lack of significant association between women's work in the field and child care might be that the households where the women worked more also had a higher food production (increased food availability), which could influence the children's nutritional status positively. In this case the negative effect of women's workload on child nutritional status may be balanced by this positive effect of increased food availability. A study by Holmboe-Ottesen et al. (107) explained the reason of lack of association to be that a great number of factors impact, and that women's workload is more obscure because other factors such as hygienic conditions and nutritional knowledge might have a more profound impact on the children's nutritional status.

The present study found that nearly all children below 2 years (the breastfed children) came with their mothers to the field. This practice can have made it possible for the mothers to breastfeed, as this commonly is done at the same time as other activities. Lack of time to breastfeed has been stated as one of the main negative factors of maternal work (76). The former study from Msanzi found the mothers to breastfeed more often in periods of heavy workload, when they spent much time on the *shamba* (8).

Further, the mothers reported that nearly all children were fed either at home by alternate caregivers or in the field by the mothers. *Uji* was most commonly given in the field. The question was not posed for children who where fed at home, but there are no reasons to believe that the children were given something which was more nutritious at home. A qualitative study from Kenya found that the women worried that the alternate caregivers whom the children was left with when the women were away, did not feed the children properly (82).

The majority of alternate caregivers in this study were siblings below 15 years. The quality of care provided by these siblings below 15 years is likely to not attain the qualities needed by a caregiver for optimal feeding and feeding related practices of the children, suggested by Kulwa et al. in a study from Dar es Salaam (77) and as discussed in 2.2.4. In the present study there were no difference in proportion of stunting and underweight between the children who were taken care of by sibling below 15 and the other alternate caregivers. In addition, it is worth to question how the older siblings solve the problem of being alternate caregivers in addition to go to school.

The present study found that the mothers had similar practice to buffer time constraints, as found in the former study(8). That study also found, from their qualitative data, that the women tended to feed their children in the morning before they went to the field and they gave the children something to eat before they began preparations of the evening meal. The former study also found a significant higher feeding frequency of the mothers who brought food to the field compared to the mothers who did not. No such comparison was conducted in the present study because of few children (n=11) in the group of children who were not fed in the field.

7.2.8 Determinants of undernutrition

Age

HAZ and WAZ were found to be negatively associated with age. As described earlier in this section, HAZ and WAZ are found to decrease with age.

Dry season cultivation

I have not been able to find other studies investigating dry season cultivation and its association with children's nutritional status. It was assumed that dry season cultivation would have a positive impact through increased food availability; however, it might be that in the households which did dry season cultivation increased the mothers' workload and thus time to provide care.

Disease

The children reported to be sick in the reference period had a lower WAZ compared to the children who were reported not to be sick in the same period, although only nearly significant ($p=0.06$). Disease was measured by fever and vomiting, which are known indicators of malaria, and diarrhoea. Malaria (69) and diarrhoea (68) are known determinants of undernutrition, but undernutrition also increases the likelihood of becoming sick, as discussed in section 2.2.3.

Months without food in stock

"Months without food in stock" was used as an indicator of food insecurity. In the present study children from households with ≥1 month without food in stock were found to have a lower HAZ, compared to the children from households with no months without food in stock, but only close to significant. Food insecurity is a well-known determinant of undernutrition (2). However, a study by Hadley from Rukwa (97) found food insecurity during pre-harvest season not to be related to children's nutritional status. Hadley suggested increased labour demands or increased infectious disease to be responsible for the deterioration in nutritional status which took place in the pre-harvest seasons.

7.2.9 Women's education and socio-economic status

The present study found no association between mothers' education and children's nutritional status. The absence of association is also found in other studies (63), although women's education is a factor known to improve children's nutritional status (33). The reason for this lack of association can be that differences are mainly found when comparing mothers with at least secondary school with mothers with lower education (63). This has been found e.g. in the TDHS 2004/05 (106). In the present study almost all women had low levels of education; only three mothers had secondary school and one had higher education. In addition, education is not associated with better nutritional status in the poorest households, as mothers need some economic power to make use of their knowledge (63). In this setting, most households were poor.

Poverty is an important determinant of undernutrition (2). In Msanzi the majority were poor, as measured through the asset score, the type of roof and by a general impression. However, the economic background variables were not associated with the children's nutritional status. This is also found in other studies (45) despite the known association between socio-economic status and child nutritional status. In this study it might be that despite of different socio-economic status, the children had similar plant based diets, where most children have low intake of fruits and animal products, and thus is susceptible to deficiencies of nutrients. Nonetheless, poverty is probably one of the main reasons of the high levels of undernutrition in this study as well.

7.2.10 Comparing with the former study

The results from our study, which were compared with the former study from Msanzi, revealed that *uji* was introduced earlier, more children were breastfed at the age of 2 years and that there were fewer uneducated women at present day. However, the prevalence of underweight children has not changed much the last 23 years. Thus, small changes have taken place, and might be explained by lack of attention and political will (see section 3.2) to develop the region. Hopefully, if the area is given attention by the authority and women empowerment takes place, the poor nutritional status of the children will improve.

7.3 Discussion of methods

7.3.1 The study design and sample size

A cross sectional design was chosen for this study as this was the most feasible due to time and resources available. The main disadvantage with this design is that the information (the explanatory and outcome variables) is collected at one point in time, which makes it difficult to identify what the causes and effects of the relationship are (120). Thus, the determinants found to cause undernutrition in the present study should be interpreted with carefulness.

The sample was selected based on random sampling, which limits chance of selection bias.

Due to time, resources and logistical matters the sample size did not apply the usual criterion of a 5% margin of error, because about 150 households were the absolute maximum of what we could handle. The 7% margin of error increased bias, and decreased the ability to generalize to the people of Msanzi and other populations. If a 5% margin of error had been applied, 284 households/children should have been included in the study.

7.3.2 Internal validity and reliability

'Validity' can be used to refer to the amount of bias in the study. If the factor or variable in a study found to cause the effect is a true association, then it is referred to as having 'internal validity'. Threats to internal validity can arise from e.g. error in the measurements, selection of study population, the questionnaire and the interview. 'Reliability', on the other hand, might be to what extent a measurement of something, taken at different occasions, can produce the same results (121;122).

Structured questionnaire and 24-hour dietary recall

We decided to use a single 24-hour dietary recall method, without estimations of amount, and a structured questionnaire, to assess the children's dietary intake and the other variables needed, due to resources available.

The 24-hour recall sheet was based on a standard sheet developed by Gibson (2005) (22) and the former study.

The questionnaire has not been validated, but both validated and not validated questionnaires were used for developing it (see section 5.5.2). The structured questionnaire had both open- and close ended response categories, which made it possible to encounter information which otherwise might have been lost. This method requires more time for coding and analyses and is therefore rarely used in structured questionnaires, but it is valuable where the researchers come from another region/country, and when the researchers are somewhat inexperienced with collecting primary data.

A factor that might have an impact on the focus of the respondents and further the quality of the responses is the length of the interview (121). Our interviews did in most cases not exceed one hour, although the questionnaire included the questions to two studies and that it was challenging to make it small enough and at the same time get the information required.

Pre-testing of the questionnaire and the 24-hour dietary recall

The questionnaire and the 24-hour dietary recall were pre-tested in 15 households, on both the main caretakers and the household heads. The pilot allowed us to add, adjust, completely change or approve the questions, so that it was possible for us to gather the information of interest. For example, unclear questions were reformulated to make it applicable to the respondents. Pre-testing increased the validity and reliability of the interview, and thus the information gathered.

The interview setting and social desirability bias

The face-to-face interview method was chosen, as illiteracy was common in the village, and all interviews were conducted in Swahili, as all the participants spoke Swahili fluently. In addition, the interviews took place in the participants' houses in a room without listeners so that the respondents could speak privately and freely express themselves.

The interview setting included the respondent (household head or main caretaker), my fellow student and me. The relationship between the respondent and the interviewer, and in this case, also my appearance and gender, can affect the answers from the respondents and influence the validity of the data. A phenomenon called social desirability response bias, where the interview object responds to "please" the interviewer or responds what he/she thinks is "correct", might have taken place (123). If this was the case, it would have introduced bias to

the study findings, through over- and/or under reporting, and influenced on the internal validity.

Msanzi village is rarely visited by foreigners, and my presence in the interview setting might have impacted on the answers given, as discussed above. Our first plan was to stay in Msanzi during the period of fieldwork, both as this was most convenient due to logistics, but also for the people in the village to get more used to us and visa versa. However, due to logistical constraints this was not possible. But after some weeks I think that the villagers got somewhat used to us being there accompanied with the field assistant and the sub village leaders. Additionally, I used to speak Kiswahili (at least I tried) and to greet in Kifipa[21] when we went to the households, which might have eased the mood and provided a friendly atmosphere for the interviews. Finally, many of the villagers also spoke about good memories from meeting the women who conducted the former study in Msanzi in the late 1980s.

Fellow student as interviewer

All the interviews were conducted by my fellow student. She is from Tanzania, speaks Swahili and has conducted research in the area before. She knew the objectives of my study and thus was able to make sure that the respondents had a proper understanding of the questions and could explain misunderstandings. This, and the fact I did not need to employ an (unfamiliar) interpreter, increased both the validity and reliability of the data.

Even though all the interviews were performed by my fellow student and in a somehow similar manner to all the respondents, the first interviews differed somewhat from the last interviews as we got more confident with the questionnaire. However, these variations can be considered small compared to the variations one could encounter if one were to use several interviewers.

Recall bias

Many of the questions in our questionnaire were retrospective and the outcome of the answers depended on the memory of the mothers. Of special concern were the following variables; measurements of the 24-hour dietary recall, disease, food in stock, mothers' workload in the

[21] The Fipas are well-know for long greeting episodes, as described by Bjelland in his book "Bistand på ville veier" (104).

field and breastfeeding practices, where the recall varied from the last day and night in the 24-hour dietary recall to several years when estimating length of exclusive breastfeeding. It is likely that these recall periods impacted on the results through recall bias, and over- or under reporting. Recall bias is maybe the major limitation of the study.

To evaluate the mothers' abilities to remember, we asked for the age of the child and there after checked for errors by the use of the health clinic card. In most of the cases the mothers' responses were in accordance with the date of birth in the health clinic card.

To reduce memory lapses in the 24-hour dietary recall, the mothers were asked in a manner so that she could visualise the previous day, what she did in the morning, when the target child woke up, what the target child was fed when she/he woke up and so on.

To reduce memory lapses according to the mothers' workload the last agricultural season, we tried to ask in a manner so that the mothers were able to think and try to visualise last year, and many small follow-up questions were asked to try to help her remember.

Some variables used in the study

Several variables used in the present study and methods used to analyse some of the variables, are discussed below. Recall bias will be touched upon in selected variables, but has mainly been discussed above.

Indicators of nutritional status

Anthropometrical measurements were used to develop the indices of nutritional status. Several advantages exists by the use of anthropometrical measurements, e.g. that they are found to be related to past exposures, present process or future events (22). Of the major limitations is that nutritional anthropometry can not distinguish between energy, protein and micronutrient deficiencies (22).

Variations in the anthropometrical measurements are described by de Onis et al. (124) to arise from e.g. the measurer's resources (e.g. experience and mood), the accuracy and precision of the instruments, the cooperation and behaviour of the child during measurements, the setting where the measurements took place and methods of data recording and children's day-to-day variations. This might introduce systematic and random errors to the results, which impact on

reliability and validity. To reduce errors we were trained in and practices performing anthropometrical measurements, read relevant literature, weighed the children twice and a third time if inconsistency and checking the scale regularly. In addition, the target child was measured after the interviews were finished, if possible, so that the child could get acquainted with us during the interview and then be as cooperative as possible when the measurements were taken. However, in some households the child was not cooperative and we struggled to get the proper measurements. Our solution to this problem was to give the child a candy and wait for the child to calm down. In addition, my appearance did contribute to the reluctance of some of the children.

The exact date of age is necessary in the weight-for-age and height-for-age indices. The mother of the child reported the age which was further checked for accuracy with the health card. The presence of health cards, among all the children except 3, improved the validity.

The observed SD values of HAZ, WAZ and WHZ distribution in the present study, are within the expected ranges of SD of the z-score distribution, which are around 1 (21).

Exclusive breastfeeding practice

Length of exclusive breastfeeding was measured by asking the mothers to recall when the first liquid or food was introduced. Additionally, a question could have been posed to the mothers about length of exclusive breastfeeding in months, to see if there were any inconsistencies in the answers given. A review article by Li et al. (125) suggest the validity and reliability of the recall of breastfeeding practices to be adequate up to the age of 3 years, but the estimation of introduction of fluids and complementary foods to be less sufficient. The use of 24-hour recall method could also have been applied. This was not possible due to sample size limitations. The 24-hour recall method is commonly used to assess the rate of exclusive breastfed children below six months in a population, e.g. the DHS. The use of 24-hour recall method is found to reduce recall bias, but it is also found to overestimate the true number of exclusively breastfed children (41). This might be explained by that prelacteal feedings and irregular feedings will not be accounted for by the use of a 24-hour recall. A cross sectional study from Uganda (41) found the prevalence of exclusive breastfed children (0-5 months) to be 50% by the use of the 24-hour recall method, but when the dietary recall since birth method was applied, none of the children were found to be exclusively breastfed at the age of six months. Both a 24-hour recall and a recall since birth were suggested to be used.

Diet Diversity- and Food Variety Scores

The use of DDS and FVS were chosen since this is a fairly easy method to estimate a proxy for the adequacy of the diet. The DDS and FVS used for the non-breastfed children were developed from the 24-hour dietary recall, without estimations of amount, of the target child. Estimation of energy and nutrients could therefore not be calculated, which might be the main weakness of this method. The FVS and DDS have not been tested and thus not validated for use in Rukwa Region of Tanzania, and is not a validated method (see section 5.6.3). However, DDS and FVS have been validated for other studies in developing countries, the Philippines (among non-breastfed children 24 to 71 months) (57) , South-Africa (children 1 to 7 years) (66) and Mali (non-breastfed children below 5 years) (65), and among young children (6-23 months) in several developing countries (64). The conclusion from these studies is that the DDS and FVS can be used to reflect the (micronutrient) adequacy of the diet. As presented in section 2.2.2 other studies in developing countries have used the DDS/FVS as indicators of micronutrient adequacy. Thus, I found it decent to apply this method in the present study.

Some studies mentioned above used both a lower limit of 10 gram, which means that foods consumed below 10 gram will not be included in the scores, and no lower limit. Since we did not record amount of intake, no such limit was set in the present study.

The main caretaker of the target child was found the most eligible to report the child's food intake. Parents are found to be reliable reporters of their children's food intake, but if they spend much time away from the children, the reliability decreases (126). This was not a big problem in the present study, as data collection took place in a period characterised of little work in the field. However, to increase accuracy, other sources were consulted in cases when the mothers did not know or remember what the children had consumed, which was most likely to happen in households with children in an older age group, as young children (below 2 years) usually were carried around with their mothers.

A single 24-hour dietary recall is not found to be sufficient to assess the actual intake of a child, and a repeated 24-hour dietary recall could have been employed to counteract within person variability (22). However, the day-to-day variations in developing countries with monotonous diets are found to be minor, compared to what can be the case in developing countries (127). In addition, the interviews were only carried out on weekdays (Monday to Saturday), but as explained above, because of the monotony of the diet the food intake on

weekdays and weekends are most likely to be similar. Nevertheless, even though a single 24-hour recall does not reflect the habitual intake of a child, several 24-hour dietary recalls on different individuals can be representative to a population at a point of time (22). To detect seasonal variations in Msanzi, repeated 24-hour dietary recalls at different times of the year should have been employed.

Disease

The mothers were requested to report all the episodes of disease the target child had experienced the last 2 weeks. This method is widely used, e.g. in the DHS, to get a picture of the disease rate. However, it has been suggested that this reference period of two weeks is too long to grasp the true disease rates, and a study from Kenya suggests three days to be a reference period more likely to catch the true disease rates (128).

Possession of assets (asset score), as indicator of economic status

We used possession of assets as one indicator of economic status, as described in section 5.6.3. In the process of developing the score, we decided to give the various items a monetary value instead of an ad hoc value, because we found it challenging to weigh the assets. The asset score has not been validated, but similar scores have been used in other studies (47;97). The other indicators of economic status used in this study, possession of cows, type of roofing and size of the land, were separately assessed for association with the asset score. The analyses revealed that a significant association was found between the asset score and either of the other economic variables, from where it might be possible to conclude the asset score to be a fairly good indicator of the economic status in Msanzi village. The development of an asset score could also have been done by the use of Principal Component Analysis. Commonly used as indicator of economic status is household income, this is however not possible in a setting as Msanzi (8).

Mothers' Workload

The method we used to measure women's workload has not been validated, and other studies, as presented in 7.1.7, have not applied a similar method. Most common has been to use a 24-hour recall method (78;79), which was also used by the former study in Msanzi (8). The main limitation with the method we used in the present study is that it is prone to memory lapses as described above. The strength with the method might be the fact that it reflects the whole year

of women's work in the field (with keeping in mind that this is only selected activities), which might be appropriate when assessing for association with stunting (long term undernutrition).

Child weight

Infants were measured together with their mothers on an electronic scale. This method is found durable and flexible by the UNICEF (109). The use of an electronic scale was recommended us during the training at Sokoine University.

Confounders

If confounders are not detected they might introduce bias to the study findings by making a wrong assumption about cause and effect (122). In the present study I tried to locate potential confounders, by the use of the UNICEF framework (figure 1). There is a high likelihood that other confounding factors exist which we did not adjust for in the analyses.

7.3.3 Incentives

We decided not to give any incentives to the households we visited because we felt it was unfair to the households not included in the study, as the majority in the village was poor. Instead we threw a good-bye party for all the residents to show that we appreciated to have stayed in Msanzi the last months and for their participation.

7.3.4 Reflections on the methodology

Quantitative methodology and the use of theory were applied in this study; nevertheless a use of qualitative methods, in addition, could have given us a more holistic approach and enriched our understanding of the life in Msanzi. The use of triangulation is found to increase the validity of the data (129). Lack of resources did not allow this; however clarification throughout the period of field work was gathered from the field assistant and the sub village leaders. In addition, two separate discussion groups, of women and men, were conducted after we had completed the data collection. This was done to evaluate and clarify our findings, and increase validity.

7.3.5 External validity

External validity refers to the ability to generalize the findings of the study population to other populations. External validity can not take place without internal validity, but internal validity does not necessary mean that external validity is achieved (121;122). The study found that most households depended on farming, that the prevalence of stunting was high and that the majority of the households were poor. Similar settings exist many places in Rukwa and in Tanzania. However, it is difficult to determine if the findings in this study can be applied to other similar settings; because different settings have for instance various cultures, disease patterns, water quality and sanitation systems.

7.3.6 Comparing with the former study

There were some challenges with conducting a partly repetitive study, and thus comparing the results from the former study in Msanzi with the present.

Firstly, the data collection in the former study was conducted over a period of one year. The long time-period made it possible to conduct several measurements/interviews at different times of the year, to grasp seasonal variations (pre-, post harvest and periods with lots of and little work in the field). This was not possible to do in the present study due to time constraints.

The 24-hour recall method to calculate the mothers' workload in the field was not used in this thesis, as the period of time we were in the field is characterized by little fieldwork. If the same method had been applied it would have been easier to compare the present and former study with regard to women's workload.

In addition to qualitative data, the former study presented a range of qualitative data, which was not collected in the present study due to time limitations (see 7.1.4).

Times have changed and the types of analyses used then are not necessarily recommended to use now, e.g. we used regression analyses instead of ANOVAs analyses when assessing women's workload and its association with different variables. The logistic regression analyses were applied to adjust for several confounders. Linear regression analyses were added in this thesis.

Growth curves and z-score vs. percent of the median

Both the NCHS/WHO reference population and the Child Growth Standards were applied in this study. The NCHS/WHO reference population was used to be able to compare with the former study from Msanzi. The new Child Growth Standards (2006) were applied as well, because they are presently recommended when calculating the anthropometrical indices (16). Moreover, the NCHS/WHO reference population and the Child Growth Standards yield different prevalence of the nutritional status indicators of the same population, and can not be compared. Thus, both were applied as discussed in section 2.1.2.

A similar reason can explain why we used the z-scores instead of percent of the median as was used in the former study in Msanzi, namely that the z-scores are recommended when developing the anthropometrical indices, and that the percent of median was more commonly used before, as it is easier to calculate (23).

8 Conclusion

The present study reveals that the prevalence of stunting and underweight among the children below 5 can be classified as very high for a population by using the WHO criteria (21). There was no difference in rate of undernourished due to gender, but both underweight and stunting were found to increase with age.

Breastfeeding was found to be universal, and duration of breastfeeding to be fairly good. However, exclusive breastfeeding was close to absent among the studied children. A common practice was to give children prelacteals (sugar water) the first day after birth, and to give complementary foods (*uji* maize or millet) already the second month after birth.

The young children's (6-23 months) complementary foods and the non-breastfed children's diet were monotonous and vegetable based. Nearly half the young children received an inadequate diet, according to WHO recommendations of ≥4 food groups a day. The diversity of the non-breastfed children's diet was not significantly related to the children's nutritional status. However, non-breastfed children with a low feeding frequency were significantly more likely to be severely stunted compared to children with a higher feeding frequency.

The number of days the women spent in the field last season revealed large variations. Children of mothers who worked the most were more likely of being underweight compared to the mothers who worked the least, but only in the unadjusted analysis. However, a tendency of poorer nutritional status among the children of mothers with high workload was observed.

Age was found to be significantly and negatively associated with height-for-age z-score in linear regression analyses. Age and dry season cultivation were significantly associated with variation in weight-for-age z-score in linear regression analyses. Children in households which performed dry season cultivation, had a lower z-score compared to the children from households which did not do dry season cultivation.

The present study found the prevalence of underweight children to be nearly the same as the former study conducted in Msanzi, despite fewer uneducated mothers at present date. The present study also found more children to be breastfed at the age of 2 years and *uji* to be introduced earlier, compared to the former study.

8.1 Further perspectives

To reduce the levels of undernutrition, and especially stunting, some major changes have to be undertaken at different levels.

Breastfeeding promotion: The low levels of exclusive breastfeeding indicate a need to promote exclusive breastfeeding according to the WHO recommendations, by counseling. A study should be undertaken to understand the reasons for giving the new born children prelacteals. Key-persons in the village should be identified, and could be used in the breastfeeding campaign.

Improvement of complementary feeding: The monotone diet the children receive should be improved. This could be done by increasing the mothers' and fathers' knowledge of children's nutritional needs and how nutritious foods can be prepared with the resources available. Maybe a more diverse cultivation could be promoted, of e.g. nutritious vegetables and fruits.

Women empowerment: Women's high work burden and time constraints should be reduced. Technology and equipment that can benefit the women in everyday life should be put into practice.

The hygiene practices (such as food handling and preparation) and sanitation system in the village should be assessed, as this is known to have an impact on children's nutritional status and might be an important determinant in the village.

The role and responsibilities of the female siblings as alternate caregivers should be assessed, as the proportion of young girls as alternate caregivers was high.

Studies should be done at different times of the year to assess seasonal variations due to children's nutritional status, feeding frequency, diversity of diet, disease and women's workload.

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Appendix 1: Consent form

We are researchers currently studying at the University of Oslo in Norway. We invite you to participate in our study which look at gender division of labour in agriculture and decision making power in the household and their impact to household food security and child nutrition. We will also looking at other underlying factors which contribute to child malnutrition.

Specifically we are going to ask you on gender division of labour in food production and time allocation, decision making processes in different activities in the household, household food availability and perception of food sufficiency, child dietary intake and disease history. Also we will measure one of the children under five years of age in the household to assess malnutrition

The information will be kept confidential. Only the research team will have access to the information. No information revealing the identity of any individual will be included in the final report.

Benefits of the study

By participating in this study, you will help to increase our understanding of gender relations to food security and child nutrition. We hope that the results of this study will help towards understanding at different levels how development assistance should be structured so as to combat food insecurity and child malnutrition

Your participation in this study is voluntary and you have the right to refuse to participate in the research or refuse to answer any questions that you feel uncomfortable with. If you change your mind about participating during the course of the study, you have the right to withdraw at any time. If there is anything that is not clear or you need further information, you are free to ask.

DECLARATION OF THE RESPONDENT

I have read the above information, or it has been read and explained to me. I have been given the chance to ask questions about the study and any question that I have asked have been

answered to my satisfaction. Therefore, I consent voluntarily to participate as a respondent in this study. I also agree for my child to participate in the study

Signature/Thumb print of a respondent/ guardian of a child:

Date:

Signature of interviewer

Date:

Appendix 2: Questionnaire

DETERMINANTS OF CHILD NUTRITIONAL STATUS AND FOOD SECURITY

Msanzi, Tanzania 2010

Date of interview:	Questionnaire No:
Name of the index child:	Index child's date of birth (verify clinic card):
Name of the mother:	Name of the household head:
Name of the father:	

Questionnaire mother/main caretaker

PERSONAL DETAILS: HOUSEHOLD

No	QUESTION	CODING CATEGORIES
1.	What is the relation of the household head to the index child?	1. □ Mother 2. □ Father 3. □ Grandmother 4. □ Grand father 5. □ Other…….
2.	How many are currently living in the household?	Children under 5:..... Children 5-15: …..... Household size: .....
3.	How many wives does the husband have?	.....
4.	Is the mother of the index child living in the household every day?	1. □ Yes 2. □ No
5.	For how long during the last 12 months has the mother of the index child been away from this household?	…….
6.	Why is the mother not always present in the household?	1. □ Working/ employed in urban area or another country 2. □ Passed away 3. □ Other…….....
7.	Do you receive remittances from the mother?	1. □ Yes 2. □ No
8.	Is the father of the index child living in the household every day?	1. □ Yes 2. □ No
9.	For how long during the last 12	

	months has the father of the index child been away from this household?	…….
10.	Why is he not always present in the household?	1. □ Working/employed in urban area or another country 2. □ Passed away 3. □ Other…….....
11.	Do you receive remittances from him?	1. □ Yes 2. □ No
12.	Who is the main care giver of the child?	1. □ Mother 2. □ Father 3. □ Mother and father 4. □ Other…….....
13.	What is the mother's level of schooling?	1. □ None 2. □ Primary school, not fulfilled 3. □ Primary school 4. □ Secondary school 5. □ Higher secondary 6. □ Intermediate and above
14.	What is the mother's occupation?	1. □ Farmer 2. □ Petty trader 3. □ Paid labour 4. □ Commercial farmer 5. □ Paid professional 6. □ Other……
15.	Do you have any other income generating activities?	1 □ Yes 2 □ No
16.	What are the activities?	1. ..... 2. .....
17.	Is this an everyday activity?	1. Yes 2. No Comment: .....
ECONOMIC INFORMATION: HOUSEHOLD		
18.	What are the main materials of the roof? (observe)	1. □ Thatch/straw 2. □ Finished roof (iron, tin, cement, ceramic) 3. □ Earth/mud 4. □ Other……
19.	How many rooms are there in your household? (excluded toilet)	1. □ 1 room 2. □ 2 rooms 3. □ 3 rooms 4. □ 4 rooms 5. □ 5 rooms 6. □ more than 5 rooms
20.	Do you have animals (domestic)?	1. □ Yes 2. □ No
21.	If yes, how many? (multiple answers)	1 □ Cattles..... 2 □ Sheep.....

		3. □ Goats..... 4. □ Chicken, ducks ..... 5. □ Pigs..... 6. □ Donkey..... 7. □ Others….....
22.	What of the following does your household have? (multiple answers)	1.□ □ Radio 2. □□ Bicycle 3. □□ Motorcycle 4. □□ Wrist watches 5. □□ Buckets 6. □□ Plough 7. □□ Mobile phone 8. □□ Cupboards 9. □□ Sofa/table 10. □□ Chair/table 11. □□ Milling-machine 12. □ Sewing machine 13. □ TV
PREVENTION AND CONTROL OF DISEASE		
23.	Where do you get your main source of drinking water from?	1. □ Tap water 2. □ Borehole 3. □ River/stream 4. □ Spring water 5. □ Rain water 6. □ Other…….....
24.	Has the child been sick for last two weeks?	1. □ Yes 2. □ No
25.	If yes, what type of illness was it? (multiple answers)	1. □ Diarrhoea 2. □ Cough 3. □ Difficult breathing 4. □ Fever 5. □ Skin disease 6. □ Malaria 7. □ Vomiting 8. □ Other…… 9. Don't know
26.	Have the child received vaccination to prevent her/him from getting disease?	1. □ Yes 2. □ No 3. □ Don't know
27.	Do you have a child vaccination card? (observe in clinic card and fill in)	1. □ Yes 2. □ No DPT-HepB (1 2 3) | BCG | Polio (B 1 2 3) | Measles
28.	Did your child receive vitamin A capsule (yellow capsules)	1. □ Yes 2. □ No

<table>
<tr><td></td><td>within the last 6 months ? (children above 6 months)</td><td></td></tr>
<tr><td>29.</td><td>Did the child receive de worming tablet within the last 6 months? (children above 12 months)</td><td>1. □ Yes
2. □ No</td></tr>
<tr><td></td><td colspan="2">CHILD FEEDING / CARE</td></tr>
<tr><td></td><td>Breastfeeding:</td><td></td></tr>
<tr><td>30.</td><td>Has the child ever been breastfed?</td><td>1. □ Yes
2. □ No</td></tr>
<tr><td>31.</td><td>What is the child fed now?</td><td>1. □ Exclusively breastfeed
2. □ Breastfeed plus food/liquid
3. □ Food only</td></tr>
<tr><td>32.</td><td>How long was the child breastfed?</td><td>……</td></tr>
<tr><td>33.</td><td>What was the first type of liquid introduced after birth? (except breast milk)</td><td>……</td></tr>
<tr><td>34.</td><td>When was it introduced?</td><td></td></tr>
<tr><td>35.</td><td>For how long? And then?</td><td>.....……</td></tr>
<tr><td>36.</td><td>What was the first type of food introduced after birth? (except breast milk)</td><td>……</td></tr>
<tr><td>37.</td><td>When was it introduced?</td><td>……</td></tr>
<tr><td></td><td>Child feeding
24 hour recall</td><td></td></tr>
<tr><td>38.</td><td>What did the child eat and drink yesterday? (Ugali, maize/millet, uji, vegetables, meat, fish, fruit, milk, beans….)</td><td>
<table>
<tr><td>Time:</td><td></td></tr>
<tr><td>Morning:</td><td></td></tr>
<tr><td>In between:</td><td></td></tr>
<tr><td>Mid day:</td><td></td></tr>
<tr><td>In</td><td></td></tr>
</table>
</td></tr>
</table>

		between:	
		Evening:	
		In between:	
		Night	
		General	
39.	How many number(s) of feedings do the child receive pr day?	1. □ 1 2. □ 2 3. □ 3 4. □ 4 5. □ 5 6. □ > 5	
40.	Was the number of feedings/meals unusual in anyway?	1. □ Yes 2. □ No	
41.	Was the type of food/drink unusual in anyway?	1. □ Yes 2. □ No	
	If yes, comment.....		
	Responsibility of child:		
42.	When you go for fieldwork, what do you usually do with the child?	1. □ Child comes with me 2. □ Stays at home 3. □ Other…	
43.	Is the child usually fed when you are in the field? (if the child left home)	1. □ Yes 2. □ No 3. □ Other…….	
44.	Who is feeding the child when you are in the field?	1. □ Mother in law/grandmother of the baby 2. □ Father 3. □ Grandfather 4. □ Siblings older than 15 years old 5. □ Siblings younger than 15 years old 6. □ Other women in the village	

		7. □ Other……
45.	During the day in the field, is the child fed? (if child comes with mother)	1. □ Yes 2. □ No 3. □ Occasionally
46.	How?	1. □ Bring food/cook in the field 2. □ Other .....
47.	What type of food do you bring to the field?	.....

HOUSEHOLD FOOD FREQUENCY:

48. How many times in the past month did the household consume the following food items:

Food/Drink item		Answer Code: 1. Everyday, 2 Several times a week, 3, Twice a week, 4. Once a week, 5.Twice a month, 6. Once a month, 7. Never
Porridge/Ugali		
Rice		
Beans, lentils		
Groundnuts		
Maandazi		
Potatoes(sweet potatoes/irish potatoes)		
Green vegetables		
Banana		
Oranges		
Tomatoes		
Onions		
Liver, Kidney, Heart		
Cow meat, Goat meat		
Chicken		
Pork		
Fish		
Dagaa		
Egg		
Milk		
Cooking oil		
Tea		
Soda		
Sugar/Sweets/Honey		
Sugar Cane		
Other..... ...		

	FOOD SECURITY	
49.	What is the main source of food in your household?	1. □ Direct from harvest/ garden 2. □ Purchasing 3. □ Exchange of food for work 4. □ Food aid 5. □ Other……..

50.	If more than one source has been chosen, rank them in order?	First main source…… Second main source……..
51.	What are the crops which you cultivated?	1. Maize 2. Beans 3. Groundnuts 4. Millet 5. Sunflower 6. Wheat 7. Other.....
52.	How many 100kg bags/ 20kgs tins did the household produce of each crop in the last harvest?	1…….. 2……. 3…… 4…….....
53.	How many bags/ tins did you sell of each crops?	1..... 2..... 3..... 4.....
54.	How many 100 kg bags/ 20 kg tins do the household have now in stock of each crop harvested	1…… 2…… 3……. 4……..
55.	Will the food stored be enough until the next harvest?	1. □ Yes 2. □ No
56.	For how long did you stay without maize stock before the last harvest?	.....
57.	For how long did you stay without beans stock before the last harvest?	.....
58.	In the past 12 months did the index child ever eat fewer meals than usual because there wasn't enough food?	1. □ Yes 2. □ No
59.	Which of the following best describes the amount of food eaten in your household in the past 12 months?	1. Have enough to eat 2. Sometimes not have enough to eat 3. Often did not have enough to eat
60.	What do you usually do when facing food shortages? (ex. Doing paid labour, selling etc)	.....

	AGRICULTURE:	
61.	Do you have your own cultivated land?	1. □ Yes 2. □ No

62.	Where do you cultivate?	1. □ Shamba 2. □ Wetland 3. □ Both
63.	Who owns the land?	1. □ Mother 2. □ Father 3. □ Both
64.	What is the size of the shamba you cultivated last harvest?	……
65.	What is the size of the wetland you cultivated last harvest?	……..
66.	For how long did you cultivate wetland?	……

Time Allocation, Division of Labour and Decision Making Power

MOTHER

67. TIME ALLOCATION AND DIVISION OF LABOUR:

Activity/Crop:	**Frequency:** Answer code: 1. Everyday, 2. Several times a week, 3. Twice a week, 4. Once a week 5. Never	**Period:** Answer code: Day/week

Crop: Maize

Land preparation:		
Hoeing		
Ploughing:		
Planting:		
Weeding 1st		
Weeding 2nd		
Harvesting:		

Crop:

Land preparation:		
Hoeing		
Ploughing:		
Planting:		
Weeding:		
Harvesting:		

Crop:

Land preparation:		
Ploughing:		
Hoeing		
Planting:		
Weeding:		
Harvesting:		

Crop:

Land preparation:		
Ploughing:		
Hoeing		
Planting:		
Weeding:		
Harvesting:		

68. Did you do paid labour (last 12 months)?
    Yes, No
69. How often?
    …….
70. Who is responsible for:
    Collecting firewood……..
    Collecting water…….
71. Do you do drink pombe (beer, spirits etc)?
    a)Yes b) No
72. How often?
    a)Everyday b)Several times a week c)Once a week d)Occasionally e)Never

73. DECISION MAKING POWER:

	Activity:	Who decides? 1. Father, 2. Mother, 3. Both
	When to prepare land?	
	What crops to grow?	
	When to plant and when to harvest?	
	When to sell food crop?	
	When to sell vegetable?	
	When to cook and what to eat?	
	To make beer?	
	To buy clothes?	
	To buy food?	
	To buy livestock?	
	Child's medical treatment?	
	Child's schooling?	
	Keep money after selling crops?	
	Keeps money after selling vegetables?	

Questionnaire father

1.	What is the father's level of schooling?	1. □ None 2. □ Primary school, not fulfilled 3. □ Primary school 4. □ Secondary school 5. □ Higher secondary 6. □ Intermediate and above
2.	What is the father's occupation?	1. □ Farmer 2. □ Petty trader 3. □ Paid labour 4. □ Business 5. □ Paid professional 6. □ hand craft 7. □ Other……
3.	Do you have any other income generating activities?	1. □ Yes 2. □ No
4.	What are the activities?	1..... 2.....
5.	Is this an everyday activity?	1. Yes 2. No Comment: .....

6. TIME ALLOCATION AND DIVISION OF LABOUR:

Activity/Crop:	**Frequency:** Answer code: 1. Everyday, 2. Several times a week, 3. Twice a week, 4.Once a week 5. Never,	**Period:** Answer code: Days/week

Crop: Maize

Land preparation:		
Ploughing:		
Hoeing		
Planting:		
Weeding 1st		
Weeding 2nd		
Harvesting:		

Crop:

Land preparation:		
Ploughing:		
hoeing		
Planting:		
Weeding:		
Harvesting:		

Crop:

Land preparation:		
Ploughing:		
Hoeing		
Planting:		
Weeding:		
Harvesting:		

Crop:

Land preparation:		
Ploughing:		
hoeing		
Planting:		
Weeding:		
Harvesting:		

7. Did you do paid labour the last 12 months?
   Yes, No
8. How often?
9. Do you do drink pombe (beer, spirits etc)?
   Yes, No
10. How often?
   Everyday, Several times a week, Once a week, Occasionally, Never

11. DECISION MAKING POWER:

	Activity:	Who decides? 1. Father, 2. Mother, 3. Both
	When to prepare land?	
	What crops to grow?	
	When to plant and when to harvest?	
	When to sell food crop?	
	When to sell vegetable?	
	When to cook and what to eat?	
	To make beer?	
	To buy clothes?	
	To buy food?	
	To buy livestock?	
	Child's medical treatment?	
	Child's schooling?	
	Keep money after selling crops?	
	Keeps money after selling vegetables?	

	ANTHROPOMETRY	
	Age of index child:	.....months
	Weight:	.....kg
	Length:	.....cm
	Length measured lying down or standing up?	1. □ Lying down 2. □ Standing up
	Sex:	1. □ Female 2. □ Male
	Oedema?	1. □ Yes 2. □ No

Appendix 3: Mothers' workload in the field

Mothers' workload in the field				
		Days		
Agricultural activities	n[a]	median	min-max	25-75th perc
Lanclearing	130	7	0-4	6.0-13.7
Planting	139	6	0-36	3.0-12.0
Weeding	137	24	0-120	12.0-36.0
Harvesting	139	9	0-60	6.0-18.0
Crops				
Maize	140	41	5-134	24.0-57.0
Beans	45	6	1-36	2.0-13.0
Groundnuts	30	21	3-52	12.0-28.3
Millet	18	25	1-91	18.5-44.5
Sunflower	22	17	2-42	12.8-26.5

[a] Number of women which performed in agricultural activities and crops. Wheat excluded.

Appendix 4: Variables not included in the final models, in linear regression analyses

Variables that did not meet the criteria ($p<0.15$) in univariate analyses (both HAZ and WAZ):

Child gender (0=boy, 1=girl), household head (0=father, 1=other), number of wives (0=1, 1=≥2), size of household (dummy, ≤ 5 people, 6 people, ≥7 people), children < 5 years in the household (0=1, 1=≥2), mother education (0=no education and primary school not finished 1=primary school finished and above), father education (0=no education and primary school not finished 1=primary school finished and above), father main occupation (0=farmer, 1=other), mother other income generating activities (0=no, 1= yes), asset score (low, middle, high), number of cows (0=0 cow, 1=≥1 cow), type of roof (0=thatch, 1=iron sheets), father pombe (0=≥several times a week, 1=<several times a week), mother pombe (0=>never, 1=never), size of shamba cultivated last season (dummy, ≤0.80, 0.81-1.60, ≥1.61).

Variables that did not meet the criteria ($p<0.15$) in univariate analyses for WAZ only:
Women workload (dummy, ≤38 days, 39-66, ≥67 days).

Variables that did not meet the criteria ($p<0.15$) in univariate analyses for HAZ only:
Food in stock (0=0months without food in stock, 1= ≥1 month without food in stock), father other income generating activities (0=no, 1= yes), number of children <16 in the households (dummy) (≤3 children, 4 children, ≥5 children), disease (0=disease, 1= no disease), dry season cultivation (0=no, 1=yes).